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Reconstitution of the University of London.

THE Government has redeemed its pledge to introduce legislation "to make further provision for the University of London." The University of London Bill, which, on the motion of the Earl of Balfour, was accorded its second reading in the House of Lords on June 29, proposes to appoint eight commissioners with plenary powers to draft statutes for the University "in general accordance" with the recommendations contained in the Report of the Departmental Committee of the Board of Education appointed by Mr. Trevelyan in 1924, subject to any modifications which may appear to them to be expedient. Thus the procedure is assimilated to that adopted in the recent reconstitution of the Universities of Oxford and Cambridge. There are, however, important differences between the two cases. Whereas the reconstitution of the ancient universities was based on the recommendations of a Royal Commission of great authority, presided over by Mr. Asquith (now Lord Oxford) — recommendations which were unanimous save for some relatively unimportant reservations by individual members—the proposed reconstitution of the University of London is to be based, not on the recommendations of the Royal Commission, generally known as the Haldane Commission, which reported in 1913, but on the recommendations of a Departmental Committee of the Board of Education. Conditions, it is true, have changed since the Haldane Commission reported. The reception accorded to the Departmental Committee's report has been comparatively friendly, but it cannot be overlooked that the constitution proposed by the Committee differs essentially from that suggested by the Royal Commission.

Another difference relates to the historical development of the universities in question. Broadly speaking, Oxford and Cambridge have retained their traditional constitutions, based on the University of Paris. They remain corporations governed by their graduate members. Certain internal reforms, such as the abolition of the celibacy of college fellows, have been effected by the pressure of public opinion. But external control in any form has always been resisted, notwithstanding acceptance of generous financial aid from the Government. The presence of outside representatives on the Council, the Royal Commission reported in 1922, "would hamper the Council in its work without securing as a rule any compensating advantage"; and the objection to representatives nominated by the Government appeared to the Commission "particularly strong."

The University of London was established by Royal Charter in 1836 with a Senate nominated by the Government to administer its educational affairs, the Government retaining full financial control. It was not until

1858 that the graduates secured a share in the administration of the University, when the privilege of nominating for a limited number of seats on the Senate was conceded to Convocation under a new charter. Forty years later the teachers of the colleges and medical schools in London were accorded a similar privilege, the Act of 1898 reconstituting the University as a teaching university. The reconstitution now under discussion in Parliament derives its motive force from the demand of the Government, voiced by the University Grants Committee, for an improved financial and executive control.

The schedule of the University of London Act of 1898 gave to the Commissioners named in the Act detailed directions for the constitution of the Senate. It enforced the 'advisory' character of its chief councils, provided safeguards for religious and sex equality, prescribed the radius for the recognition by the University of public educational constitutions, insisted that the internal and external degrees of the University should represent "as far as possible the same standard of knowledge and attainment," and gave instructions on several other matters. These provisions were fully discussed by Parliament. If the present Bill passes, Parliament will abrogate its right to discuss the details of academic organisation, reserving only the right to reject statutes. Government of a university by statutes without rigid and permanent directions from Parliament offers certain obvious advantages, provided fundamentals are safeguarded. Statutes can be amended to meet changing conditions without cumbersome Parliamentary procedure. Under the present Bill, statutes for the University can be altered or supplemented by the University, except statutes, if any, that the Commissioners may consider ought not to be altered by the University. The Bill directs the Commissioners, before adopting statutes, to receive representations "by or on behalf of the Senate or Convocation or any fifty graduates of the University, or by or on behalf of any other bodies or persons appearing to the Commissioners to be directly affected by the proposed statute"; and there are the usual provisions for the approval of statutes by the Privy Council. Thus the arrangements for publicity and for preliminary discussion by those specially qualified are adequate.

This is not the occasion for a detailed discussion of the recommendations of the Departmental Committee, either at large or in relation to the promotion of scientific education and research. Controversy has so far centred—as was to be expected—round the status and powers of the proposed Council which is to be given financial and executive control. This reform is fundamental; but the question of the relation of the Council to the Senate, the body responsible for educational policy, will have to be closely examined by the Commissioners. Presumably all the proposed Commissioners are already in agreement as to the creation of the Council. On other matters, the Commissioners can adopt modifications of the Departmental Committee's recommendations, and no doubt many suggestions will be forthcoming in due course in regard to such matters as the number and mode of election of heads of colleges as members of the Senate, the devising of some method more dignified than co-option of appointing a number of members of the Senate as independent experts or on grounds of services rendered to the University—the elder statesmen or aldermen of the University—and the appointment of the Principal as a member of Senate and Council *ex officio*. Statutes should also authorise the payment of fees to members of the Council, thus emphasising the serious nature of their duties and the demands on their time and energy.

The important question of the relation of the University to its affiliated colleges is a matter which will be within the competence of the Commissioners, who may make statutes for the colleges, subject to the consent of the respective governing bodies. Their powers appear to extend to the incorporation or disincorporation of colleges in the University, a subject of acute controversy within the University. Under the present statutes, colleges were affiliated to the University without any clearly defined privileges and obligations, and it will be of great advantage both to the University and to its colleges if their relations are placed on a firmer basis.

The personnel of the Commissioners has been selected with care and judgment. The chairman, Mr. Justice Tomlin, will ensure judicial treatment of the questions to be considered. Two graduates of the University, Sir Josiah Stamp and Prof. T. P. Nunn, and the present Principal Officer, Sir Cooper Perry, who will retire from his University office shortly, may be deemed to represent the University. The point of view of the Board of Education and the London County Council will be represented by Sir Amherst Selby-Bigge, the late Secretary of the Board, and Sir Cyril Cobb respectively. Oxford contributes a representative in the Master of Balliol (Dr. A. D. Lindsay), and the special interests of women will find a natural protector in Miss Philpotts.

Past history has shown that the University of London through its graduates can exercise powerful political influence. Will that influence be used on the present occasion against the Bill? Convocation, at a sparsely attended meeting held during the strike, adopted three resolutions declaring that the creation of a Council to control the finances of the University would have

"prejudicial effects upon the University"; that the reconstitution of the Senate in accordance with the recommendation of the Departmental Commission would be "a grave error"; and, finally, strongly deprecated the setting up of a Statutory Commission. The Senate has adopted a resolution declaring its opinion that as regards the relative positions of the Council and the Senate, the scheme proposed by the Majority Report of the Departmental Committee should be rejected on the ground that it will be found to be unworkable in practice, that it will deprive the truly representative body (the Senate) of all effective control, that it will not clear the body charged with control of finance from any possible imputation of partiality; and finally, that it will complicate further the already too complicated machinery of the University. The Senate further offered to submit a scheme of agreed reforms. The inference to be drawn from this resolution is that the Senate would prefer that the Council, if created, should have the status of a statutory finance committee.

One final suggestion. Would it not be well for the Government to make some announcement as regards increased financial aid for the work of the University, if and when reconstituted? The great developments in university education, which London, as the capital of the Empire, urgently needs, cannot be accomplished, however perfect a constitution may be provided by the authority of the Government, unless the money is forthcoming. The University may reasonably expect the Government, which has shown so much solicitude for its spiritual welfare, to contribute generously to its material needs. T. LL. HUMBERSTONE.

Eugenic Reform.

The Need for Eugenic Reform. By Leonard Darwin. Pp. xvii + 529. (London: John Murray, 1926.) 12*s*. net.

THIS is in every respect a notable book by a most distinguished author. Major Darwin has now for fifteen years occupied the presidential chair in the Eugenics Education Society, and comparatively few realise the services which he has rendered towards making clear the social implications of the results of the scientific study of heredity. The word 'Eugenics' signifying 'the study of the agencies under human control by which the human stock can be improved' was coined by Galton, as most people know. Most are also aware that it was associated in the public mind with a number of fantastic projects for the compulsory mating of specially selected specimens of opposite sexes in order to improve the race. For this conception of the subject Galton is directly responsible; it has led to eugenists being regarded as a collection of faddists, and has drawn on to the whole subject the sharpest shafts of ridicule and sarcasm. G. K. Chesterton has said of eugenic reform that it could be imposed only on slaves and cowards, and it is, no doubt, of 'Galtonian' reforms that he was thinking when he made this statement.

The present reviewer is forced to confess that he formerly shared the common attitude towards the subject, an attitude which, as he must regretfully admit, is still maintained by some of his most admired scientific friends. It was in 1913, when he had the good fortune to listen for the first time to a presidential address by Major Darwin, that the reviewer first saw that a wholly different interpretation could be given to eugenic reform, an interpretation calculated to appeal strongly to the common sense of all who take the trouble to give their attention to the subject. This interpretation, which, though theoretically admitted, was not regarded as of practical importance in comfortable Edwardian days, is now forcing itself on the attention of every one who has to deal with social affairs. Major Darwin pointed out that, if we went on fostering the unrestricted multiplication of the least competent members of the nation by continually increasing doles extracted from the pockets of the more competent and therefore well-to-do, we should inevitably lower the quality of the race. It is a sinister portent that the large families which were reared in our rectories and in the manses of Scotland in Victorian days, from which we gathered so many distinguished and able men, have disappeared, whilst there is no serious diminution in the offspring of our dock labourers and unskilled workers. Major Darwin's conception of eugenics was essentially the extension of his father's doctrine of natural selection to human affairs.

The book which we are considering opens with a biological introduction which deals with the Mendelian theory of heredity and discusses the inheritance of acquired qualities and the Lamarckian theory of evolution. This part is by far the weakest section of the book, for Major Darwin labours under the disadvantage of not being a biologist, and this disadvantage is increased by the fact that, as he admits in the preface, he has relied for assistance and advice mainly on Mr. R. A. Fisher and Mr. C. B. S. Hodson. Of these the first is a mathematician, and the second name is obviously a slip for Mrs. Hodson, the respected assistant secretary of the Eugenics Education Society, who undoubtedly has had some training in biology, but is scarcely fitted to give serious criticism in this subject.

Major Darwin accepts the extreme Mendelian view, namely, that the whole force of heredity in any individual is capable of being analysed into a series of units or 'genes,' and that a chance assortment of 'genes' is

handed on by the parent to his children. This view, which has been rejected by many biologists with a really wide outlook on the science, including systematists, embryologists, and palæontologists, leads, if logically pressed, to impossible and absurd conclusions. The innate common sense of Major Darwin leads him to see this: he plaintively confesses that if genes are unalterable he cannot see how evolution can ever have taken place, for all the genes which make up human heredity must have been present in the original amœba. It may be added that the 'factorial analysis' of heredity adds nothing to our knowledge of the subject: the 'genes' or 'factors' are purely imaginary units, and the number is continually added to as Nature shows herself unwilling to be compressed within mathematical formulæ. As the author naïvely confesses, it is impossible to devise means of analysing human capacities into genes, and eugenic reform cannot wait whilst the attempt is made; therefore Mendelism is of service to eugenics chiefly by fostering belief that heredity is not a haphazard thing but follows fixed rules. But this belief is far older than Mendelism; no farmer, nor even any common-sense observer of human affairs, needed Mendel to teach him this; it is expressed in unequivocal language by the Founder of Christianity himself: "neither can a corrupt tree bring forth good fruit."

Major Darwin is no happier in his criticisms of Lamarckism. He points out that there are certain qualities which he does not think could have been 'acquired' in this sense by animals; as, for example, the protective resemblance shown by the plumage of a bird. How, he asks, could the bird know when its plumage assimilated with its surroundings? Well, we do not know how a bird would react to changed surroundings, but we do know that many reptiles, amphibia, and fishes can and do control their colour so as to make it match their environment, and that this control is exercised through the eye. If Major Darwin will keep a common frog in a dark tank he will find that it soon assumes a very dark brown tint. If it is now removed to a white porcelain dish it will in half an hour assume a light straw-coloured tint. If, however, the optic nerves of the dark frog are severed, it will remain dark on the whitest porcelain. What goes on in the mind of the frog, what it feels or thinks, neither Major Darwin nor any one else knows.

Then Major Darwin says that whilst doubtless a muscle increases in size with use, Lamarckians have never explained how this power was 'acquired.' On this subject it is necessary to speak firmly and decisively. Neither Lamarck nor any other competent biologist has ever advanced a theory to explain how living beings could develop out of dead matter. The fundamental properties of life are as clearly manifested in amœba as in man; every faculty shown in the higher forms of life is present in the simplest form in germ—*ex nihilo nihil fit*. These properties are the presupposition of every valid theory of evolution. This was clearly seen and expressed by no less a person than Alfred Russel Wallace. The author's third objection that Lamarckian change, if it really occurs (and his father admitted that it did), is extremely slow in its action and can therefore be left out of account in considering eugenic measures, has a considerable measure of truth in it; yet even here a *caveat* must be entered. It is not the case that "millions of years" are needed to effect any noticeable change. It is not "millions of years" since palæanthropic man ranged over Europe, and yet since that time we have acquired straight backs and thighs. The Lamarckian view is that evolution is due to changes of habits (in Lamarck's phrase, the effort to satisfy new needs awakened by new surroundings), and that these habits induce changes in structure which are passed on to the next generation. The first stage in this transmission consists merely in a quickened response to the same stimulus which induced the corresponding change in the parent. It is only after a long time that the change becomes so engrained in the constitution that it appears without the stimulus at all. Baron Nopčsa, in a recent brilliant address to the London Zoological Society, pointed out that in the adaptations which fit the human leg to maintain the upright position both stages can be found. The thickened pad on the sole of the foot appears whilst the embryo is in the womb, but the change in the ankle-joint only appears after walking has begun, and fails utterly to appear if the foot for any reason is not used. It is quite probable that good education—the development of the brain by mental exercise, not the cramming of it with facts—does leave in the progeny of the educated an increased capacity to learn.

Besides Lamarckian adaptation, however, which being an epitome of the past history of the species, accounts for the racial differences which divide mankind, there is another kind of variation prominent amongst our domestic animals which also occurs largely amongst civilised city-dwellers, who, like the denizens of the farmyard, are domesticated. This is a weakening of developmental energy caused by bad conditions surrounding the germ in its earliest period of growth. This weakening produces a disharmony in growth which results in weird structural aberrations, and once produced it is handed on to subsequent generations and produces the same result in the progeny as in the parents. To this cause not only the 'fancy' character of our domestic breeds but such pathological aberrants as epileptics and mental defectives owe their origin. Nevertheless, if such individuals are transferred to

healthy natural surroundings *and left to support themselves by their own efforts*, this plasma-weakness gradually passes off and the natural structure is regained. A beautiful example of this reversion can be seen every day in London; and it is one which seems to have been going only for forty or fifty years, since it is never mentioned in the works of Charles Darwin, and it would have greatly interested him had he seen it. As all know, pigeons originally escaped from dove-cotes have multiplied all over London and maintain themselves in our squares, no doubt in the innocence of their hearts mistaking our tall London houses for their ancestral cliffs. A large proportion of these pigeons are assuming the plumage and shape of the wild rock pigeon, yet this is certainly not due to crossing, for the wild progenitor is now an exceedingly rare bird and is in fact almost extinct. So the emigration of a city-stunted population to Australia, if they were not coddled but left to their own efforts, might in time give rise to a population of respectable physique.

The author, as in filial duty bound, attaches great importance to natural selection—and so do we. If advance is the result of energy and vigorous striving, a race will progress only as the weak and lazy are eliminated or, at any rate, prevented from procreating progeny—and in this lies the central core of all Major Darwin's proposals. He points out the disastrous effects of public assistance; the class assisted does not increase in its efforts at self-maintenance, but depends more and more on doles; and it increases in fertility whilst the class from whom assistance is drawn diminishes in numbers. He then considers how the elimination of the less worthy class might be promoted. He considers, and rightly so, that parenthood should be prevented in the case of all certifiable as mentally defective. This could be accomplished if lifelong segregation were instituted with the acceptance of voluntary sterilisation and freedom as an alternative. He thinks that parenthood should be prohibited even in cases where the mental defect is held to be due to 'environmental factors,' since even if such parents would not hand on the defect to their children—and we consider it very probable that they would do so—they are quite unfit to give parental care and good upbringing. Major Darwin discusses the objections to sterilisation which are both futile and sentimental. It is objected that sterilised individuals would feel free to adopt an immoral life. This, we might rejoin, is not our business: they are in no way forced to do so, and even if they did, this would be a very much lesser evil than the contamination of the next generation by them. After all, people who now desire an immoral life are deterred not by the fear of illegitimate offspring, but the dread of venereal disease; yet that is no argument against stamping out that disease if we can. The author would further sterilise or segregate the habitual criminal, and when hard necessity has made us shed some of our sentimentalism we shall agree with him. As he remarks, 120,000 new recruits join the ranks of labour every year, and yet it seems probable that our trade will never rise to its pre-War level, so that some regulation of population is an absolute necessity.

This necessity, it seems to us, can only be met by birth-control; that is, limitation of size of family. Here, however, the author shows himself fussy: he is afraid that contraceptive measures in certain circumstances might do harm. The answer to this is that since contraceptive practices are widespread amongst the more intelligent members of the community, to extend the knowledge of them amongst the class that is multiplying too quickly can do no harm. Of course, as Major Darwin sees, this would leave the utterly reckless class uninfluenced. So the right of any one to have children whom he cannot support must be challenged sooner or later, and the ultimate remedy for that is the threat of sterilisation if the family is added to. It seems to us that another remedy not envisaged by the author would be to treat all public assistance as a loan which must be repaid before the beneficiary is allowed to vote.

Major Darwin then goes on to discuss mate-selection, divorce, and kindred matters. On the question of divorce he is stern and conservative. Like all eugenists, he considers marriage as an institution mainly for the purpose of the next generation and family life as indispensable, and this life would inevitably be destroyed by easy divorce. As to mate-selection, no doubt prudence should be exercised in selecting a wife, both with regard to health and character, but as the author truly remarks, love laughs at locksmiths, and once passion is aroused, prudence is apt to be thrown to the winds. Hence, where care ought to be exercised is in the quality of the opposite sex with which our children are familiarised during their young and formative years, for this quality will create the ideals which will arouse passion later on.

The conclusion of the volume is naïve and surprising. The author having come to the conclusion that 'science,' as he conceives it, leads to a mechanical conception of the universe and causes him to regard his fellow-being as an automaton, and as therefore having no individual rights as compared with the welfare of the race, yet finds, when he looks within, that he is a being with a free-will; and so he rejects the conclusions to which 'science' leads him. This he regards as an antinomy which he is powerless to resolve. It might perhaps have induced him to inquire whether the postulates of his 'science' were not doubtful; whether, in fact, we

really can begin with 'matter' and its laws, when matter, as Huxley admitted, is inconceivable except as presented to a conscious mind; and whether therefore Lamarckian evolution, which assumes that in animals, as in us, there is something that feels, strives, learns, and remembers and transmits its memories in part to its offspring, is not preferable to the view that animals owe their origin to a series of 'chance' variations that have accidentally come to pass. We think that the author would get some light on his difficulties if he were to study the "Psychological Principles" of Ward and "L'Évolution créatrice" of Bergson. E. W. M.

Modern Physics in Chemistry.

Fundamentals of Physical Chemistry: for Students of Chemistry and related Sciences. By Prof. Arnold Eucken. Translated and adapted from the second German edition by Dr. Eric R. Jette and Prof. Victor K. Lamer. (International Chemical Series.) Pp. xxiii+699. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 27*s.* 6*d.* net.

THE translators of Prof. Eucken's text-book observe that there appeared to be room for a book in which kinetic theory, thermodynamics and quantum theory, each discussed on the basis of experimental facts, are considered of equal importance for the development of the subject. Kinetic theory and thermodynamics have long formed part of the studies of chemical students, and there can be little doubt that a really practical working knowledge of physical chemistry must include them, but the quantum theory is relatively new and has not yet in all cases received adequate treatment from the point of view of the student of chemistry. In its mathematical aspects it has formed the subject matter of several important treatises, but these are for the most part addressed to students of physics and have a very limited appeal to chemists. It must therefore be admitted that a treatment in which these three components of modern physical chemistry are considered in a connected manner, and especially in close relation to experiment, is very desirable, and an examination of Prof. Eucken's book shows that he has been very successful in presenting the material in a form suitable for students of chemistry.

It is clear at the outset that in such a presentation an adequate knowledge of mathematics is essential, and as the author remarks in his preface, a practical acquaintance with the subject is only possible on a mathematical foundation. For this reason, whilst the book will be stimulating and valuable to those students who are equipped with the small amount of higher mathematics necessary (the outlines of which are given in the first part of the book), it will be of very limited use to those not so equipped. Students who merely wish to attain to a smattering of the subject, based on vague and often unsuitable analogies, are not considered, and indeed in these days need scarcely be considered by any author of a book which attempts to go beyond the very elements of the subject. At the same time, it must be admitted that an attempt to make the whole treatment logical has resulted in some cases in a rather more difficult style of mathematical deduction than is necessary. For example, the theory of concentration cells and of ionic transport in electrolysis may be treated without first making use of the general equations for transport, based on the theory of diffusion; and there can be no doubt that students coming to the subject for the first time would obtain much clearer ideas and would feel much less difficulty than can be the case when the general method is put into application forthwith. The same remark applies to many other parts of the book, and on the whole it may perhaps be considered more suitable for students who have already an elementary knowledge of most of the subjects dealt with.

The book is divided into two main sections, the first called "Thermodynamics" (divided into physical thermodynamics and chemical thermodynamics), and the second "The Structure of Matter." In the first part, however, is included the classical kinetic theory, and the abundant use made of kinetic ideas and equations is one of the best features of the treatment. One might perhaps criticise the way in which the fundamental equation of the Second Law of Thermodynamics is first introduced on p. 50 in an equation (No. 49), which is made to appear as if it followed in some way from the preceding argument, whereas it is not really deduced until much later, and then on the basis of the properties of ideal gases. In this section the common error of deducing the equation for the adiabatic expansion of gases without pointing out that the specific heat is tacitly assumed to be constant is made (p. 83), in spite of the fact that the variation of specific heats with temperature is fully considered in another place.

The section on the theory of solution has been completely rewritten by the translators in the light of the conception of activity, and it forms a useful and brief summary of this method of treatment. The new theory of Debye and Hückel is also included, and a praiseworthy attempt is made to exhibit the fundamental assumptions and the method of calculation without reproducing the rather long and difficult details of the actual calculations. It is shown that the theory in its simplest form, *i.e.* when the ions are assumed to be point charges, fails to account for the experimental facts, but the further very valuable result emerges that,

even when the correction for the sizes of the ions is fully applied, the theory still fails to reproduce the facts. A further correction term, depending on the actual structure of the ions and the deformability of the external electronic orbits, can at present be applied only in a semi-quantitative form, and it is clear that the problem, as in the case of all those in which the structure of molecules appears, becomes extremely complex. It is further shown that the theory is at present unable to distinguish between complex ion formation (as is commonly assumed in the case of cyanides and silver, for example) and the specific interaction of ions. Thus, the effect of a cyanide on the solubility of silver cyanide is treated in the same way as the effect of hydrochloric acid on the solubility of sodium chloride. It is clear that, although progress has been made in this perplexing region, there are still formidable difficulties to be overcome.

The section on the structure of matter follows the usual lines. The proof that the experiments which seemed to point to the existence of sub-electrons are vitiated by incorrect assumptions as to the structure of the particles, as was supposed by Millikan, probably came too late for inclusion in the book, but the fact that Aston's whole number rule is not always true, and cannot be regarded as a law of Nature, might have been mentioned. The Bohr atom is made the basis of the whole discussion, although static models are used in the consideration of Born's calculations of heats of formation, etc. The quantum theory of the atom is given in more detail than is usual in books intended for chemical students, but the calculations are omitted in difficult cases and the results only stated. It is quite clear from the whole of this section that, apart from the spectroscopy of some simple atoms, the theory is still too complicated to yield information of much real value to chemists, since in the case of more complex atoms the results are still more or less qualitative. The theory of spectra, however, is of direct interest to chemists, and if the considerations put forward in this section do no more than indicate that the theoretical basis of much speculation on absorption spectra is fallacious, they will serve their part. The real significance of the quantum orbits, as distinguished from the old idea of vibrating electrons, is quite satisfactorily explained.

The translation leaves much to be desired. In many cases the exact opposite of the German meaning has emerged, in some cases owing to the translation of "noch" as "not"; in other cases lack of knowledge of facts has led to such errors as the translation of "Kohlenoxydknallgas" as "an absolutely dry mixture of the gases CO, H_2 and O_2," which, it is stated, will not explode! The technical meanings of many German words are apparently unknown to the translators, who have rendered "Energieverteilungsgesetz," for example, as "the equilibrium law" (p. 73); they usually translate "darf" as "dare," and so on. As an example of the faulty translation, the following, selected from numerous cases, may serve. On p. 112, in discussing the quantum theory of specific heats, they say: "The failure of the classical theory obviously dates from the day when heat energy was added to a system consisting of a diamond crystal at 20° abs. in an atmosphere of hydrogen or helium, and it was found that this energy was absorbed only by the gas molecules." The German text (p. 92), however, reads: "Das Versagen der klassischen Theorie tritt handgreiflich zu Tage, wenn man sich bei etwa 20° abs. einen Diamantkristall in einer Wasserstoff- oder Heliumatmosphäre vorstellt: Führt man dem System Wärmenergie zu, so wird diesselbe nur von den Gasmolekeln aufgenommen." Incorrect translations in very many cases make the text completely obscure if not even incorrect, and it is difficult to understand how the translators could have failed to perceive that in many cases their rendering is meaningless. A list of errors has been forwarded to the translators.

J. R. P.

The Biology of Lepidoptera.

Biologie der Schmetterlinge. Von Dr. Martin Hering. (Biologische Studienbücher, 3.) Pp. vi+480+13 Tafeln. (Berlin: Julius Springer, 1926.) 18 gold marks.

NO scientific book has appeared hitherto that deals adequately with the many biological problems that are exemplified in Lepidoptera. These insects have so long proved a convenient source of material for fundamental research that a comprehensive work, bringing together accumulated knowledge in an accessible form, should appeal to a wide circle of zoologists. This want has now been met to a large extent by the admirable volume by Dr. Martin Hering, of the museum of zoology of the University of Berlin, which is now before us. His treatise surveys a breadth of field unexcelled by previous writers on these insects and is a storehouse of information relative to most phases of their biology. Throughout the book he discusses the principles underlying the phenomena described and, although his theoretical conclusions may not always seem to be sufficiently supported by facts, his original viewpoint is particularly stimulating.

In his general introduction, Dr. Hering divides the order into two main groups depending largely upon the presence or absence of the anal vein (Cu_2 in the most recent interpretation), and in this scheme, it may be added, the Hesperiidæ are relegated to a position intermediate between the higher and lower families

of the order. The first main section of the book is devoted to ontogeny, or individual development, from fertilisation of the egg to the eclosion of the imago. With regard to oviposition certain remarkable facts are alluded to. It appears that *Polyommatus rutilis* consistently lays its eggs in pairs, one egg of the pair producing a male and the other a female. There appears, furthermore, to be an alternation of male- and female-producing eggs in the ovarioles. With regard to *Papilio memnon*, some of the eggs are laid in pairs and others singly; the eggs in pairs produce male insects, while the isolated eggs give rise to females. In discussing parthenogenesis, the Psychid moth *Solenobia triquetrella* F. is mentioned as reproducing by this method in northern Germany, while in the southern form of this species fertilisation is the invariable rule.

The second section is concerned with the life of the imago. A very full account is given of the significance and distribution of the various types of scent scales and tufts that are so frequent among Lepidoptera. Some reference is also made to the presumed chemical nature of the odours produced. Senses and tropisms are likewise discussed at length, and there is a useful summary of what is known concerning the tympanal organ, mainly through the work of Eggers.

The third section, which extends to more than 240 pages, will commend itself to the general biologist. Here the author elaborates his views on geographical distribution, dimorphism, coloration, mimicry, etc. Certain of the conclusions that are arrived at are not convincing, such as the following. Large-sized species are more generalised than small-sized; the spring generation of seasonally dimorphic forms is more primitive than the summer brood; the lengthier the feeding period of larvæ and the shorter the pupal instar is an indication of primitiveness. With reference to the significance of colour patterns the classification of Heikertinger is followed, and we note in the discussion on mimicry there appears to be no mention of the name of Poulton.

The long chapter on leaf- and other miners is particularly good, and the author adopts a convenient terminology indicative of the different kinds of mines produced. The relations of Lepidoptera to ants and termites likewise form the subject of a separate chapter, and in this connexion the absence of any reference to the remarkable Lycænid *Liphyra brassolis* is unexpected. Further on in the book coloration is dealt with, both from its environmental and experimental aspects, while hermaphroditism, intersexuality, hybridism, all come in for discussion, along with other subjects too numerous for separate mention.

The bibliography at the end of the volume is intentionally restricted but it is too short to be an adequate guide to the literature. We miss reference to a number of leading authorities through the book, while many authors are quoted with no indication other than the date as to where their work is published. In whatever features one may disagree, however, they are insufficient to obscure the outstanding merit of the book.

A. D. IMMS.

Our Bookshelf.

Practical Hints to Scientific Travellers. Edited by Prof. H. A. Brouwer. Vol. 1. Second, revised edition. Pp. v+122+9 plates. Vol. 2. Second, revised edition. Pp. v + 150 + 7 plates. Vol. 3. Pp. v + 185 + 6 plates. (The Hague: Martinus Nijhoff, 1925.) 5 guilders (8*s*. 6*d*.) per volume.

THE object of this work is explained by its title. It consists of a series of independent articles, each dealing with a more or less remote portion of the earth, and written by a man with years of field experience in that particular region. The contributors include representatives of several nations; most of them are well-known geologists, whose names are sufficient guarantee that full reliance can be placed on the advice that they give. All except two of the articles are in English; those two, on Indo-China and Morocco, being in French.

Of the three volumes now to hand (the first two of which are in their second edition), vol. 1 deals with the East Indies and South and East Africa; vol. 2 with various Arctic countries, and with Turkestan; and vol. 3 with Mexico, Indo-China, India, New Zealand, New Guinea, and Morocco. In some of the articles the treatment is much more detailed than in others, but from most of them information on the following subjects is obtainable: preliminary studies and arrangements, climate, means of transport, appropriate equipment, native servants, food-supply, and medical care. Various hints are given concerning the etiquette and idiosyncrasies of the native inhabitants, upon whose attitude the smooth running of expeditions in many lands will largely depend.

Any one about to visit one of the regions here dealt with on a survey or other scientific expedition can be recommended in all confidence both to study this work as a preliminary and to take it with him. He will not fail to derive many useful hints from a perusal, not only of the article relating to the particular country he is visiting, but also of those dealing with other comparable lands.

A Synopsis of the Families and Genera of Nematoda. By Dr. H. A. Baylis and R. Daubney. Pp. xxxvi+277. (London: The British Museum, 1926.) 10*s*. 6*d*.

THE Nematoda as a zoological division contains free-living as well as parasitic forms, and the number of the former is probably as great as, if not greater than, that of the latter. Yet the study of the parasitic forms, owing to their growing interest in relation to disease, has become more and more divorced from that of the free-living. The authors regard this growing separation

as indefensible and they have incorporated both groups in one system of classification. However sound this may be in theory, the result as shown in this volume is somewhat incongruous. The Nematoda are assembled into five orders in all, and the whole of the vast and varied assortment of free-living worms is included with Ascaris and Oxyuris in the single order Ascaroidea.

Apart from questions of classification, however, upon which there is much present-day difference of opinion, the work will prove a trustworthy and succinct guide to the various genera of roundworms together with the habitat usually taken up by the species of each genus and the name of its typical species or genotype. Under each genus is listed the papers most useful for reference. The general arrangement of the volume is admirable and should form a boon to the specialist; as, however, it does not list species, its use to the general reader is unfortunately limited. The year 1923 has been chosen as the closing date for the admission of new genera to the volume, and although a few names made since that date have been included, these are limited to synonyms of earlier genera or to new names to replace those already preoccupied.

The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur E. Shipley. (Published under the Authority of the Secretary of State for India in Council.) Birds. Vol. 3. Second edition. By E. C. Stuart Baker. Pp. xx+489+7 plates. (London: Taylor and Francis, 1926.) 30*s.* net.

WITH the publication of this volume, which, like its two predecessors, deals solely with the Passeres, the author has brought to a conclusion his work on that great order of birds. In the three volumes issued up to date, 1336 species and subspecies have been recognised. In the first edition of the Avifauna, the Passeres were dealt with in two volumes, and the number of species then acknowledged was 936. The advance of ornithology has therefore given Mr. Stuart Baker much more ground to cover, largely owing to the necessity for his dealing with the numerous racial forms which have of late years been described.

The high standard set in the first two volumes has been fully maintained in the present one, which, in addition to numerous woodcuts, contains seven coloured plates by the author, that of the Zosterops being particularly pleasing.

The map of India which accompanies the volume would have been more instructive had the topographical features of the country been more clearly shown. The account of the birds of British India will probably be completed in three additional volumes.

The Statesman's Year Book: Statistical and Historical Annual of the States of the World for the Year 1926. Edited by Sir John Scott Keltie and Dr. M. Epstein. Sixty-third Annual Publication, revised after Official Returns. Pp. xxxvi+1496. (London: Macmillan and Co., Ltd., 1926.) 20*s.* net.

EACH issue of this work of reference adds new features without sacrificing the old. The arrangement of countries remains the same, except that the kingdom of Hejaz has lost its place among the independent states. It is in regard to India that the principal changes occur. That section of the book has been expanded from forty-four to sixty pages, the increased space being devoted to the provinces of British India and the independent states over which the Indian Government exercises certain control. Each of these entities is now treated in the same way as the provinces of other parts of the Empire. Among the introductory matter, which includes a section on the League of Nations, new features are sections on the International Institute of Agriculture, a list of European and North African air routes, and tables showing taxation, national debt charges, and paper currency of various countries. The coloured maps are two, showing the distribution of republics and other political divisions in the Soviet areas in Europe and Asia. In spite of additions the bulk of the volume is not increased.

A Report on the Sugar Cane Mosaic Situation in February, 1924, at Soledad, Cuba. By Prof. Edward M. East and Prof. William H. Weston, Jr. (Contributions from the Harvard Institute for Tropical Biology and Medicine, 1.) Pp. vi+52+9 plates. (Cambridge, Mass.: Harvard University Press; London: Oxford University Press, 1925.) 8*s.* 6*d.* net.

IN this, the first of a new series of publications from Harvard University devoted to tropical biology and medicine, an account is given of the mosaic disease of sugar-cane as seen by the authors on the Soledad estate, Cuba. The disease is thought to be of long standing in Cuba (unlike most of the British West Indies), but, at Soledad, it is not appreciably reducing the yield and quality of the Crystalina cane ordinarily grown in the island. The extensive bibliography, and the plates (some in colour) showing mosaic and certain other types of chlorosis in sugar-cane and maize, are useful features of the book.

Geography in School. By James Fairgrieve. Pp. x+364. (London: University of London Press, Ltd., 1926.) 7*s.* 6*d.* net.

THERE is little that is new in this book, but there is nothing that is not said in an interesting way. Every thoughtful teacher of geography has faced the problems which the author discusses in the light of his long experience of school work, and no teacher could fail to derive something of value from what Mr. Fairgrieve has to say. Especially valuable is his insistence on reality in geography and his warnings of misunderstandings that are liable to be caused by the necessarily small scale of so many maps and the lack of personal knowledge of the world of most teachers. The book has a useful bibliography and full index.

Pression de la lumière. Par Pierre Lebedef. Traduit du russe par T. Kousmine. (Collection de monographies scientifiques étrangères, No. 9.) Pp. 71. (Paris: Albert Blanchard, 1926.) 7·50 francs.

PIERRE LEBEDEF devoted twelve years of his life to the study of the pressure of light, and this little monograph gives us, in a convenient form, a description of his experiments. The work practically consists of two papers, one on the pressure exerted by light on solids, and the other on the pressure on gases, the latter being important because of its application to the tails of comets. Some bibliographical notes are appended.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Muscular Action.

A NUMBER of papers by various writers have recently appeared on this subject, mostly dealing not with the action of the muscle itself but with the material consumed by its action and the products formed by their consumption. Taking the somewhat parallel case of an engine, the papers alluded to aim at describing what is put into the fire-box, what falls into the ash-pan, and what goes up the chimney. Nothing of any value, however, is said as to the nature of the engine, its efficiency, or how and why it performs its work. The function of a muscle is to exert a pull, and the pull depends on the shortening, or tendency to shorten, of the cells of which the muscular fibres are composed, when something is transmitted to them by the nerves.

One would like to know—What is it that the nerves transmit? And what is the origin and nature of the force which deforms or tends to deform and shorten the cells?

A nerve can be made to act on a muscle in many ways; by electric currents, for example, or by chemical or mechanical irritation, but this does not indicate the character of the natural stimulus any more than the fact that a pipe can convey power to an engine by carrying water or gas indicates the real nature of its contents.

Nervous stimulus involves the expenditure of work independently of the work done by the muscle in which it induces contraction. What is the proportion between these two expenditures? Again, as regards efficiency. Efficiency may be specified either as the over-all efficiency, by comparing the potential work in the fuel with that realised by the engine, or, what is more important as regards muscular action, by the work expended in the muscle compared with the realised external work.

When a muscle is in tension, work is expended whether the muscle remains stationary or contracts; but it is only during contraction that useful work is done, and the work consumed in keeping a muscle taut but stationary amounts to a leakage of power.

Does this leakage continue at the same rate for the same tension while the contraction is going on?

This might well form the subject of experiment, and were it determined it would be possible, for any particular case, to state the most efficient speed of contraction.

So far as is known, all the work done by the muscles in accelerating themselves and their attachments is wasted. In walking on a resilient level surface, for example, the whole of the muscular work is spent in this way, for the walker might perform the same journey in a frictionless carriage by merely starting it with a push the energy of which could be recovered at the journey's end.

It must not be assumed, however, that the whole of the acceleration of the leg in walking is supplied by muscular effort. The legs, like pendulums, have natural periods, and the muscular acceleration is that required to convert the natural period of the leg to the forced period of the step.

Letters touching on these questions have already been published in NATURE of April 15, 1920; June 3, 1922; and January 31, 1925. A. MALLOCK.

9 Baring Crescent, Exeter, June 19.

Collisions of the Second Kind with Excited Mercury Atoms in the 2*P* State.

A NUMBER of experiments have recently been performed by various experimenters in which a mixture of gases containing mercury vapour as one constituent has been illuminated by light from a water-cooled quartz mercury arc. In interpreting the results of these experiments it has generally been assumed that the following process takes place. Mercury atoms first absorb radiation λ2536, an electron thereby being raised to the $2p_2$ state. Having reached this excited state the mercury atom may collide with one of the other atoms or molecules present and transfer its potential energy over to the other atom or molecule. The energy thus transferred may do one of several things. It may cause a molecule to dissociate; it may excite the colliding molecule or atom; it may all be changed into thermal kinetic energy of the two colliding bodies; or it may do combinations of the above.

In the interpretation of their results most of the experimenters have considered only the effect of mercury atoms in the $2p_2$ state. Recent experiments performed by the writer have shown that mercury atoms in the 2*P* state are also effective in the above process.

The apparatus and method were the same as used by Loria (*Phys. Rev.*, **26**, 573-584, Nov. 1925) with his sealed-off tubes. A mixture of zinc and mercury vapours was illuminated by the light from a water-cooled quartz mercury arc, and the following zinc lines were observed.

Wave-length (Å.U.).	Intensity.	Notation.	Energy necessary to excite (volts).	Remarks.
4810 4722 4680	8	$2p_{1,2,3}-1s$	6·63	Sharp triplet
3345? 3302 3282	2	$2p_{1,2,3}-3d$	8·48	Diffuse triplet
3075	5	$1S-2p$	4·01	Resonance line
2138	2	$1S-2P$	5·77	" "

λ3345 is hidden by the mercury line λ3341. λ2138 was only obtained with long exposures.

When the exciting light was filtered through weak acetic acid (concentration 1 in 180) the zinc sharp triplet was reduced to an intensity of 2. λ2138 did not appear, but the exposure was not long enough to show definitely anything about this line. The intensities of the other lines remained very nearly the same. This weak acetic acid was found to absorb completely all wave-lengths shorter than λ2000 and to transmit λ2536 with nearly full intensity.

When this mixture of zinc and mercury vapours was illuminated by the uncooled or hot mercury arc, the sharp triplet and a very faint trace of λ2138 appeared. The zinc diffuse triplet and the resonance line λ3075, if they appeared at all, did not have sufficient intensity to be seen on the plate. When the exciting light was filtered through weak acetic acid no zinc lines appeared.

These results may be interpreted as follows. When the mixture of zinc and mercury atoms is illuminated by light from the water-cooled mercury arc, some normal mercury atoms are raised to excited states by absorbing light. Some of them absorb λ2536, an electron thereby being sent to the $2p_2$ level. In this state the atom has a potential energy of 4·86 volts. Other mercury atoms absorb λ1849, an electron going

to the $2P$ level, giving these atoms a potential energy of 6·67 volts. Now, excited mercury atoms of either kind may collide with normal zinc atoms and transfer their potential energy to the zinc atoms, which are thereby raised to excited states. If an excited mercury atom has more energy than is necessary to excite a zinc atom, the energy remaining changes into thermal kinetic energy of the two colliding atoms. The excited zinc atoms returning to the normal state give out the zinc spectrum lines observed.

The energies necessary to excite these observed zinc lines are given in the table above. The only zinc line which a $2p_2$ mercury atom with its 4·86 volts energy could excite is λ3075, requiring 4·01 volts. A $2P$ mercury atom having an energy of 6·67 volts might excite either the sharp triplet requiring 6·63 volts or λ2138 requiring 5·77 volts. When we filter the exciting light through acetic acid, λ1849 is absorbed but λ2536 is transmitted. This means that no mercury atoms can now be raised to the $2P$ state, but about the same number can absorb λ2536 and reach the $2p_2$ state. As a result the intensity of the sharp triplet is much reduced, showing that it owed most of its existence to $2P$ mercury atoms. The zinc line λ3075 kept nearly the same intensity, showing that it depended principally on $2p_2$ mercury atoms.

When we illuminate by the hot arc, in which λ2536 is reversed, no mercury atoms will absorb λ2536 and be changed to the $2p_2$ state. However, we have some mercury atoms in the $2P$ state which have absorbed λ1849, and these collide with zinc atoms, causing them to emit the sharp triplet and λ2138. Now if we filter the light from the hot arc through acetic acid, λ1849 is absorbed and we have no excited mercury atoms present. Consequently no zinc lines appear.

There is some evidence that the zinc diffuse triplet requiring 8·48 volts is caused by mercury atoms in the $3d$ state. The discussion of this triplet will be reserved for the full report of this work.

It might be said that the zinc atoms could absorb λ1849 directly without the necessity of the intermediate $2P$ state of mercury. Powers (*Phys. Rev.*, **26**, 761-765, 1925) and Kapuscinski (NATURE, **116**, 170 and 863, 1925) have found such a possible absorption for cadmium. In order to test this possibility, these experiments were repeated with a tube containing pure zinc and practically no mercury vapour. No zinc lines were obtained in any case.

These experiments show, then, that the effect of mercury atoms in the $2P$ state must be considered in the interpretation of the results obtained when any mixture of gases including mercury vapour is illuminated by a quartz mercury arc.

J. G. WINANS.

University of Wisconsin,
Madison, Wis., U.S.A., May 24.

Activated Fluorescence and Doppler Effect.

KLEIN and Rosseland deduced from thermodynamical considerations that an excited atom can, in consequence of a collision, fall into the normal state without emission of radiation (impact of the second kind). A part of the energy that becomes free can be spent in exciting the other atom, giving rise to the phenomenon of the "activated fluorescence" which was found to occur in mixtures of metallic vapours by Franck and his school.

For example, if mercury atoms which are brought into the $2p_2$ state by absorption of the 2537 line (corresponding to a potential of 4·9 volts) collide with atoms of another element possessing a lower resonance potential, the lines of this element are found to be emitted. The excess of energy must be distributed between the two atoms as kinetic energy.

As no direct proof of this latter point, so far as I know, has been given, I have tried to observe the speed acquired by the atoms as a Doppler effect, and I give here a preliminary account of the results, which agree also quantitatively with the theory.

I used a mixture of mercury and sodium vapours, contained in a bulb of fused silica, which was continuously evacuated by a diffusion pump. The mercury was put into a side tube, heated to 120°, so that the pressure of its vapour in the bulb was of the order of 0·5 mm. The bulb contained some sodium, and was heated to 300°-350°. On illuminating with the light of a water-cooled mercury lamp, a visible glow of D light appeared. The D lines were observed with a 40-plate echelon grating, and their breadth was measured with an ocular micrometer. It was found to be, as a mean value of six observations on D_1 and D_2, 0·16 Å.U. The lines were strongly reversed, the central part being absorbed by the sodium vapour before escaping from the bulb.

The breadth to be expected is easy to calculate. The kinetic energy must correspond to the difference $V_2 - V_1$ of the excitation potentials of mercury and sodium, *i.e.* to 4·9 − 2·1 = 2·8 volts; hence, and from the law of the conservation of momentum, we get the equations—

$$m_1 v_1 = m_2 v_2 \; ; \; \frac{m_1 v_1^2 + m_2 v_2^2}{2} = e(V_2 - V_1),$$

where m_1, v_1 and m_2, v_2 are the respective masses and velocities of the two atoms. The velocity of the sodium atom (which owing to its smaller mass absorbs nearly all the energy) is thus found to be $4{\cdot}3 \times 10^5$. The distribution of the velocities of the excited sodium atoms is uniform as regards the direction in space, but is not a Maxwellian distribution, because the molecules have all the same velocity. Hence it follows that the distribution of the intensity in the broadened line is quite different from that due to the ordinary Doppler effect of thermal agitation; and it is easy to see that our distribution must be a uniform one, with a breadth of the lines $\Delta\lambda = 2\lambda v/c$. Introducing for v the value given above, we obtain $\Delta\lambda = 0{\cdot}17$ Å.U., which agrees with the observed results within the limits of experimental error.

Also the distribution of intensity, so far as could be determined by eye observations, agreed completely with that predicted by the theory. To be sure that the broadening of the lines was due to the expected effect, I observed with the echelon spectroscope the D lines obtained by resonance in a bulb at the same temperature as in the previous research, illuminated with the light of a sodium vacuum lamp; the lines were found to be very narrow.

FRANCO RASETTI.

Firenze, Istituto Fisico dell' Università,
June 2.

High Frequency or Ironless Induction Furnaces.

IN an unsigned article in NATURE for May 29, entitled "High Frequency or Ironless Induction Furnaces," the writer suggests that his experiments on the heating of copper cylinders under certain conditions are at variance with the conclusions reached in our paper on this subject.

The statement in question was, ". . . consider the frequency which gives maximal (misquoted as "maximum") heating in several cases." Maximal in respect to what? Constant voltage applied to the inductor (!) or constant inductor current? (as the writer seems

to imply). He should have appreciated that neither condition was assumed.

We were considering maximal charge heating under constant power input to the inductor, and it was expressly stated that only inductors satisfying certain conditions were contemplated. The writer's experiments have no relation to the statement in question. Let us examine his experiments more closely.

We believe that the Ajax-Northrup inductor has 1·6 turns/cm.; then with 200 amp. at 50 cycles, a long cylinder of copper 5 cm. in diameter would absorb approximately 3 watts per cm. length. An elementary calculation indicates that this power would result in a temperature rise of 13° C. in 5 minutes—a temperature rise which might well escape the notice of hand-thermometry.

On the other hand, at 25,000 cycles, the power input would be 67 watts per cm. length into cold copper, and this, when account is taken of the large temperature coefficient of resistivity of copper, would in 8 minutes result in a temperature approaching 700° C.

It is important to remember that the resistivity of copper at its melting point is nearly six times its value at room temperature; so that the lowest frequency at which copper could be efficiently melted in 5 cm. diameter cylinders is about 220 cycles per second.

The fact that the charge has finite length will tend to increase the heating at the higher frequencies, and when it is borne in mind that the Ajax-Northrup converter produces damped waves ("containing all frequencies"), it will be realised that no very great precision can be claimed for these calculations. They are, however, more definite than the writer's statement of his inductor current—a statement more likely to satisfy the potential user than the physicist.

Again, regarding the exception which we have taken to Northrup's "fundamental statement" that at high frequency "the resistance of a charge is equal to its reactance," surely it is about time that this remark, which has appeared in technical papers for the last ten years, was laid to rest. Scientifically it is wrong; commercially it does not appear to serve any useful purpose, and even at the risk of being "noteworthy" we must continue to take exception to a "fundamental statement" by any authority when it is fundamentally incorrect. We must repeat that the ratio of resistance to reactance at high frequency is

$$\frac{1}{\sqrt{2\pi}.R}\sqrt{\frac{\rho}{p}}.$$

N. RYLAND DAVIS.
C. R. BURCH.
Research Department,
Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park, Manchester, June 3.

IN reply to the communication of Messrs. Burch and Davis, I have to say that:

1. The anonymity of the article was not of my seeking. My name was omitted owing to a misunderstanding.

2. I regret misquoting maximal as maximum. The use of the English equivalent did not, however, alter the meaning of the quotation.

3. The last paragraph of their letter evidently arises from some misinterpretation. In my article I pointed out quite legitimately that they took exception to a certain statement of Northrup's but made no comment, favourable or otherwise, concerning their attitude.

4. Implied criticisms concerning the accuracy of my measurements are out of place, since the experiments were intended to show, and did show clearly, that under practical conditions and at frequencies specified by the authors the heating effect on the copper charge was not merely less than some other value, but insignificant.

5. The authors state that only inductors satisfying certain conditions were specified. As it is impossible to construct inductors exactly complying with the theoretical conditions, their arguments are out of reach of rigid experimental verification. On the other hand, they arrive at certain general conclusions from which it can be deduced that an inductor current of, say, 25-50 cycles frequency would be suitable for heating a cold copper charge of 3 cm. radius. I endeavoured to check this conclusion experimentally at 50 cycles, and although a kilowatt was being dissipated in the inductor coil, no serious temperature rise of the charge took place in a period of 5 minutes. The inductor coil was designed for high frequency currents, and from this point of view the conditions were not favourable for the low frequency experiment.

The conclusions of Burch and Davis are so revolutionary, and if capable of practical application are so important, that I hope shortly to repeat the experiment, using an inductor specially designed for low frequencies. Such an experiment should determine if ironless inductive heating at these low frequencies is a practical proposition.

FRANK ADCOCK.

The Drop-weight Method of Measuring Surface Tension.

THE letter by Prof. Harkins on the above subject in NATURE of May 15 seemed to me to be very interesting. As, however, he has severely criticised my own views on the subject, I have thought it best to make some reply, for it is possible that a misunderstanding has arisen.

The method I adopted for calculating surface tension from the weights of drops of liquid falling from circular tubes is given in the *Philosophical Magazine*, vol. 45, p. 1088, 1923. I would refer any one interested to this paper, as it is quite unnecessary to reproduce any of the details here. The method was based on certain postulates which might replace Tate's laws in the greater accuracy with which they expressed the experimental facts, and which also seemed to lend a certain clarifying expression to the hopeless rigmarole that has been written round the subject for so many years. The fundamental operation in my calculations is certainly *not* taken from Harkins's work. I used certain data of Harkins and Brown (*Jour. Amer. Chem. Soc.*, vol. 41, p. 512, 1919), because at the time they were the most accurate I could find, and I saw no reason for repeating the experimental work unless I could be reasonably sure of a greater accuracy.

Harkins refers to my method as "cumbersome," "indirect," "involved," etc. The calculations could easily be shortened by the compilation of certain tables, but I do not understand why the ordinary mathematical operations of addition and multiplication should be "cumbersome" in my case and not in Prof. Harkins's. I suppose my method may be considered indirect because I have not followed in the tradition of certain formulation from which to the more conventional-minded it would be wrong to depart.

In ignoring the difference in gravity for Chicago and London, I have incurred an error in my results of 1 in 1000. It will be seen from my paper that I have merely given the figures for the surface tension correct to about 1 in 450.

Harkins's ingenious attempt to show that a drop hanging from a circular tube must inevitably satisfy

the equation $W = 2\pi r\gamma$ when the radius of the tube becomes extremely small, is not by any means conclusive, and does not seem to be supported by adequate experimental evidence. In any case, it could only be proved by extrapolation from a curve, and we should find ourselves involved in an argument as to whether the surface tension is the same for a thin mass as for the bulk of the liquid in all cases. The truth is that neither Harkins nor any one else has ever given a quite satisfactory solution of the dynamical problem of the drop detachment. His way out of the difficulty seemed to me to be somewhat vague and unsatisfactory; but that is only a point of view, and perhaps may not matter very much.

The main point at issue seems to be whether it is worth while checking any further propaganda on behalf of my method as opposed to Prof. Harkins's; and on this matter, of course, I have nothing to say. But I should be glad if Prof. Harkins would point out where my method is "erroneous," as at the moment I do not know what to make of his extremely general criticism, which occupies nearly two columns of this journal, and to which I can only make an equally indefinite reply. T. IREDALE.

Armstrong College, Newcastle-upon-Tyne.

Cirrus at a Lower Level than Alto-cumulus.

IN his letter to NATURE of February 6, 1926, p. 199, Mr. C. J. P. Cave has directed attention to the fact that well-defined cirrus clouds may occur at a much lower level than we generally assume to them, say, under a sheet of alto-cumulus. To support his view he describes a striking observation similar to that made by me on Sunday, June 13, at Strasbourg. During the morning and early afternoon of that day the weather was rainy and the sky covered with alto-stratus and nimbus. The nimbus ceased about 16.30 (G.M.T.) and the alto-stratus merged gradually into a sheet of fleecy alto-cumulus moving from west-south-west. It had a straight edge separating it from a beautiful clear sky.

At 17.30 I saw at an angular altitude of near 45° to the east-north-east a patch of well-defined white cirrus clouds under the alto-cumulus, and detached from them. As at the same moment many cirriform streaks were developing from alto-cumulus and acquiring the form of *cirrus-uncinus*, I believe the cirrus mentioned above may have been similar streaks afterwards separated from alto-cumulus.

Later, in the clear blue sky, some of these streaks were seen that had lost their *cirrus-uncinus* form. I am sure that if any one had observed the sky only at this moment he would undoubtedly have noted common cirrus, and there is no reason, I suppose, to say that they have not the same structure, as we know that in many cases high cirrus clouds are formed by snowflakes.

It is interesting to note that Mr. Cave's observation and my own were made exactly with the same sky aspect; namely, a sheet of alto-cumulus with a straight edge and cirrus seen under it, near the edge. We are thus led to ask: Is all the low cirrus derived from alto-cumulus, and is it always seen near the edge of the sheet? The cirrus derived from the anvils of cumulo-nimbus seems to be an exception. The general meteorological conditions of the days of the two observations as regards cloudiness were also similar, the clouds being placed at the transition of a "corps" to a "traîne" of a "cloud system," using the modern French nomenclature. On January 24 a low pressure area was above western Scandinavia and another to the south-west of Iceland. These were fast-moving depressions with well-defined warm sectors passing over the British Isles. On June 13 a low-pressure area was situated to the west of Ireland, and it commanded in Europe a circular stream of occlusions.

A revision is desirable of the altitudes assigned by the International Classification to the cloud forms, and also of the definitions of these forms, to take into account the new ideas of the structure and formation of clouds. ANTONIO GIAO.

Geophysical Institute,
38 Boulevard d'Anvers, Strasbourg (France),
June 14.

The Zoological Names *Simia*, *S. satyrus*, and *Pithecus*, and their Possible Suppression.

THE attention of the zoological profession is invited to the fact that the proposition is before the International Commission on Zoological Nomenclature to re-open the case of *Simia*. In its present form the proposition is for the Commission: (*a*) absolutely to suppress the generic names *Simia* and *Pithecus* and the specific name *Simia satyrus*, on the ground that retention of these names and the application of the rules to them will produce greater confusion than uniformity; (*b*) to insert into the Official List of Generic Names, *Chimpansee* Voigt, 1831, 76, for the chimpanzees *Pongo* Lacépède, 1799, type *pygmaeus* 1760, for the orang-utans, and *Macaca* Lacépède, 1799, type *sylvana* 1758, for the Barbary ape.

The argument before the Commission gives an extensive historical review of the subject; this will be published in Bulletin 145, Hygienic Laboratory.

Briefly summarised, the argument maintains: (1) that because of the importance of the Primates in connexion with investigations on infectious diseases, the nomenclature of certain genera has passed far beyond a status in which this subject is of importance only to zoologists in general and to mammalogists in particular; (2) that it is absolutely essential that unambiguous names be adopted internationally for experimental animals used for studies dealing with problems involving the life and death of human beings; (3) that the names *Simia*, *Simia satyrus*, and *Pithecus* are so confused in zoological literature as to preclude hope of reasonable uniformity in their use in zoological, bacteriological, serological, and public health work; (4) that the safest solution is to suppress these names entirely; (5) and that the International Commission should select thoroughly unambiguous and suitable substitutes which will preclude possibility of confusion in interpreting results as reported by bacteriologists and others in different countries—results which deal with human life.

The secretary will delay announcement of final vote until about September 1, 1927, in order to give to zoologists, bacteriologists, and others who may be interested, time to consult the premises formulated in Bulletin 145, and to express their views to the Commission. Application for copies of Bulletin 145, Hygienic Laboratory, should be addressed to the Surgeon-General, U.S. Public Health Service, Washington, D.C. C. W. STILES,
Secretary to Commission.

Hygienic Laboratory, Washington, D.C.

Names for Companion Stars.

I HAVE been expecting to see some comment in NATURE upon Sir Oliver Lodge's suggestion under the above title in the issue of March 13, 1926, but none seems to have appeared. It is not my purpose to dwell upon the propriety of naming so insignificant and dense an object as the companion to Sirius for

one whose contributions to science have been so large and brilliant. It is the suggestion regarding the companion to Algol that needs comment. Vogel's contributions to the art of measuring radial velocities put him in the first rank, but they do not include the discovery of the first spectroscopic binary. As this is an error that has often been repeated it may be well to set down the facts.

In his third annual report on the Henry Draper Memorial, published early in 1889 (our copy reached New Haven on April 16), E. C. Pickering states: "One photograph of Zeta Ursæ Majoris shows the K line distinctly double, and others show it single." In the January, 1890, number of the *American Journal of Science*, Pickering has an article dated November 12, 1889, in which he states that the K line in this star occasionally appears double, and he goes on to give what we now know to be the correct explanation, namely, that we are dealing with a binary, both components of which are bright.

At the meeting of the Prussian Academy of Science held on November 28, 1889, Vogel communicated six observations of Algol which show it to be a spectroscopic binary. These observations were first printed in *Astronomische Nachrichten* 2947 (dated January 11, 1890), in an article by Vogel dated December, 1889. Vogel's first observation of this object is dated December 4, 1888, while the duplicity of the lines in the spectrum of Zeta Ursæ Majoris was noted on a plate secured at Harvard on March 29, 1887. We see, therefore, that no matter what criterion is used to fix the epoch of the discovery of the first spectroscopic binary, we must conclude that the first of these objects to be detected was Zeta Ursæ Majoris by Pickering.

The above illustrates a difficulty which will be constantly met if Sir Oliver's suggestion is followed out; we should often be involved in matters of priority if these names are assigned during the lifetimes of the investigators concerned or too soon after their deaths. FRANK SCHLESINGER.

Yale University Observatory,
June 4.

Energy Levels of the Carbon Monoxide Molecule.

IN their communication under this title in NATURE of July 3, p. 12, Messrs. Duffendack and Fox make a suggestion in connexion with the scheme of electronic energy levels of neutral carbon monoxide which I recorded in a recent letter. It is briefly, that there are two sets of levels involved corresponding to triplet and singlet terms in the corresponding atom. I would like to say that this and other suggestions were made to me by Prof. Birge and Dr. Mulliken in private communications some three months ago, but too late for publication in my letter. It is clear that the whole scheme of levels can be interpreted on Birge's views, which are outlined in his important letter on "The Structure of Molecules" (NATURE, Feb. 27, 1926). The common ground level is $1S$. The initial levels of the 4th positive and the Ångström bands are respectively $1P$ and $2S$. The initial level of the Cameron bands is the triplet $1p_{123}$, and of the third positive bands is $1s$, while the new level which Duffendack and Fox postulate is probably $2p_{123}$. All the above levels have their counterpart in the corresponding magnesium atom, and the inferences which may be drawn therefrom account for all the facts.

The $3A$ positive bands of Duffendack and Fox are clearly the bands which I interpreted as an $n'=4$ sequence. The interpretation as arising from a $2p_{123}$ level is, however, preferable for two reasons: it avoids the anomalous intensity distribution in which the states $n'=2$ and 3 are absent, and secondly, the existence only of the states $n'=0$ and 1 is in harmony with recent work of Birge and Sponer on the heat of dissociation of the molecule. It may perhaps be added that not only are s to s transitions possible in band spectra but so also are p to p transitions (*e.g.* the $3A$ bands of carbon monoxide).

R. C. JOHNSON.

Department of Physics,
Queen's University of Belfast.

The Physical Basis of Insect Drift.

THE letter of Dr. E. P. Felt (NATURE, May 29, p. 755) illustrates how difficult it is in these days for the student of one science to keep in touch with developments in other sciences, developments which may have a considerable bearing on his own subject. We know all too little about the conditions in the upper air, but we know more than "the extremely few observations made by airmen in balloons, dirigibles, or aeroplanes." If Dr. Felt were to get in touch with the Weather Bureau at Washington, or with the Blue Hill Observatory, he would probably be able to obtain data which would be of great value in connexion with the question of insect drift. Observations of wind in the upper air are made as a matter of routine in many places in the northern hemisphere, and in some in the southern, so that there should be plenty of material to work on.

No doubt winds in the upper air have a great deal to do with the dispersal of insects, and convection currents occur at times up to much greater heights than those mentioned by Dr. Felt. At the same time there may be other factors besides wind; it is not easy to see how the extraordinary migrations of *Vanessa cardui* in Europe can be explained on purely meteorological lines unless other insects are similarly affected, which, so far as I know, is not the case. No doubt the appearance of *Colias edusa* in England from time to time might be explained by meteorological considerations, but if so a "clouded yellow year" should be a year when other continental forms appear here. There is evidently scope for a considerable amount of team work between meteorologists and entomologists. C. J. P. CAVE.

Stoner Hill, Petersfield,
June 17.

Abnormal Venous Circulation in a Frog.

ONE of our senior boys here, Alan Cadbury, when dissecting a frog, directed my attention to the fact that the right anterior vena cava appeared to be completely missing. Closer examination proved this to be actually the case. In order to return the blood from the right anterior region of the body to the heart, a commissural vessel had been established connecting the bases of the external jugular vein of the two sides, the venous blood from the entire anterior region of the body thus finding its way back to the sinus venosus through the left anterior vena cava. The specimen was a well-grown male.

In a communication to NATURE of April 25, 1925, Dr. N. B. Eales has directed attention to variations occurring in the distribution of the anterior abdominal vein of the frog and remarked on their evolutional significance. No such significance can be plausibly attached to the present case, but the anomaly seems rare enough to be worth recording. The anterior abdominal vein opened into the liver as usual.

F. W. FLATTELY.

Leighton Park School,
Reading, June 10.

Oxidation, Passivity, and Corrosion.[1]

By ULICK R. EVANS.

WHEN a clean surface of metal is heated gently in air, a fine series of colours is often produced, the sequence of tints being that which would be expected from optical principles. In the case of lead, four 'orders' of tints can be observed: red, for example, occurs four times in the sequence. The transparent oxide film which is responsible for the effect can be lifted from the lead, and it is found that for any given film the colour as seen by reflected light is complementary to that seen by transmitted light. On copper and iron the sequence is essentially the same as on lead, but the fourth-order tints (corresponding to fairly thick films) cannot be seen; indeed on iron—no doubt owing to the low transparency of the oxide—only the first-order colours are really bright, although, if the oxidation is carefully carried out, the sequence can easily be followed as far as the third-order red.

It is important to notice that absolutely no change in the appearance of the iron occurs until the first yellow 'temper tint' arrives; this appears quickly at high temperatures, more slowly at lower temperatures. At ordinary temperatures iron can be kept in dry air indefinitely without undergoing visible change. It is generally considered that an oxide film is produced; but that, since diffusion of oxygen through an oxide is very slow at low temperatures, the film becomes protective, and ceases to thicken further, before it reaches the thickness needed to give the first (yellow) temper colour.

This view is supported by some experiments on the changes produced by oxygen on the chemical behaviour of electrolytic iron. The iron was very kindly prepared for me by Dr. W. H. Hatfield; it was fused *in vacuo* in a magnesia crucible before being rolled into sheet. When freshly ground, the iron was found to be capable of precipitating copper from $N/10$ copper nitrate solution within a few seconds. But after exposure for 21 hours to dry air or oxygen (freed from carbon dioxide) it was found to lose its activity, and drops of the copper nitrate solution then produced no effect even after standing on the surface for many hours. In other experiments, strips of the iron, freshly ground, were subjected to a temperature gradient in air or oxygen, so as to give a film of gradually increasing thickness, ranging at one end from thicknesses too small to give temper colours, through intermediate thicknesses displaying the three orders of tints, up to considerable thicknesses at the other end, where the scale had the slaty-grey appearance characteristic of magnetite.

On testing the films with small drops of copper nitrate, it was found that only a limited range of thicknesses afforded protection; this range was situated in the invisible region, and extended almost—but not quite—to the place where the first yellow tint commenced. At points near to the unheated end of the specimen, where the film was too thin to give protection, general deposition of copper quickly occurred. Near the heated end where the film was visible the protection also failed, but in a different way. Deposition of copper commenced at certain isolated points or lines, and spread out from these places over the oxidised surface. This copper was certainly deposited on the *outside* of the oxide film, since when the copper was afterwards dissolved away with ammonia the oxide film reappeared. The points around which deposition occurred almost certainly represented pores or cracks in the oxide scale; indeed, in the thicker scale, the cracks were sometimes visible. At a crack, the exposed iron would act as the anode of a local cell and the oxide around as cathode, copper being deposited on the latter without destroying it.

The behaviour of the part of the strips showing temper colours is of some interest. A short immersion in copper nitrate solution causes the tints to become dull, owing to the deposition of metallic copper upon the film (the colour of this copper can be seen if the specimen is held at a suitable angle); at the same time, the tints shift in a direction which would seem to indicate a thickening of the film at each point. If, at this stage, the copper is dissolved away with ammonia, the colours re-emerge with practically undiminished brightness. If, on the other hand, the strip is kept in the copper nitrate solution until the colours are completely hidden by a thick deposit of pink copper, the colours, when the copper is dissolved away by ammonia, reappear distinctly weaker than before.

Analogous results are obtained when copper strips, covered with an oxide-film of varying thickness, are treated with dilute silver nitrate, although on copper the protective power of an oxide skin is much less permanent than in the case of iron. The maximum resistance is again situated in the invisible region, but the films thick enough to give first-order tints resist the reagent for almost as long a time. As in the case of iron, the thick films fail in quite a different manner from the very thin films; on the thick films tiny isolated crystals of shining silver appear, no doubt at the sites of pores, whilst where the film is very thin general deposition of darker silver occurs.

Both on iron and copper the behaviour of the oxide-film in protecting the metal varies *gradually* as the thickness is increased: there is no sharp change at the point where the first visible tint appears. This observation has a bearing on the cause of the 'passivity' displayed by iron which has been treated with oxidising agents. Some authorities have maintained that this cannot be due to a protective film, basing their argument on the facts (1) that no film is visible on passive iron, and (2) that iron covered with a visible film is not, as a rule, passive. These particular objections to the oxide film theory would seem to possess but little weight. The poor protection afforded by relatively thick visible films is almost certainly due to the increase in the probability of spontaneous cracking which accompanies an increase in thickness. Clearly, however, the conditions of formation of the film greatly affect the protective character; some oxidising agents, for example, seem to give more reliable films than oxygen itself. It is, of course, possible that other causes besides the presence of a film on the iron might

[1] Based on two lectures on the "Tinting, Tarnishing, and Corrosion of Metals," delivered at the Royal Institution on May 20 and 27.

give rise to the phenomenon known as passivity; but all the cases so far examined by the present writer appear to be due to protective films.

It is well known that solutions of oxidising agents, such as chromates, render iron passive towards copper salts. In the case of electrolytic iron this passivity can also be brought about by dissolved oxygen, provided that it is present in sufficient quantity at all points on the surface. Since oxygen is not very soluble in water, some special arrangement is needed to ensure the oxygen supply to the point where the specimen is supported. This can be attained by using the "eccentric whirler" recently described by the writer [2]; the specimen, consisting of a metal disc pierced centrally with a circular hole, is slipped over a glass tube blown to bulb-form at the lower end, and attached eccentrically on a vertical spindle, which can be driven by a motor. When the spindle rotates, the whirling disc mounts the tube and the point of contact with the glass alters from one moment to the next; thus there is no fear of oxygen exhaustion at the point of support. If a disc of mild steel is thus 'whirled' in distilled water containing oxygen, it soon attains a yellow appearance, due to the formation of adherent ferric hydroxide over the surface generally; [3] if taken out after 100 minutes, dried and tested with copper nitrate, the iron is found to blacken within a few seconds. When, however, the experiment is repeated with electrolytic iron, quite different results are obtained. It is found that this material develops rust only in minute spots, between which the metal remains bright; the spots probably represents the sites of pores in the metal into which oxygen cannot rapidly penetrate; only a trace of iron passes into solution. If the specimen is taken out after 100 minutes 'whirling,' the iron is found to be quite passive towards copper nitrate. Some specimens of electrolytic iron have been found to remain free from rust altogether when whirled for many hours in water containing oxygen, probably because they were free from pores.

It should be understood that the comparatively non-rusting behaviour of electrolytic iron only refers to conditions of *uniform aeration*. If the same iron is exposed in the same water under conditions of *differential aeration*, rusting occurs readily. Thus if a strip of electrolytic iron be partly immersed in a nearly vertical position in the water, so that oxygen reaches the upper part more easily than the lower part, corrosion quickly commences; it is plainly visible after 30 minutes. Iron passes into solution at the points where the oxygen-concentration is lowest as the comparatively soluble ferrous hydroxide, and although this will ultimately be oxidised to the much less soluble ferric hydroxide (the main component of 'rust'), the ferric hydroxide, being formed as a secondary product at an appreciable distance from the seat of origin of the ferrous hydroxide, does not form a continuous film over the metal and has no protective character.

The setting up of corrosion by differential aeration is well shown by experiments on the behaviour of steel in contact with sodium chloride solution. When a drop of salt-water is placed on a sheet of mild steel, corrosion occurs in the centre of the drop; the peripheral portion of the drop—the part which oxygen can reach most readily—remains quite uncorroded. Similarly, if a strip of steel be partly immersed in sodium chloride solution, corrosion occurs over the portions well below the surface; just below the water-line there is a zone of quite uncorroded metal.

Experiments have shown that the corrosion is connected with electrical currents set up by the variation in oxygen concentration; the portion where the oxygen concentration is lowest functions as the anode, or corrodible portion. These currents only flow if oxygen is supplied continuously to the cathodic area, but they produce corrosion upon the part which is not directly reached by the oxygen. The mechanism would appear to be as follows. Oxygen reaches the portion next to the water-line and causes a kind of passivity. The potential is raised above that of the lower, relatively unaerated, portions, and this determines the flow of current; measurements by McAulay and Bowden [4] have shown that the potential over the aerated zone may become so much as 0·2 volt 'nobler' than that of the unaerated zone. The unaerated portion suffers anodic corrosion yielding ferrous chloride, whilst at the aerated portion the cathodic reaction produces sodium hydroxide; along the line where the ferrous chloride and sodium hydroxide meet, we get white ferrous hydroxide, rapidly oxidising through the green intermediate body, to brown ferric hydroxide, and thus a membrane of rust is produced at the junction of the anodic and cathodic regions. Thus the *direct* effect of oxygen is to produce a species of *passivity* at the points actually reached by it; but the *indirect* effect is to cause *corrosion* at the points not reached directly.

The corrosion set up by these differential aeration currents becomes most serious when the unaerated anodic area is much smaller than the aerated cathodic area, since then the whole effect is concentrated on a limited surface, and the rate of penetration downwards will be quite rapid. If a minute cavity exists in the metal and becomes filled with liquid, this will be relatively inaccessible to diffusing oxygen, and will therefore become anodic to the main portion of the surface; the attack will here quickly eat down into the metal, causing 'pitting.' The mouth of the pit will become covered with a loose hump or blister of rust, due to interaction of the anodic and cathodic products, but since this rust is not formed *in situ* at the anodic area, it will not protect the metal from corrosion; on the contrary, by shielding the interior of the pit from oxygen, it will, for a time, tend to promote the attack. Thus, when once pitting has commenced, it is difficult to stop it.

Differential aeration currents probably constitute the most serious practical cause of corrosion of zinc, iron, steel, lead, and aluminium articles. But electric currents set up in any other way will cause corrosion, provided that the immediate anodic and cathodic products are soluble bodies; where—as in the case of lead in a sulphate solution—the direct anodic product would be an insoluble compound, there is comparatively little attack.

Numerous other ways of generating these corrosion

[2] American Chemical Society Corrosion Symposium, 1925. See *Ind. Eng. Chem.*, **17**, 1925, 370.

[3] This yellow colour is due to the characteristic tint of ferric hydroxide, and in no way resembles the yellow temper colour.

[4] *J. Chem. Soc.*, **127**, 1925, 2605.

currents are known. In the case of copper, if water is moving rapidly over the surface at one place and is comparatively stagnant elsewhere, the copper ions will be carried away more quickly from the point of rapid motion than from the rest of the surface, and therefore a concentration cell is set up; the point of rapid motion is anodic and suffers corrosion. Where a material consists of two phases, a current may flow between these two phases, even when the composition of the liquid is the same everywhere. This is possibly the reason why—as mentioned above—a steel disc suffers alteration even under conditions of uniform aeration; for though—by whirling—we may diminish or even eliminate differential aeration currents, we can still get currents set up between the iron and carbide particles of the steel. Owing to the fact that under conditions of whirling the individual anodic and cathodic areas are of microscopic, instead of macroscopic, size, the hydroxide is precipitated close to the surface, and tends to cling to it. Thus the rust produced under these conditions of uniform aeration is far more adherent than that produced by differential aeration.

Climatic Changes during Geological Times.[1]

By C. E. P. BROOKS.

II. CAUSES OF GEOLOGICAL CHANGES OF CLIMATE.

THE preceding article closed with a discussion of Wegener's theory of continental drift. That theory is still *sub judice*, but it was pointed out that even if it be ultimately accepted, it does not solve the problem of climatic changes. Köppen and Wegener themselves recognise this, for they adopt astronomical changes as an explanation of glacial and interglacial stages, and suggest also that astronomical changes may have been important in the Tertiary succession of Europe. Apart from this, however, any one looking at Wegener's reconstructions and remembering the way in which the land and sea distribution at the present day dominates the local distribution of climate, cannot but realise that these extensive rearrangements must have brought about corresponding changes of climate, quite apart from those due to the supposed changes of latitude. Köppen and Wegener implicitly assume that the distribution of climate depends only on the distribution of solar heat at the outer limit of the earth's atmosphere, but even if the radiation from the sun be supposed to have remained constant, there are many factors of climate other than the astronomical conditions. These factors have been discussed in a large number of books and papers which include some very brilliant work. This great mass of literature is surely worth a thought.

In the middle decades of the nineteenth century, when radio-activity had not been discovered and pre-Quaternary glaciations were a heresy, the earth was believed to be cooling from an original molten state and the uniform warmth of the earlier geological periods was attributed to this earth-heat. In this scheme of things the Quaternary glaciation—"The Great Ice-Age"—marked the gap between the waning of earth-heat and the assumption of full control by the sun. This primitive view is no longer tenable, but still it occasionally crops up, as in the ingenious speculations of Marsden Manson, who supposes that the internal heat maintained the oceans at a high temperature, thus giving rise to a dense mantle of cloud which shut out the heat of the sun. The earlier ice-ages were due to local cooling in the centres of the great continents, the Quaternary to the final cooling of the seas, while the introduction of the present zonal distribution occurred when the last remnants of the universal cloud layer broke down.

Another early theory of climatic changes, variations in the heat received from the sun, perished from lack of evidence. Dubois attempted to bolster up his hypothesis that during the Quaternary glaciation the sun was a red star by arguments from colour blindness regarded as an ancestral trait belonging to the time when the earth was bathed in a perpetual sunset glow. Other views attributed the Quaternary ice-age to the shutting out of the sun's heat by a cloud of cosmic dust, and one ingenious theory gives us an ice-age for the birth of each planet between the earth and the sun. Recently Huntington and Visher[2] have attempted to revive the theory of solar control. Starting from the accepted view that the earth is slightly warmer at minima of the eleven-year sunspot period than at maxima, and the controversial view that storminess increases from minima to maxima of sunspots, they suppose that the warm periods were times of few sunspots and the ice-ages times of many sunspots. Such an enormous extrapolation from a small and imperfectly understood basis would not be warranted unless supported by convincing evidence. At present we know nothing of the variations of solar activity during the geological past, and even if the variations which Huntington and Visher postulate have actually occurred, it is improbable that they would have the results which are attributed to them.

Whatever may be the case with the total radiation received by the earth in a year, there can be no doubt that its distribution in seasons and latitudes has varied greatly with changes in the obliquity of the ecliptic and in the eccentricity of the earth's orbit. The idea that these changes were responsible for geological changes of climate is very old, but it was not until the appearance of Croll's brilliant essay, "Climate and Time," that they won general respect. Croll supposed that the most favourable conditions for glaciation occurred during times of great eccentricity, and were located in the hemisphere with winter in aphelion, the short hot summer being insufficient to melt the accumulated snowfall of the long cold winter. Murphy first pointed out that the reverse was more likely to be true, and subsequent research has confirmed Murphy's view. Although the total quantity of heat received over a whole hemisphere in a year is not affected by astronomical changes, this is not true of individual belts of latitude, and in high latitudes more heat is received in the course of a year when summer falls in

[1] Continued from p. 17.

[2] Huntington, Ellsworth, and Visher, S. S., "Climatic Changes: their Nature and Cause." New Haven, 1922.

perihelion than when summer falls in aphelion. Moreover, the summer conditions are of greater importance for glaciation than are the winter conditions.

This astronomical theory of climatic changes has to face two great difficulties. First, it requires glaciation to alternate in the northern and southern hemispheres, while geologists believe that glacial stages have been synchronous over the whole world; and secondly, the astronomical time-scale is incompatible with the geological time-scale as set out in the absolute chronology of de Geer. Recently, means have been found to overcome the first of these difficulties; thus R. Spitaler,[3] after an elaborate computation of the temperature of land and sea in different latitudes under a great variety of astronomical conditions, considers that each stage of the Quaternary ice-age represents a time of maximum eccentricity covering several precession periods of 21,000 years each, the ice-sheets advancing when aphelion fell in spring or summer and retreating when aphelion fell in autumn or winter, but being able to persist through the whole stage owing to the general cooling of the oceans. Spitaler's scheme, however, requires much more time than the geologists will allow. W. Köppen[4] attributes a similar persistence to the cooling introduced by the ice-sheets themselves; on the basis of calculations by M. Milankovitch, in which the heat received in summer is regarded as the essential variable, he achieves a more moderate time-scale, which, however, still presents several difficulties. Thus Spitaler and Köppen make the main glacial stages synchronous in each hemisphere, but with secondary maxima at different times. The astronomical theory has this in its favour, that we can be reasonably certain that the postulated astronomical changes have occurred. But if they were of such dominant importance during the Quaternary, it is curious that they have not been recognised in the climatic alternations of earlier geological periods—for example, there should have been several ice-ages at intervals during the Tertiary. If until the Quaternary they were masked by much greater effects due to non-astronomical factors, why not attribute the Ice-Age itself to the latter also?

The interval between the founding of the astronomical theory by Croll and its recent revival has witnessed the birth and death of the carbon dioxide theory, introduced by Arrhenius[5] in 1896 and taken up by F. Frech, T. C. Chamberlin and others. The theory is that carbon dioxide acts like the glass of a greenhouse, allowing the sun's rays to reach the earth's surface almost unchanged, but absorbing the greater part of the return long-wave terrestrial radiation. Subsequent research has shown, however, that water-vapour has exactly the same properties, and that there is always sufficient water-vapour present to absorb practically all the radiation which would be taken up by carbon dioxide, so that the latter can play only a very minor rôle.

Chamberlin introduced another remarkable conception—the reversal of the oceanic circulation.[6] Ocean currents are due to three causes, differences of temperature in different parts of the surface, differences of salinity, and the action of the wind on the surface layers. At present the latter cause predominates, the warm surface waters of the tropical oceans being driven westwards and then polewards by the prevailing winds. Chamberlin supposed that at times the evaporation in the inter-tropical regions was so great that the surface layers, owing to their increased salinity, became heavy enough to sink to the bottom, where their heat was conserved as they spread polewards, until they emerged in high latitudes and brought about mild polar climates. The chief objection to this is that great evaporation implies also heavy rainfall, while the periods in which the mild polar climates prevailed are marked by aridity in middle latitudes.

Somewhat less sensational variations in the system of ocean currents have frequently been adduced as causes of climatic change. The remarkable difference of climate between the British Isles and Labrador is usually attributed to the fact that the former are washed by the warm Gulf Stream Drift, the latter by the cold Labrador Current, and it has been supposed that the opening of a gap between North and South America, by allowing the warm water of the Guiana Current to pass through into the Pacific, caused the Quaternary ice-age in Europe. This particular conclusion is not warranted by the premises, but from the great differences of climate which can exist between places along the same parallel of latitude, it is obvious that the redistribution of land and sea may account for considerable changes of climate. This was the view of Lyell, who attributed the Quaternary ice-age to an expansion of the tropical oceans, from which much water was evaporated, and in high latitudes an extension of the land areas, on which the water-vapour fell as snow. Similarly, W. Ramsay[7] has insisted on the importance of high ground in lowering the temperature, not only locally but also over the whole world. Such ideas must remain speculative, however, until they have been supported by an adequate numerical basis.

F. Kerner has done more than any one else to calculate what effect a given change of land and sea distribution would have on the local and general temperatures; his results show that geographical changes go a long way towards accounting for the climatic vicissitudes of Europe during the Tertiary,[8] but he failed to account for the mild Arctic climates of the Jurassic and Eocene, his calculated January temperatures for the 75th parallel being nowhere above the freezing-point.[9] One of Kerner's papers, however,[9] contains a suggestion of what may ultimately prove to be the most important factor in climatic changes, namely, the cooling power of an ice-covered polar ocean. Brooks had previously shown a similar cooling power of land ice; when an ice-sheet reaches certain dimensions, the cold ice-winds bring the neighbouring land below the snow line, and the process continually repeated enables the ice-sheet to grow to very large dimensions. Calculations show that the extension of

[3] Spitaler, Rudolf, "Das Klima des Eiszeitalters." Prag, 1921. (Lithographed.)
[4] Köppen, W., und Wegener, A., "Die Klimate der geologischen Vorzeit." Berlin, 1924.
[5] Arrhenius, Svante, "On the Influence of the Carbonic Acid in the Air upon the Temperature of the Ground," *Phil. Mag.*, **41**, 1896, p. 237.
[6] Chamberlin, T. C., "On a Possible Reversal of the Deep Sea Circulation and its Influence on Geologic Climates," *Jour. Geol.*, **14**, 1906, p. 363.
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[8] Kerner, F. "Synthese der morphogenen Winterklimate Europas zur Tertiärzeit." Wien, 1913.
[9] Kerner, F., "Das akryogene Seeklima und seine Bedeutung für geologischen Probleme der Arktis." Wien, *Sitzungsber. Ak. Wiss.*, **131**, 1922, p. 153.

the Scandinavian ice to England, and the rapid collapse of the ice-sheets at the close of the Quaternary glaciation, are accounted for by this effect. A floating polar ice-cap can be dealt with in the same way; at the close of a warm period the ocean will remain entirely free of ice until the temperature falls to freezing-point in winter. A small further fall, and a floating ice-cap will spread over the whole of the polar ocean. Kerner's and Brooks's calculations indicate that a general rise of temperature by 5° F. persisting over many years would suffice to render the whole Arctic Ocean non-glacial, a change which would reverberate over the whole globe.

This idea entirely alters the scale of the problem. Many factors which are inadequate to account for the temperature change of some 40° F. in the polar and cold temperate regions between an ice-age and a warm period may easily account for a change of 10° F., the remaining 30° being due to the cooling power of land ice and sea ice. Only two types of climate are possible, the 'non-glacial' or warm and the 'glacial' or cold. The transition from one to the other may be due to any of the climatic factors which have been so ardently advocated, but the close association between cold climates and mountain-building suggests the dominance of geographical causes. After a major orogenic period the continents are high and extensive, the ocean currents are restricted, and perhaps volcanoes send out large quantities of dust to interfere with the free passage of the sun's rays; all these causes, combined perhaps with unfavourable astronomical conditions, lower the amount of heat reaching high latitudes, so that the temperature of the polar oceans falls below the freezing-point in winter and a floating ice-cap is formed. After a long period of rest and erosion, the continents are low and small, there is a free oceanic circulation, and volcanoes are unknown; so much heat reaches high latitudes that the polar oceans are above the freezing-point even in winter, and there is no ice.

What of the Upper Carboniferous glaciation of the tropics? The geographical theory can be indicated only briefly; it postulates a high plateau, with a cold ocean to the south, a warm ocean to the north, and a permanent 'south-west monsoon' blowing from the former to the latter, covering the plateau with a dense layer of low cloud which with the assistance of a volcanic dust veil reflected a large proportion of the sun's rays back to space and kept the temperature low enough for snow to fall abundantly above a level of about 6000 feet, giving rise to ice-sheets which reached the sea. Whether the difficulties which confront this theory are greater than those confronting the theory of continental drift which is its only alternative, time will show.

Recent Developments in the University of Sheffield.

ON July 1 and 2 the University of Sheffield celebrated the twenty-first anniversary of the granting of its charter of incorporation. Congratulatory addresses were presented by sister universities throughout Great Britain and the Dominions, scientific and other institutions and societies, and public bodies. Among the recipients of honorary degrees may be mentioned H.R.H. Princess Mary, Lord Derby, Sir Austen Chamberlain, Sir Charles Eliot, Prof. P. F. Frankland, and Engineer Vice-Admiral Sir Robert B. Dixon. New engineering and metallurgical laboratories were formally opened by Sir Robert Hadfield, and the numerous delegates and other visitors were afforded an opportunity of acquainting themselves with the work of the various departments.

The University of Sheffield received its charter twenty-one years ago, but the history of the institutions out of which it grew goes back much further. The Technical School, the germ of the present Applied Science Department, was founded in 1886; Firth College, from which the faculties of arts and pure science took their origin, dates from 1879; while the Medical School will be able to celebrate its centenary in 1928. These three institutions united in 1897 to form the University College of Sheffield, which received full university status in 1905. The history of the University during the past twenty-one years has been one of almost unbroken progress in every direction. The numbers of its students and staff have greatly increased, especially since the War; the amount of research work carried on within its walls has grown steadily; new departments and courses have been established as the need for them arose and the resources of the University permitted; and generous financial support has been received from private and public sources. Though a complete survey of recent progress is not possible here, a few notes on the main lines of development may perhaps be not without interest.

The most rapid and extensive progress in recent years has taken place in the Department of Applied Science, which includes the faculties of engineering and metallurgy, and a number of associated departments. Expansion in these branches has been made possible largely by the growing recognition in industrial circles of the importance of technical training and scientific research. Thanks to the generous support of leading Sheffield industrialists, the departments of the faculty of engineering have been able to make several important additions to their resources. The Edgar Allen and Jonas Research Laboratories, opened in 1923, are designed respectively for research in magnetism, magnetic properties of materials, and allied subjects, and for investigations on the mechanical properties of materials. Further provision for research in this latter subject has been made in the new laboratory opened by Sir Robert Hadfield on July 2, which is being used at present for work on the effects of high temperatures, heat treatments and repetition stresses, but can be adapted, as the need arises, for the investigation of many other engineering problems. All these new laboratories are equipped with the most modern machines and apparatus, constructed in many cases in the engineering workshops.

One of the most important post-War developments is the establishment, in association with the faculty of engineering, of a Department of Fuel Technology. This

is essentially a research department, and the majority of its students are honours graduates in chemistry. It co-operates closely with the mining and metallurgical departments, and has entered into a working arrangement with the Safety in Mines Research Board and the Fuel Research Board, whereby the facilities for research work at the disposal of each body are shared mutually, and the respective staffs engage in conjoint work. Among the subjects that have particularly engaged the attention of the department have been the properties and production of blast-furnace coke, the constitution and properties of coal, and problems of gaseous combustion.

The Mining Department, an integral part of the faculty of engineering, has also made rapid progress, especially on the research side of its work, which has dealt chiefly with flame-proof electrical apparatus, coal-cutter steels, winding and haulage ropes, and mine ventilation. The Department has co-operated with the Safety in Mines Research Board and with the mining industry of the surrounding area. Its work has grown to such an extent that the present accommodation is inadequate, and a scheme is in hand for the erection in the near future of an entirely new mining department.

No account of the progress made in applied science would be complete without a reference to the Department of Glass Technology, which is equipped with a complete glass works, and laboratories in which a large body of research has been carried out. In connexion with the Department there has been formed the Society of Glass Technology, with a membership of about 650, distributed through twenty-two countries.

The faculty of metallurgy has existed separately since 1917, but the subject has played a leading part in the activities of the Applied Science Department since its earliest days. Owing to the nature of the chief industries of Sheffield, the needs of which it was originally created to serve, the faculty chiefly concentrates on the metallurgy of iron and steel, and it is now the best equipped in the country for work in this sphere. Recently, in response to the growing interest in scientific research among the lighter industries of the city, increasing provision has been made for non-ferrous metallurgy. A notable feature of the activities of the Department is the close association of practical training with theoretical instruction. Its equipment includes a complete steel works, fitted with plant of sufficient capacity to produce open-hearth, crucible and electric steels for the use of both the Metallurgical and Engineering Departments. Recent developments include the provision of a new laboratory designed specially for post-graduate research work on the physical properties of steel, and the institution, with the aid of a grant from the Department of Scientific and Industrial Research, of research work on electrodeposition, which will be of great importance to the Sheffield plating trades. Other Government departments and research associations maintain research workers in the metallurgical laboratories.

Though the rapid expansion of the Applied Science Department has been a notable feature of the recent history of the University, considerable development in other directions can be recorded. There has been a great increase in both teaching and research work in the faculty of pure science. Chemistry has had to extend its laboratory accommodation by the erection of a large hut in the quadrangle, and there has been a steady output of research, carried out largely with the aid of students, which has been concerned mainly with investigations on the reactivity of substituents in the benzene nucleus, the remarkable isomerism of diphenyl derivatives, and adsorption by porous bodies. Physics also has been compelled to provide for its enlarged teaching work by the erection of a hut, and has further acquired four new research rooms. The research work carried out in the Department has followed the line, laid down originally by Emeritus Prof. W. M. Hicks, of specialisation in spectroscopy, and a very considerable equipment in this branch of physical study has been gathered together.

In the faculty of medicine three recent developments are worthy of notice. There have been, in the first place, changes in the curriculum and organisation of the faculty, with the object of bringing both its teaching and research work into closer contact with the city hospitals. Anatomy and physiology, formerly taken for the second M.B., Ch.B. examination, have been extended into the third M.B., Ch.B. course, and thus, during the third and part of the fourth year, theoretical work in these subjects is carried on simultaneously with clinical training. A series of posts in physiology and pathology, the holders of which work both in the University and in the hospitals, has been created. An important part in linking up the teaching work of the University with the clinical part of the medical course is played by the Department of Pharmacology, established in 1921, which has devoted itself to extensive investigations on subjects of combined laboratory and clinical interest. In addition to the accommodation at the University, the Department possesses a field laboratory in the country, specially created for experimental work on nutritional and other problems. The opportunities for medical research provided in the Department have resulted in a large output of work, including amongst other subjects the etiology and treatment of rickets, the factors of diet and environment responsible for the structure of the teeth, conditions controlling the rate of development of caries in children, the treatment of exophthalmic goitre, the action of alcohol and the toxic action of cereals. The third line of development in the medical work of the University has been the re-establishment of the dental school, in connexion with which new laboratories, provided with the most modern equipment for the teaching of dental mechanics, have been opened. A complete course of instruction for degrees and diplomas in dental science has been arranged, and hospital accommodation for clinical work is provided.

The foregoing notes, though they mention only the most important developments of recent years, show that Sheffield has taken its place side by side with the other universities of Great Britain, as an institution actively engaged both in the propagation and in the expansion of knowledge. The main lines of expansion which it is destined to follow are laid down, and further progress may confidently be expected as funds become available.

News and Views.

THE King's birthday honours list, publication of which was delayed on account of the General Strike, was issued on July 3. It includes the following distinctions conferred in recognition of scientific services or association with scientific work:—*Privy Councillor*: Sir Halford Mackinder—chairman of the Imperial Shipping and Imperial Economic Committees and first Principal of University College, Reading, now the University of Reading. *K.B.E.*: Sir Frank W. Dyson, Astronomer Royal; Prof. W. Somerville, late Sibthorpian professor of rural economy, University of Oxford. *D.B.E.*: Dr. Mary A. D. Scharlieb, consulting gynæcologist, Royal Free Hospital. *Knights*: Colonel H. G. Lyons, Director and Secretary of the Science Museum; Dr. Brajendra Nath Seal, Vice-Chancellor of the University of Mysore. *C.B.* (*Civil Division*): Dr. G. C. Simpson, Director of the Meteorological Office; Mr. F. E. Smith, Director of Scientific Research, Admiralty. *C.M.G.*: Dr. A. W. Hill, Director, Royal Botanic Gardens, Kew; Mr. J. O. Shircore, Director of Medical and Sanitary Services, Tanganyika Territory. *C.B.E.*: Mr. A. Abbott, Chief Inspector of Technical and Continuation Schools, Board of Education. *O.B.E.*: Mr. E. W. Wallis, secretary of the Royal Sanitary Institute. *I.S.O.*: Mr. D. d'E. de Charmoy, Assistant Director and Entomologist, Agricultural Department, Mauritius; Mr. A. R. Wright, assistant comptroller, Patent Office.

THE Commonwealth House of Representatives has passed two Bills dealing with the reconstitution of the Institute of Science and Industry. The Bills received the hearty approval of members on all sides of the House, the sole complaint from the Opposition (Labour) being that their introduction had been unduly delayed. The first Bill outlines the scheme of reorganisation, which abolishes the former directorship and provides for a central council composed of three members appointed by the Governor-General (who will constitute an executive committee and exercise all the powers of the council between meetings), the chairman of the six State advisory committees, and such other members as the council may desire to co-opt on account of special scientific knowledge. A sum of 250,000*l.* is appropriated for the purposes of the council, and this will ensure that for the first few years its programme will not be subject to yearly modification to accord with the exigencies of the Treasury. The name "Institute of Science and Industry" has been discarded, and the body will in future be known as the "Council for Scientific and Industrial Research," which is more in accord with British and Canadian practice. The second Bill establishes a Trust Fund of 100,000*l.*, the income from which is to provide assistance (*a*) to persons engaged in scientific research, and (*b*) in the training of students in scientific research. Considerable progress has already been made by the executive committee in the preparation of proposals for the first session of the new council, which will commence on June 22. It is hoped to establish very close relations with the British Department for Scientific and Industrial Research, and to that end the chairman of the executive committee (Mr. G. A. Julius) will visit Britain towards the end of this year.

THE Mellon Institute of Industrial Research is a good example of what can be done by the co-operation of enlightened manufacturers and by able administration. Its system of industrial fellowship was initiated in 1906, and although this remained in the experimental stage for nine years, since 1915 it has been in a strong position both financially and administratively. Dr. E. R. Weidlein, the director, states in his recent report that fifty-four of these fellowships, employing ninety-four research chemists and engineers, were held in the Institute during the year ended February 28, 1926, and that more than 125,000*l.* was contributed for their maintenance by the fellowship donors. The total sum of about 775,000*l.* has been received from companies and associations during the last fifteen years. In a separate document the Institute issues a list of the contributions made to scientific literature and of patents taken out during 1925. This list is of formidable length, but what strikes one most is the exceedingly practical nature of the majority of the investigations pursued and their great diversity. Problems relating to coal, coke, and petroleum are, perhaps, most conspicuous, but there is also a goodly array of contributions relating to metallurgy, refractories, laundering, and foodstuffs.

DR. WEIDLEIN has also written an essay entitled "The Administration of Industrial Research" (*Industrial and Engineering Chemistry*, January 1926), in which he discusses the various factors that make for success in the conduct of a research organisation, such as the selection of research workers, organisation, co-ordination of effort, and the virtues of team work. The principles involved in the management of a research laboratory are set out on the lines of Taylor's "Principles of Scientific Management," and "the functions of laboratory organisation" are analysed in detail. The essay may be recommended for perusal by directors of research; it will interest them, although they may not find it entirely convincing. Many of the 'principles' and 'functions' enumerated appear to be obvious, not to say platitudinous, and one is left with the impression that an organisation in which every entity and activity, physical, moral and intellectual, is dissected, described, catalogued, charted and labelled, is scarcely the place where the free spirit of scientific adventure can dwell with patience or good will.

DR. WEIDLEIN is undoubtedly on strong ground when he pleads for a proper business foundation for every institution devoted to industrial research, but we foresee trouble if, as he advises, the activities of a research department are "adjusted constantly to suit the needs of the concern," or if the research worker becomes too intent on "keeping in line with psychological laws." Some of the author's *obiter dicta* are also open to question. We can, for example, hear

Candide and the initiators of gas-warfare chuckle when they read: "If a scientist is productive in his investigations, his work must result for the good of humanity"; and we do not think that Schiller, who wrote that "talent is formed in quietude, character in the current of the world," would have agreed with the assertion that "The character of virtue is best seen in the life of a scientist devoted to the service of research."

ON Thursday last, July 1, unfortunately too late for insertion in our issue of July 3, we received the following telegram from Prof. W. H. Keesom, of the University of Leyden: "Helium solidified under a pressure of 150 atmospheres at the temperature of its boiling-point and under 28 atmospheres at 1·5° Abs. Solid helium forms transparent mass." This achievement thus rounds off the work of the late Prof. H. Kamerlingh Onnes, begun more than thirty years ago. By his extraordinary energy and organising ability Kamerlingh Onnes built up his cryogenic laboratory in Leyden, and in 1904 was able to obtain supplies of liquid air. By 1906 he was liquefying hydrogen on a large scale, and in 1908 he succeeded in liquefying helium. This enabled him to obtain a temperature of 4·22° Abs., and by reducing the pressure the temperature was further reduced to 0·9° Abs. Attempts were made with the pressure so low as 0·2 mm. to solidify helium but without success, and it has remained for Prof. Keesom, apparently using an increased pressure method, to complete the work which 'the master' left unfinished.

To all interested in navigation the problem of the issuing of suitable signals at danger spots in the ocean or near the coast is of the greatest interest. There are many spots where it is too expensive to provide a keeper to attend to the light and fog signals; where also, on account of the rocky bottom, strong tides, and ships' anchors, it is impracticable to maintain a submarine cable connexion. It is interesting to hear, therefore, that the Marconi Company has established an unattended fog-signal station on Rosneath Beacon on the Firth of Clyde. It was installed last January and its working has proved very satisfactory. The control is by radio waves, and we see no reason why the same method should not be applied to control other kinds of mechanical apparatus acting at a distance. Rosneath Patch is a sandbank in mid-channel at the mouth of the Clyde between Gourock and the opposite Argyllshire coast. A reinforced concrete beacon marks the Patch. Automatic apparatus has now been installed which gives signals by exploding a mixture of air and acetylene gas. Once started, the 'guns' continue giving explosions until they are switched off or until the acetylene gas is exhausted. These guns are the only automatic signals at present in use, being cheap to install and maintain. At Rosneath Beacon they get their supply of acetylene gas from a carbide-to-water plant. A radio receiving apparatus is fitted and is synchronised with the transmitting set on Gourock Pier, 1¼ miles from the Beacon. When fog is observed, the transmitting apparatus is put into operation and the radio impulses act on the receiving apparatus. The signals being periodic prevent atmospherics acting on the receiving set. When the fog clears, another set of periodic impulses having a different period is transmitted and stops the signals. The annoyance to the neighbourhood is thus reduced to a minimum. The essential features of the sending apparatus are a pendulum and mercury break, a spark coil and a quenched spark transmitter.

THE Cretan earthquake on June 26 has been followed by others in various parts of the world, on June 28 in Sumatra and Rhineland, on June 29 in southern California and at Salisbury in southern Rhodesia, and on June 30 by another in Sumatra. In a letter published in the *Times* of June 30, Prof. Turner places the epicentre of the Cretan earthquake in 35° 0′ N. lat., 24° 0′ E. long., or just south of Crete, the same spot having been the seat of seven smaller earthquakes between 1913 and 1922. The damage at Candia and in some of the surrounding villages was considerable, including injury to many of the remains from Knossos collected in the Candia museum. A telegram from Rome, dated June 28, states that more than two thousand houses have been destroyed by earthquake-shocks in several villages in the province of Foggia in southern Italy, but these shocks can scarcely be connected with the Cretan earthquake, even if they occurred on the same day. The earthquake in Rhineland at 11 P.M. on June 28 was evidently felt over a wide area, at Cologne, Freiburg and other places in Germany, at Basel and Bern in Switzerland, and at Strasbourg, Epinal and Belfort in France. Though few details are as yet known of the Sumatra earthquake of June 28, it was clearly one of great strength, for many villages have been destroyed, and the railway and main roads near Padang have been much damaged. One of the most interesting of the recent earthquakes was that in southern California on June 29. At Santa Barbara it was strong enough to cause some very slight damage. It was probably an after-shock of the destructive earthquake in the same district on June 29, 1925 (NATURE, 1925, July 11, p. 56, and August 29, p. 324).

THE Royal Air Force display, such as was seen at Hendon on July 3, is more spectacular than the old *Kaisermanöver* and more exacting than Fleet exercises, and sums up from year to year the visible progress in design, operation, and discipline. A hundred and thirty aeroplanes in the air during the day, with half-a-dozen out of action from minor causes, is a remarkable achievement of design and maintenance. Types ranged from the 700 h.p. single-seat fighter, with corresponding speed and climb, to the eight-ton twin-engine bomber (900 h.p.), and the three-engine 20-seat commercial aeroplane (1000 h.p.). 'Aerobatics' by individual pilots, squadron drill with nine aeroplanes, orders being given by radio telephony, and group drill with six squadrons, stirred the layman to loud applause and the expert to deep appreciation. The Hill tailless aeroplane and the first British-built Cierva autogyro might be considered as outward signs of the work of the Director of Research, which

also lies less directly and visibly behind all manner of detail advances in standard equipment. From this pageant and from day to day work we may judge soberly that the British Air Service is holding its own in a keenly competitive world.

SIR FLINDERS PETRIE, in a letter to the *Times* of July 2, reports on the work of the British School of Archæology in Egypt during the past season. The investigations of Mr. R. S. Sandford on the history of the Nile during the pluvial period, carried out in the region between Thebes and Sohag, have linked the gravels carried down from the eastern granite mountains with palæolithic man. Starting from a gravel terrace at 150 ft., the 100-ft. terrace was laid down during the Chellean and early Acheulean period, the 50-ft. terrace in Acheulean times, while the latest gravel terrace at 10 ft. above river level contains Mousterian implements. Miss Thompson, continuing her work in the Fayum, has found, in addition to crude pottery and a large number of flint arrow heads and knives, a new feature in the form of granaries situated at a higher level. These are about 3 ft. across and sunk in the gravel. They are lined with coiled straw rope. The grain was mostly emmer and barley, but also included true wheat. Investigation of the tumuli on the island of Bahrein in the Persian Gulf by Mr. Mackay produced scanty results; but a bronze spearhead indicates a date of 1200–1500 B.C., which is supported by the character of the pottery. The forms of the pottery include Mesopotamian types, but the greater part is entirely independent. The work on the back of an ivory statuette is like nothing known elsewhere.

THE weather for the second quarter of the year, April-June, was generally wet, cool, and dull in the British Isles. Warm and bright weather at this season is so essential for vegetation that a few facts gathered from the Greenwich weather observations, which represent the south-east of England, may help to show the absence of fair conditions. The rainfall was in excess of the average in each month, yielding an excess of 3·66 in. for the three months ending June. April was mild, but the latter part of the month was colder than the early part; April 25 and 26 had maximum day temperatures below 50°, and for seven days from April 20-26 the maximum day temperature was below 54°, the normal maximum for the month being 57°. May was unusually cold for the first 20 days, and during this period the maximum temperature was only above 60° on 4 days; the highest day temperature was 63°. Warmer weather set in after the third week, which brought the mean temperature for the month to 52°·5, which is only 1°·5 below the normal. In June only 8 days at Greenwich were above the average, and 22 days were below the average temperature. The absence of bright sunshine was evidently the cause of the continued cool weather. April had sunshine for 101 hours, which is 3·37 hours a day, or 1·65 hours a day less than the normal; there were only 11 days with more than 5 hours' sunshine, and in all, only 6·4 hours' sunshine in the last 11 days of April. May had 149 hours' sunshine, which is 4·81 hours a day, or 1·66 hours a day less than the normal. In June the total sunshine was 180 hours, or 5·99 hours a day, which is 0·71 hours a day less than the normal.

THE evolution controversy in the United States still sends echoes across the Atlantic. The *Forum*, an American periodical for an intelligent but non-specialising public, has in its June issue a reply by Prof. H. Fairfield Obsorn to an article attacking the "Fancies of the Evolutionists," by John Roach Straton, which appeared in February last. Prof. Osborn sets out to demonstrate "certain irrefutable facts" constituting the evidence for the geologic antiquity and creative evolution of man. The article is both a summary of present knowledge relating to the origin, evolution, and distribution of mankind, and a history of discovery in this province of research, necessarily in both cases brief and in outline only. The accusation of a conspiracy among evolutionists is met by a statement of the fact that in the case of crucial discoveries, such as that of the Trinil skull or Neanderthal man, the interpretation which assigned them the place in the human evolutionary series which they now hold was not immediately and universally accepted by scientific men. Further, Prof. Osborn points out that the experience of a hundred and fifty years, or on some matters of centuries, has brought the methods of scientific research in this field to such a point that the evidence can be interpreted with certainty and precision. The data are not "blurred or indecipherable documents like the palimpsests of many sacred writings, but are absolutely unchallengeable records as clear as daylight to the man who has learned how to read them" —a statement to which Prof. Osborn's own article may perhaps suggest some slight reservation. The existence of a fact is indisputable, but what of its interpretation? Prof. Osborn himself did not at one time accept the human attribution of the Piltdown jaw. However, his position is sound, and the main argument is not to be shaken by a minor inconsistency.

MR. HERBERT KRIEGER, of the United States Museum, while on his way to south-eastern Alaska, where he will carry on the work of restoration of the totem poles of that area, has made a survey of the pit-house sites of the old Yakima and Klickitat Indians of the Columbia River region of the State of Washington. This area would appear to have supported one of the densest populations in early America. Mr. Krieger reports the existence of a chain of house-sites stretching for 500 miles along the banks of the Columbia from the Dalles in Oregon to the Canadian border. The river was undoubtedly one of the great trading centres and routes of travel. Eight skeletons and forty-five artefacts were obtained by excavation in a burial ground. The artefacts showed no sign of Hudson Bay Company influence. The skulls exhibited cradle-board deformation similar to that of neighbouring tribes of to-day. Pictographs cut in the basalt cliffs of the river bank showed shields, bows, arrows, goats, big-horn sheep, and

designs suggestive of the rising sun, lightning, and so on. It is perhaps worth mention that Mr. Harlan I. Smith has recently recorded pictographs, which these would appear to resemble, found in a similar position in British Columbia.

THE *Times* of June 29 contains an interesting account of the recent Hokkaido eruption written by its Tokyo correspondent. Like some other Japanese volcanoes, Tokachi has two peaks. One of them has a fairly well-defined crater with its north-east wall denuded or blown away. The other, known as Iwo-dake or sulphur mountain, had a small crater occupied by a lake. On May 7 the mountain, supposed to be extinct, showed some signs of activity: slight rumblings were heard and a small column of steam was emitted. On May 23 the rumblings, which had continued, became more pronounced, and on the following day the crater of Iwo-dake was breached by the rising lava-column, a large portion of the crater-wall fell down the mountain-side, and the water of the lake was released. The resulting destruction and loss of life were caused chiefly by the avalanche of mud, which swept over an area ten miles long with a maximum width of four miles. Its force is shown by the fact that at Kami Furano a mile and a half of the railway line was torn away and twisted like wire. When the water subsided, an area of ten square miles of highly cultivated rice land was left covered by a layer of sandy mud with an average thickness of 18 inches.

WE must all deplore the disappearance of examples of English architecture dating from the Middle Ages and later which is rapidly taking place in our villages owing to economic and social development. The awakening of public interest in this matter is tardy and spreads but slowly among those in whose hands control is vested. Sir Frank Baines's lecture on "The Preservation of Ancient Cottages," delivered before the Royal Society of Arts on May 6 last and now published in that Society's journal, is opportune, and should be made widely known. As he points out, the ancient workman's cottage is not merely a thing of considerable beauty; it is almost the sole piece of tangible evidence we possess of the social and economic position and of the material conditions of life among the peasant population from the Middle Ages up to the seventeenth and early eighteenth centuries. The lecture, as published, is illustrated by photographs of a large number of examples of this class of domestic architecture. Of these, the number which have now disappeared, among them some of the most beautiful and characteristic, is in itself an eloquent argument for the urgent necessity of early action.

DR. F. A. BATHER, president of the Geological Society, will unveil a mural tablet to William Smith on July 10 at 29 Pulteney Street, Bath. After the unveiling ceremony, there will be a luncheon at the Guildhall, to be followed, in the afternoon, by an address by Dr. Bather at the Royal Literary Institution on William Smith and his work.

SIR ERNEST RUTHERFORD (Cambridge), Sir Frederick Hopkins (Cambridge), Prof. H. A. Lorentz (Haarlem), and Dr. H. L. le Chatelier (Paris), were elected foreign members of the Académie Polonaise des Sciences, Cracow, last year. In conformity with the statutes of the Academy, such elections have to receive the sanction of the president of the Republic of Poland. We are glad to know that this has now been given, and that the elections can be announced.

SIR JAGADIS C. BOSE, founder and director of the Bose Research Institute, Calcutta, who is at present in England lecturing and giving experimental demonstrations on plant stimuli and responses, has been elected president of the Indian Science Congress to be held in Lahore in January next.

ROYALTY has always been credited with the parentage of anecdote, but we hope that this one is genuine. A charming young American, having met the Prince of Wales at a reception, asked him to tell her how he ought to be addressed, as, for example, on an envelope. The Prince—says the story—took her programme and wrote upon it: "To His Royal Highness, The Prince of Wales, K.G., F.R.S."

UNDER the title of "Illumination Research," the Department of Scientific and Industrial Research has issued a pamphlet, which will be supplied gratis on request, in which the work of the Illuminating Research Committee appointed in July 1923 is described. At the present time the following problems are under investigation: The transmission of light by window glass, the effect of the colour of the walls of a room on the light in the room, the use of prismatic glass in the windows, the lighting of picture galleries, the effects of enamel reflectors as used in works, the effect of glare on the eye and the influence of the amount of light on the ease and accuracy with which fine work can be done. The pamphlet does not deal with finance, but there are few who would care to challenge the expenditure of a few thousand pounds in this way in order to determine how best to get value for the millions of pounds spent annually in Great Britain on illumination.

WE have received the "Classified List of Publications of the Carnegie Institution of Washington" dated December 1925. This, with its detailed abstracts, is itself a publication of some value; but it does not appear to indicate clearly those works that have been issued since the distribution of the previous list.

WE have recently received volume 3, for 1924, of the *Publications biologiques de l'École des hautes Études vétérinaires*, Brno. Ten contributions are contained therein; in the index they are paged consecutively, but in the text, pagination commences afresh with each paper, a much less convenient arrangement. Botanical problems of development are dealt with, by Staroštík, on the bud of *Ficaria verna* and the influence of external agents on its growth, by Pavlů on the histology of the beet, and by Václavík on correlation between cotyledon and axillary bud in the pea. The other seven papers are zoological or physiological, again with emphasis on the experimental study of development.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in experimental physiology in the University of Manchester—The Internal Registrar (July 14). A junior lecturer in mechanical and electrical engineering and a junior lecturer in geography at University College, Nottingham—The Registrar (July 17). An organiser of mining instruction for Derbyshire—Director of Education, County Education Office, S. Mary's Gate, Derby (July 17). A research chemist for work on plasters and other materials used for impressions and models in dentistry—Secretary, Department of Scientific and Industrial Research, 16 Old Queen Street, Westminster, S.W.1 (July 21). An assistant at the Commonwealth of Australia Observatory at Mount Stromlo—The High Commissioner for Australia, Australia House, Strand, W.C.2 (July 22). A temporary assistant chemist at the Naval Ordnance Inspection Depôt, Holton Heath—Secretary of the Admiralty (C.E. Branch), Admiralty, Whitehall, S.W.1 (July 24). An assistant lecturer in pure mathematics at the University College of Wales, Aberystwyth—The Secretary (July 28). Temporary assistant chemists in the Government Laboratory—The Government Chemist, Clement's Inn Passage, Strand, W.C.2 (July 31). An additional zoologist for the *Discovery* Expedition—The Secretary, *Discovery* Committee, Colonial Office, Downing Street, S.W.1 (July 31). A junior technical officer for the wireless experimental department of the Royal Aircraft Establishment—Superintendent, R.A.E., South Farnborough, Hants (July 31, quoting A.79). A botanist for the agricultural department of the Government of Nigeria—Private Secretary (Appointments), Colonial Office, 38 Old Queen Street, Westminster, S.W.1 (August 15). A director of the Veterinary Laboratory of the Ministry of Agriculture and Fisheries at New Haw, Weybridge—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (November 1). A director of research under the Research Association of British Paint, Colour and Varnish Manufacturers—Mr. J. B. Graham, 8 St. Martin's Place, W.C.2. A man with teaching experience in physics, chemistry and mechanics—Cordwainers' Technical College, St. John's Lane, E.C.1. An assistant at the Darlington Technical College, chiefly for geometrical and engineering drawing, and either engineering science or mathematics — Chief Education Officer, Education Office, Darlington. An advisory agricultural economist at the Midland Agricultural and Dairy College, Sutton Bonington, Loughborough — The Principal.

Our Astronomical Column.

LARGE SUNSPOTS.—The naked-eye sunspot recently noted in these columns was followed shortly afterwards by the appearance of another which was seen as a naked-eye object from June 26 until July 1. In a small telescope, the spot appeared elongated with a double umbra ; there were several small companions near it and others in a cluster following at some distance. Details of position, etc., are given below in the usual tabular form. This latest spot brings the total number of naked-eye spots to eight for the first six months of 1926, as compared with eight for the whole of the preceding year.

No.	Date on Disc.	Central Meridian Passage.	Latitude.	Longitude.	Area.
8	June 23–July 5	June 29·2	21° N.	140°	1/1250

(Area expresses the proportion covered of the sun's hemisphere.)

PONS-WINNECKE COMET AND METEORS.—Mr. W. F. Denning writes : "Announcements emanating from Russia have been published to the effect that a meteoric shower might occur between June 24 and July 1. The fact that the parent cause, Pons-Winnecke's comet, would be situated at a distant point of its orbit, which it occupies twelve months before perihelion, robbed the prediction of any weight that it might otherwise possess. It is true that in 1916 there was a meteoric shower ten months after the comet had passed its perihelion, but there were great doubts as to whether the cometary materials were abundant at a spot so remote in front of it. The result of observation was anticipated, for though June 24-30 proved fairly clear, few meteors could be seen in the brilliantly moon-lit skies of the period.

Meteoric observers will anticipate a shower next year with more confidence and with conditions which appear to be favourable. Even in 1928 there may be many meteors seen, judging from the experiences of 1916, which showed that they were distributed far behind the comets. Probably also the stream is spreading out with time, and that even if the ellipse is not at present continuous it will ultimately assume that form.

The brightest meteor lately seen was on June 27, $23^h\ 20^m$ G.M.T. The meteor was moderately slow and about equal to Jupiter : duration, 2 sec. The probable radiant was in Sagitta and far from that of the Pons-Winnecke comet. The meteor was also observed by several other persons in Bristol, and they mention it as giving a distinct flash like summer lightning."

NOVÆ.—The *Observatory* for June contains a detailed summary of the paper read by Dr. J. Lunt on Nova Pictoris at the May meeting of the Royal Astronomical Society. The radial velocity indicated by the dark lines gradually increased, being (in km./sec.) −71 in 1925 May, −81 in early June, −92 in late June, −320 July to August, −395 in mid-September, −411 in January, −436 in March. Bands resembling those in η Argus began to appear in October, and gradually became more evident. The nebular bands customary in the later stages of novæ did not appear until March. Dr. Lunt endorses the words of Prof. Hartmann's telegram to *Astr. Nachr.*, "The star swells up and bursts." He considers that the star was discovered at the simmering preparatory stage, and that the explosive ebullition came later. The cause is conjectured to be a release of atomic energy within the star.

F. Pingsdorf of Parana (Argentine) gives a series of measures of brightness of the nova. The following summary gives the magnitude at the beginning of each month : December $4{\cdot}2^m$, January $4{\cdot}3^m$, February $4{\cdot}6^m$, March $5{\cdot}1^m$, April $5{\cdot}4^m$, May $5{\cdot}5^m$. The star thus remained an easy naked-eye object for a year, which is longer than most recent novæ, though less than Tycho's famous star.

Beobacht. Zirk. No. 23 contains a note by Prof. M. Wolf on his faint nova in the spiral nebula N.G.C. 4303 (Messier 61). He obtained two photographs on June 1 that show a marked diminution of light since discovery on May 12. Its magnitude was then about 14^m, and 15^m on June 1 ; on the latter date it was $0{\cdot}2^m$ fainter than the star south preceding the nucleus at a distance of 1·3′. This rapid decline makes the American estimate of the star's total light as being 10 million times that of the sun appear somewhat doubtful.

Research Items.

DEPOPULATION AND DISEASE IN THE NEW HEBRIDES.—Dr. P. A. Buxton, of the London School of Hygiene and Tropical Medicine Expedition to the South Pacific, in a communication to the Royal Society of Tropical Medicine and Hygiene, which is published in vol. 19, No. 8, of the *Transactions* of that Society, discusses the question of depopulation in the New Hebrides and examines the evidence bearing on the statement generally made as to the extent to which this is due to diseases introduced by Europeans. Depopulation appears to be going on rapidly on all the islands except Tanna, Aniwa, and the north part of Pentecost. On Tanna, Tonga, Tongariki, and Buninga, numbers are stationary or rising, and on Futuna and Aneityum they may have reached their lowest and begun to rise. A calculation based on figures going back as far as any records are available for the five islands Aneityum, Aniwa, Futuna, Erromanga, and Epi, shows that there is no consistent rise or fall throughout the period, which in one case goes so far back as 1865. This seems to imply that the principal causes of depopulation were as active in the last century as now. To some extent the decline may be due to native customs—the institution of gerontocracy, which reserved marriageable females to the old males, abortion, a practice which repression of polygamy tends to increase, wars, belief in magic, bad housing, and unsuitable feeding of infants. The evidence of pedigrees shows an actual decrease in the birth-rate. The recruitments of native labour carried off the younger men as well as introduced disease. Of diseases, the most serious are malaria and yaws, but dysentery and pulmonary diseases play an important part. Two disquieting facts are that the rate of decline is no less now than it was fifty years ago, notwithstanding the abolition of 'blackbirding' and the reduction in the severity of epidemics, and that about 118 males are born per hundred females, this disproportion persisting through life. These facts almost warrant the prediction of the eventual extinction of many of the races now living in the New Hebrides.

THE ARTIFICIAL PRODUCTION OF LUSTRE ON FLINT IMPLEMENTS.—Mr. W. J. Lewis Abbott, 8 Grand Parade, St. Leonards-on-Sea, writes to say that he has discovered a process which simulates the somatic change in flint implements responsible for the production of the high glaze usually accepted by archæologists as a criterion of age. He points out the inapplicability of the term 'patina'—in origin a term used to describe the surface lustre of bronze—to all the various types of metamorphosis to which flint is subject. These metamorphoses are either superficial or somatic. The high glaze which arises from the superficial metamorphosis is due to attrition and can be produced artificially by sand-blast or running water charged with sand. The somatic metamorphosis in Nature is practically confined to the vitreous variety of flint, although it sometimes occurs in the normal and very rarely in the cryptogranular. In mixed flint it will appear in the vitreous and stop at the cryptogranular. The black, almost opaque flint becomes like a slightly clouded, otherwise colourless, clear hyalite, more brilliant and transparent than 'Hungarian' opal, taking the most brilliant colours in the presence of various salts of iron. The metamorphosis takes place below the surface and works towards it until the conversion is complete, or it may occur in excessively small islands. The specimen may retain its elasticity, but if this is lost, it is obvious that the implements were made before the alteration set in. This form of metamorphosis has now been produced artificially. Flint—vitreous, normo-vitreous and normal—fashioned into implements by Mr. Abbott himself, has been submitted to a certain process which has entirely opalised it, with the result that the nearly opaque flint is now translucent, of various shades of brown, and has a most brilliant glaze. Specimens have been submitted to Sir Arthur Keith, who states that he has "never seen a richer or finer patina," and characterises Mr. Abbott's discovery as "very clever and dangerous."

FISH STOCKING IN AMERICA.—Mr. C. W. Creaser has recorded the results of successful attempts at stocking the upper waters of the Great Lakes with smelt, *Osmerus mordax* (*Michigan Academy of Science, Arts and Letters*, vol. 5, 1925). All the eggs used in the various stocking operations were from Green Lake, Maine; the smelt, which is a native of this lake, belongs to a freshwater race of the marine species common along the North Atlantic coast. Evidence is produced to show that transplantation of eggs, which was first started in 1906 and was continued in different years up to 1921, has led to firm establishment of the species, and that in some localities natural spawning has been going on for several years. Mr. Creaser gives an interesting account of the spawning of this fish in Crystal Lake, Michigan; this takes place very early in the spring (April), before the ice breaks up in the lake as a whole. The fish move in a body into small streams; the main run is at night, most fish returning to the lake in the daylight. A vivid description is given of the solid masses of fish assembling to spawn. The fish were extremely susceptible to light, which they avoided; so strong was this reaction that the entrance of fish into the stream could be regulated by a flash-light. A reaction to currents was also exhibited. A note on the feeding habits of the smelt elicits the fortunate fact that the adults feed in the summer almost entirely on a species of minnow on which other fish do not feed, and that hence they cannot be regarded as serious competitors for food. Details of age determination by scale reading are given; the smelt first breeds at the end of its second winter.

BOT FLIES OF THE PUNJAB.—*Bulletin* 160, *Agricultural Research Institute*, Pusa, 1926, is devoted to an account of certain of the bot flies prevalent in the Punjab and is written by Captain H. E. Cross. A very common species, forming warbles in goats, is *Hypoderma crossii*, which infects 40-90 per cent. of those animals in the Salt Range area. The larvæ, pupa and adult of this species are described and figured, but the eggs have so far remained undiscovered. The ox warble, *Hypoderma lineatum*, and its occurrence in the Punjab is noted, and this appears to be the first record of its being found in India. The camel bot fly, *Cephalopsis titillator*, is widely distributed throughout the Punjab and various stages in its life-cycle are figured and described. This insect is viviparous and the first stage larvæ occur in the nostrils of the camel. When about 7 mm. long until fully grown they are met with in the pharynx and are finally expelled through the nostrils, pupation taking place in the soil a few hours later. So far as known, the species does not entail much injury to its host, but it is possible that it may cause *kapauli* (pus in the sinuses), which is a fatal disease. Among other species the common sheep bot, *Oestrus ovis*, the wild sheep bot, *Oestrus*, sp. nov. ?, the horse bot, *Gasterophilus equi*, are also dealt with. The bulletin concludes with a brief discussion of the injuries caused by these flies and of the methods of treatment.

THE SWAMP CYPRESSES.—The swamp cypresses, and particularly Glyptostrobus, are not well known in Great Britain, so that the taxonomic and anatomical notes by Prof. Augustine Henry and Marion McIntyre in the *Proceedings of the Royal Irish Academy* (vol. 37, B. 13, 1926) will serve a useful purpose. Glyptostrobus, the water-pine of the Chinese, they conclude, is a monotypic genus; this species being found only in two swampy localities in south-eastern China. The Chinese regard the presence of the tree as propitious to the rice crop, and the villagers resist its molestation, even by the photographer. *Glyptostrobus pensilis* is also one of the rarest cultivated trees in Europe, only one specimen growing in the open being known to the authors (at Nymans, Sussex). There are living plants under glass at Kew and Glasnevin. The three living forms of the much better known swamp cypress of America, Taxodium, are also passed in review as to macroscopic and microscopic characters of branchlets, leaves, flowers and cones, in order to permit a comparison with Glyptostrobus. In view of the necessity, often present to the palæobotanist, of distinguishing between genera on structural features alone, a comparative study of the wood of these two genera and also of Wellingtonia and Sequoia is included in the paper.

BIOCHEMICAL DIFFERENCES BETWEEN THE SEXES OF MUCORS.—In the Mucors, Blakeslee, in particular, has shown that in many species two sexual strains may be distinguished; individual mycelia of the same sex will not conjugate, whilst conjugation occurs freely between mycelia of different sex. These 'heterothallic' strains thus occur in sexual pairs, but the form and structure of one sex is practically identical with that of the other, and, apart from the behaviour on conjugation, the two sexes cannot be distinguished, except, perhaps, by a difference in vigour of growth. Blakeslee has provisionally designated these as (+) and (−) strains, the plus strain being the more vigorous when this growth distinction can be drawn. Sophia Satina and Blakeslee now report (*Proc. Nat. Acad. Sci.*, Washington, March 1926), in a preliminary manner, upon a biochemical study of these Mucor sex strains. They conclude that the (+) and (−) races show significant, average, biochemical differences in respect to (*a*) the Manoilov reaction, (*b*) catalase content, (*c*) reduction of potassium permanganate by extracts of the mycelium, and (*d*) reduction of tellurium salts in living cells. In a subsequent paper they apply biochemical tests to unisexual flowering plants, obtaining additional evidence in support of the conclusion that the female plant and the (+) strain of a Mucor show similar biochemical behaviour. A certain statistical element enters into this type of observation. As the authors put it, the general rule that the human male is the heavier is not vitiated by the fact that on chance selection of a human pair an especially buxom female might be put in contrast with a meagre male.

AGRICULTURE IN ARID LANDS.—In a paper on the struggle with arid conditions in the Volga region (*Matériaux pour l'étude des calamités*, No. 8, January-March 1926) Mr. N. M. Toulaikoff, who is director of the experimental station at Saratoff, makes several constructive suggestions for safeguarding agriculture against the arid conditions in the Volga region. An average rainfall of about 16 inches is small enough considering the summer heat, but it is not the slight total amount that natters so much as its irregularity in fall. While poor crops and want occur generally in years of deficient total rainfall, there have been instances of abundant crops in years of scanty rainfall. In those years the rain fell in the seasons demanded by the crop. The main crop of the peasants has always been summer wheat, which suffers severely from spring drought and cannot recover when the rains come so late as June and July. More satisfactory crops would be rye, which develops before the most usual period of drought, and maize, millet, sorgho, and beet, which develop in June and July and do not suffer from the prolonged heat of summer. A study of these problems has been made on experimental farms, and it is considered that the likelihood of famine could be minimised if not banished by adapting agriculture to the peculiarities of the climate.

GEOLOGY OF THE WEALD.—Among regional surveys now being carried out may be mentioned the work of the Weald Research Committee of the Geologists' Association. This consists of a geological survey on the 'six-inch' scale of the Weald, which is being actively pursued by the members of the Committee, who number about two dozen, each member having undertaken to survey the country comprised in at least one 'six-inch' sheet. It is just over fifty years since the survey by W. Topley was published by the Geological Survey, but while our knowledge has been extended locally, no general geological survey has been attempted previous to the initiation of this committee. No point of geological interest is being neglected; the petrology as well as the palæontology of the beds is being worked out in detail, while a good start has been made in the complex problems involved in the denudation of the area. This branch of the work will occupy a considerable time, but some points of interest are already being elucidated; for example, a late Pliocene terrace discovered in the Mole gap has produced widespread planation in the district especially north of Ashford. The Committee has very properly not set itself any definition of the Weald, for its researches must extend well beyond the region to which the name applied originally. In this connexion the gravels of Rayleigh in Essex may be cited. These contain pebbles of Lower Greensand chert, which may have been derived from the Weald through the Medway gap, and if this proves to be the case the pebbles travelled across what is now the lower Thames.

THE TRAVEL OF DEPRESSIONS.—The *Meteorological Magazine* for April gives an interesting and descriptive account by Lieut.-Col. E. Gold, assistant director of the Meteorological Office, on the foregoing subject. The article should prove most instructive to meteorologists not well versed in the new ideas relative to cyclones which are proving of immense value to the weather forecaster, either official or otherwise. From the initiation of forecasting, cyclonic depressions have necessarily proved almost the controlling feature. The movement of cyclones in the British Islands and their vicinity differs so widely, and the area controlled or affected varies so considerably, that it seems almost impossible to forecast effectively. The development by Bjerknes of the idea of cold and warm sectors in the individual cyclones separated by definite surfaces of discontinuity has enabled the Bergen school to divide cyclones into different classes according to their stage of development. They draw a distinction between (*a*) cyclones which have a definite warm sector with definite lines of separation from the cold sector, and (*b*) cyclones in which there is no warm sector at the surface of the earth. Class (*a*) are generally growing cyclones which usually move with increasing speed as they grow, and Class (*b*) are dying cyclones which tend to become stationary. In Class (*a*) the centres of the cyclones move in the direction of motion of the air in the warm sector, and approximately with

the speed of motion of the warm air; a diagrammatic representation is given of such a cyclone. A description is also given of Class (*b*), in which there is no warm sector. Cyclones of Class (*a*) eventually lose their warm sector and change into Class (*b*); the warm sector only disappears at the earth's surface, the warm air being lifted up by the colder air, and the discontinuity will continue to exist at greater heights. The author alludes to the difficulty of giving in so short an article anything like a complete account of the technical investigations, but his mastery of the subject has suggested much which is helpful to the less initiated.

ELECTRON EMISSION ENERGY WITH OXIDE CATHODES.—In the *Zeitschrift für Physik* of April 30, Herr H. Rothe describes a series of measurements on a number of triode valves with oxide cathodes in which the energy of emission of the electrons was determined, using Richardson's equation, and also by means of the cooling effect produced by the emission. The values found by the two methods, which agreed quite well with one another when the emission current was saturated, were exceedingly small. The relation between the emission from such cathodes and the amount of gas removed from them was investigated. It seems that it is not possible to free oxide cathodes from gas perfectly; apparently the emission current which passes through the oxide layer radially decomposes the oxide and so constantly produces new gas. The author considers that the high emission of these cathodes depends on the metal particles, produced by this decomposition, which remain embedded in the oxide. It is noted that if the emission current is below the saturation value the cooling effect is considerably greater than that corresponding to the energy of emission. A fatigue phenomenon has been investigated, which in almost all the tubes caused the emission current to fall off rapidly with the time.

THE PALLADIUM-HYDROGEN EQUILIBRIUM.—The absorption of hydrogen by palladium has been the subject of much experimental study since it was first reported by Graham, and the results of the latest investigation by L. G. Gillespie and F. P. Hall appear in the *Journal of the American Chemical Society* for May 1926. They describe a method of securing equilibrium by means of a new heat treatment, and the isotherms which they determined indicate the presence of two solid solutions. At the higher temperatures the solution richer in hydrogen is said to consist of a hydride Pd_4H_2.

SILVER IODIDE IN GELATIN IODO-BROMIDE EMULSIONS.—R. B. Wilsey has recently found, in studying the crystal structure of mixed crystals of silver iodide and bromide, that the cubic lattice characteristic of silver bromide has some of its bromine replaced by iodine with an enlarged lattice spacing when it is crystallised with silver iodide. But when the iodide is present to the extent of about 40 per cent. or more, there was a second lattice spacing corresponding to that of silver iodide. Emery Huse and C. E. Meulendyke of the Kodak Research Laboratory (*Journal of the Royal Photographic Society*, June, p. 306), have sought to fix the proportion of silver iodide present when it begins to form separate crystals from a mixture of the two salts. A series of gelatin emulsions was prepared containing increasing quantities of iodide, and exposures in a spectrograph were developed physically, as silver iodide is scarcely amenable to alkaline development. The physical development of silver iodide gives a very sharp-edged sensitivity limit at wave-length 440 mm., and as the iodide was increased this first appeared when the iodide constituted 32 per cent. of the mixed haloids, and remained as the iodide was increased, and was entirely lacking at 30 per cent. or less. The authors therefore conclude that silver iodide separates in emulsions of this type as definite crystals, apart from the silver bromide, when the silver iodide content reaches approximately 32 per cent.

HELIUM IN NATURAL GASES OF JAPAN.—The thirteenth report of the Aeronautical Research Institute, Tokyo Imperial University, published early this year, contains an account of an examination of natural gases from Taiwan, Hokkaido, Honsyu and Kyusu, primarily for helium, by Messrs. Y. Kano and B. Yamaguti. The gas samples were taken from various sources, such as oil reservoirs, coal-mines, mineral springs and volcanoes, and were analysed for helium by Cady and McFarland's method, for other constituents by Hempel's standard method. The purity of the helium was tested spectroscopically. Carbon dioxide, sulphuretted hydrogen, oxygen, carbon monoxide, methane, ethane, nitrogen and heavy hydrocarbons were among the chief constituents of the gases investigated, and from the analytical results it has been possible to classify the natural gases into three types rich in carbon dioxide, in hydrocarbons and in nitrogen respectively; as in the case of helium in American natural gas, the percentage of this element is highest in nitrogen-bearing gas. The helium content of some mineral spring gases examined reaches 0·2-0·3 per cent., but unfortunately the amount of gas available from this source is strictly limited and insufficient for industrial purposes; very small quantities of helium were found in the gas from the Taiwan and Hokkaido areas, where it is associated with petroleum, the average being 0·005 per cent., again an impracticable amount for commercial purposes. The oil and gas reservoirs of Taiwan and Hokkaido are of Tertiary age, from which the low helium content of the gas from these sources is accordingly explained. The authors find that the percentage of helium in a hot spring gas depends to a certain extent on emanation content, though no direct ratio could be established, this agreeing with McLennan's conclusions with regard to Canadian natural gas. Samples containing no helium generally possess the least radioactivity, and this to some extent supports the theory that the origin of helium in natural gas is to be ascribed to disintegration of radioactive substances; if this is so, then it is clear that the geological age of a gas reservoir is an important criterion of helium possibilities.

SIZES OF AERODROMES.—It is a matter of some considerable importance to determine the size of aerodrome necessary in order that a landing may be made on it if engine failure occurred at any time during getting off. In an interesting paper by H. Glauert to the Aeronautical Research Committee (R. and M. 996, pp. 10. London: H.M. Stationery Office, 1926, price 6*d*.), this question is investigated more especially in the two cases: (1) where the aeroplane continues in its original direction after the engine failure; and (2), where the aeroplane, climbing on a steady turn, on failure swings back into the wind. A comparison of the results of these two cases shows that an important saving in the necessary size of the aerodrome can be secured by the turning climb, but the size of aerodrome indicated is larger than that of current practice unless the stalling speed and power loading are limited. Curves are given showing the necessary size of aerodrome in terms of stalling speed and power loading of the aeroplane. In particular, the required size of the aerodrome was found to decrease as the angle of climb increases and as the stalling speed decreases.

The Chemical Constitution of Thyroxine.

ALTHOUGH the stimulant action of the thyroid gland upon the general metabolism of the body has been recognised for more than a generation, yet it is only within the last decade that the isolation of a pure crystalline principle, possessing the stimulating effects of the whole gland, has been successful. This was first accomplished by Kendall in 1914; since then this author has described a number of the derivatives of the pure substance, which he called "thyroxin," and has suggested a structural formula for it. Our knowledge of it has now been carried a step further by Harington, who has improved the method of extraction so that it gives a much higher yield than Kendall's method, and has proceeded, with the larger amount of material thus available, to determine its chemical constitution by methods of degradation and synthesis. Although at present synthesis has only been carried to the penultimate stage, there is every reason to hope, considering the way in which the author has unravelled the constitution of this compound, that the complete synthesis will soon be successful.

Before describing Harington's work, a few words may be said about the physiological properties of thyroxine. This subject, together with some recent work on its derivatives, has been reviewed by Kendall in his Chandler lecture ("Influence of the Thyroid Gland on Oxidation in the Animal Organism." By E. C. Kendall. New York: Columbia University Press; London: Oxford University Press, 1925. Price 3*s*. net). The activity of thyroxine in stimulating metabolism is remarkable: 1 mgm. injected intravenously in a patient suffering with myxœdema will increase the basal metabolic rate 2·5 per cent., corresponding to an increased output of 400 gm. carbon dioxide; the effect is, within limits, proportional to the dose. Moreover, the time relations of the response are characteristic. Thus, in a normal adult there is a latent period of six to eight hours; thereafter the metabolic rate rapidly increases but the maximum is not reached until the eighth or tenth day. The metabolism then returns slowly to normal, the rate of fall depending on the amount present in the body. A dose of 5-10 mgm. affects the metabolism for five or six weeks. It can replace the administration of dried thyroid gland in the treatment of cretinism and myxœdema; in a normal person, not only is the metabolism increased, but also the signs and symptoms of over-activity of the thyroid gland are also produced. Under normal conditions the thyroxine formed in the body appears to be responsible for about 40 per cent. of the metabolism, since complete thyroid deficiency causes a drop in the basal metabolic rate of this order.

The principle of the method of extraction from the thyroid gland is hydrolysis with alkali, followed by precipitation of the filtrate with acid, but whereas Kendall used 5 per cent. sodium hydroxide, Harington found that 10 per cent. barium hydroxide resulted in a greatly increased final yield (C. R. Harington, *Biochem. Journ.*, vol. 20, 293, 1926). After about six hours' boiling of the dried thyroid in ten volumes of alkali, 60-70 per cent. of the total iodine appears in the filtrate; 40 per cent. of this can be precipitated on acidification as a creamy flocculent precipitate. The latter requires further hydrolysis with the alkali, when about half the iodine remains in solution and half is carried down with the insoluble barium salts; the latter contain the thyroxine. The precipitate is boiled in alkaline sodium sulphate solution to remove the barium and the filtrate precipitated with acid. The precipitate of crude thyroxine can be further purified by solution in alcohol made alkaline with caustic soda and re-precipitating with acetic acid. Further material is obtained from the gland residues by boiling with caustic soda, adding sodium sulphate, filtering and precipitating the thyroxine in the filtrate with acid. After re-crystallisation, by dissolving in alkaline alcohol and adding acid, further purification is effected by dissolving in dilute hot sodium carbonate, when the sodium salt separates out on cooling. This is re-dissolved in alkaline alcohol and the thyroxine precipitated with acid. The pure substance crystallises in rosettes and sheaves of fine needles. On heating, it darkens at 220° C. and melts with decomposition and evolution of iodine at 231°-233° C. It is insoluble in water and organic solvents; it is soluble in cold dilute solutions of alkali hydroxides, but insoluble in acids. It is soluble in 90 per cent. alcohol with the aid of either alkali hydroxide or mineral acid. The yield was about 0·027 per cent. of the fresh, or 0·12 per cent. of the dried gland, corresponding to about 14 per cent. of the total iodine originally present; Kendall's yield was 0·0011 per cent. of the fresh gland. The physiological activity of the material extracted by Harington's method was shown to be the same as that of thyroxine prepared by Kendall's process.

The compound contains 65·3 per cent. iodine; analysis led to the empirical formula $C_{15}H_{11}O_4NI_4$; Kendall's formula is $C_{11}H_{10}O_3NI_3$, and the difference between the two is due to the fact that Harington found a lower nitrogen content than Kendall. The former observer confirmed his analysis, however, on a commercial sample of thryoxine prepared according to Kendall's process. Kendall considers thyroxine to be triiodo-dihydro-oxindole propionic acid; Harington considers it to be the tetraiodo substitution derivative of the parahydroxy-phenyl ether of tyrosine.

The arguments in favour of the latter appear conclusive: the products of disintegration of the molecule have been identified; the foundation of the molecule has been synthesised and only requires the addition of the iodine atoms to become identical with the original thyroxine. The first step in the breakdown of the molecule is the removal of the iodine; this Harington accomplished by shaking a dilute alkaline solution in an atmosphere of hydrogen with a palladium hydroxide—calcium carbonate catalyst. The iodine was split off as potassium iodide, and the hydrogen taken up was exactly equivalent to the iodine removed. The resulting compound was called desiodo-thyroxine (*Biochem. Journ.*, vol. 20, 300, 1926). Its formula was found to be $HO . C_6H_4 . O . C_6H_4 . CH_2 . CHNH_2 . COOH$.

The interest of the subject appears to justify a somewhat detailed account of the successive steps in the disintegration and synthesis of desiodo-thyroxine. The facts that the latter gave positive Millon's and ninhydrin reactions, and that all the nitrogen was present as amino nitrogen, suggested that the compound was an α-amino-acid with at least one phenolic group; the proportions of carbon and hydrogen suggested the presence of two benzene rings. Fusion with potassium hydroxide produced parahydroxybenzoic acid, quinol in varying amounts according to the conditions, ammonia, oxalic acid, and a substance with the formula $C_{13}H_{12}O_2$. The latter possessed only one phenolic group; the experiment thus suggested the presence of two benzene rings, one of which has a phenolic group in the para position to a side chain, from which a two-carbon fragment is split off as oxalic acid.

Exhaustive methylation of desiodo-thyroxin gave

a product which lost trimethylamine on boiling with alkali and yielded an unsaturated acid, $C_{16}H_{14}O_4$, containing only one methoxyl group. On oxidation with potassium permanganate, oxalic acid and $C_{14}H_{12}O_3$ were formed; the latter was found to be an aldehyde which on further oxidation yielded an acid $C_{14}H_{12}O_4$. Thus methylation shows that desiodothyroxin is almost certainly an amino acid, and that it contains only one phenolic group; the splitting off of oxalic acid suggests the presence of a three-carbon side chain. Now fusion with potash led to the conclusion that two benzene rings are present; if linked through a carbon atom, a ketone should have been formed instead of an aldehyde on oxidation of the methylated product; hence they must be linked either directly or through the oxygen atom, which is still unaccounted for. Considering the latter supposition the more probable, the author proceeded to meet the degradation by synthesis.

The steps in the disintegration by exhaustive methylation and in the subsequent synthesis may be rendered clearer if the following structural formulæ are given:

Desiodo-thyroxin: HO . C_6H_4 . O . C_6H_4 . CH_2 . $CHNH_2$. COOH.
$C_{16}H_{14}O_4$ (unsaturated acid) CH_3O . C_6H_4 . O . C_6H_4 . CH : CH . COOH.
$C_{14}H_{12}O_3$ (aldehyde) CH_3O . C_6H_4 . O . C_6H_4 . CHO.
$C_{14}H_{12}O_4$ (saturated acid) CH_3O . C_6H_4 . O . C_6H_4 . COOH.
$C_{13}H_{12}O_2$ (from potash fusion) HO . C_6H_4 . O . C_6H_4 . CH_3.

The starting-point in the synthesis was parabromanisol, CH_3O . C_6H_4 . Br; on condensation with the potassium salt of paracresol in the presence of copper bronze, 4 (4′ methoxyphenoxy) toluene, CH_3O . C_6H_4 . O . C_6H_4 . CH_3, was formed. On boiling with hydriodic acid, the compound $C_{13}H_{12}O_2$ was produced, whilst on boiling with permanganate the toluene compound was oxidised to the corresponding benzoic acid, $C_{14}H_{12}O_4$.

The complete synthesis of desiodo-thyroxin was carried out by a slightly different route; parabromanisol was condensed with potassium phenate to give (4′ methoxyphenoxy)-benzene, from which, by the hydrocyanic acid method, the aldehyde $C_{14}H_{12}O_3$ was obtained. The latter could be oxidised to the acid $C_{14}H_{12}O_4$. From the aldehyde both the acid $C_{16}H_{14}O_4$ and desiodo-thyroxin were synthesised; two methods were used in the case of the latter. The aldehyde was condensed with glycine anhydride in the presence of acetic anhydride and sodium acetate; the product on boiling with hydriodic acid and red phosphorus underwent simultaneous reduction, demethylation and hydrolysis, with the production of desiodo-thyroxin. In the alternative method the aldehyde was condensed with hydantoin, which on boiling with the same reagents yielded the desired product.

As regards the position of the iodine atoms in thyroxine, the author considers that it is probable that two are present in each benzene ring, in each case lying on either side of and next to the oxy-groups, *i.e.* in the 3, 5, 3′, 5′ positions. The details of the final synthesis will be awaited with interest.

Annual Visitation of the National Physical Laboratory, Teddington.

ON Tuesday, June 22, the General Board of the National Physical Laboratory made its annual visitation of the Laboratory. As in previous years, a large number of members of scientific institutions, technical societies, Government departments, and industrial organisations were also invited to be present. The visitors were received by Sir Ernest Rutherford, president of the Royal Society and chairman of the General Board, and the Director.

The extensive programme of exhibits illustrated well the comprehensive nature of the work which the Laboratory undertakes.

In the 14-foot wind channel a model of the Cierva autogyro, which has aroused so much interest in aeronautical circles, was undergoing test. The model is mounted on three supports forming an inverted pyramid. The vertical forces on the feet of these supports can be measured, enabling the three component forces on the model to be determined, and quantitative data to be obtained for comparison with the conventional type of aeroplane. Another exhibit showed experimental arrangements for the investigation of the spinning characteristics of a model aeroplane. The model under test is mounted on an axis parallel to the wind direction in such a manner that its incidence can be varied. Examination of its behaviour permits the main features of the spinning motion to be studied so that it is possible to indicate what features in design are undesirable from this point of view.

In one of the smaller wind channels experiments were in progress to determine the convective dissipation of heat from the surface of an aerofoil in a wind current. Thin strips of platinum foil cemented to the entire aerofoil and parallel to the span can be heated electrically. Their temperatures can be determined by resistance measurements and equalised by adjustment of the currents traversing them. Measurements of their resistance and of the currents determine the rates of loss of energy from the individual strips.

A new 1-foot wind channel has been added to the equipment of the Department. This is intended primarily for the development and calibration of instruments for measuring wind speed and direction.

Among the exhibits of the Metallurgy Department were eight samples of British Standardised Steel, issued jointly by the Iron and Steel Institute and the National Physical Laboratory. These comprised four carbon standards containing respectively 0·10 per cent., 0·27 per cent., 0·65 per cent., and 1·09 per cent. of carbon, two sulphur standards containing respectively 0·027 per cent. and 0·071 per cent. of sulphur, one standard containing phosphorus (0·029 per cent.) and one manganese (0·69 per cent.). These standards are prepared from fine millings taken from six-inch bars. Millings taken from the outer layers and the core are rejected, samples of the remainder being subjected to analysis by the Laboratory and various co-operating authorities.

Specimens of pure elements prepared in the Department were also on view. Mention may be made of two of these with which some advance has been made, namely, beryllium and silicon. The former is prepared by the electrolysis of a mixture of the fluorides of beryllium, sodium, and barium, a rotating cathode being used. This is slowly withdrawn at a predetermined rate with the pure metal adhering. Special precautions are taken to prevent contamination of the metal by enclosing the salts in special crucibles. Specimens of these made of magnesia and alumina were shown in the foundry. For work on the constitution of silicon-aluminium alloys and on age hardening in aluminium alloys, very pure silicon is required. Samples were shown of 99·8 per cent. purity. Another exhibit illustrated the microscopic examination of metals usually liquid at ordinary temperatures. Such materials as are used in dental practice are included in this category. By surrounding them with a freezing mixture of carbon dioxide snow and acetone, it is possible to polish the surface to the degree requisite for microscopic examination.

In the William Froude National Tank a model self-propelled single screw vessel was shown under test. Simultaneous measurements were recorded of propeller thrust, shaft revolution, and distance travelled. These enable the propeller torque and power expended under varying conditions produced in the tank to be compared, and permit the losses due to the propeller, hull, and sea conditions to be apportioned.

In the Engineering Department research was in progress on the mechanical properties of metals and alloys for use at high temperatures, such as are experienced in modern steam engines and gas engines. At high temperatures metals generally used undergo continuous creep under steady loads, lower than those obtained in normal tensile stress determinations. Experimental work is being done to determine the rate of creep of such materials at various temperatures. For this purpose the test pieces are surrounded by an electric furnace maintained at the required temperature, a steady load being applied by a lever system. Any elongation can be measured by means of micrometers attached to the apparatus. Fatigue can also be studied in a special machine in which the stresses are produced by means of an alternating current, the specimen being heated in position by heating coils.

An investigation was also being carried out on the impact strength of chains. Normally chains are annealed periodically in order to counteract any tendency to embrittlement and the tests were designed with the view of determining the effect of this annealing on the strength of the chain. Of interest also was a trough in which the production of capillary and gravitational waves in water by means of a current of air acting on the surface was demonstrated.

In the Metrology Department, apparatus was shown for the absolute measurement of end gauges up to 4 in. in length. The gauge is converted into a Fabry-Perot étalon by means of two optical flats wrung on to its end faces, the flats having portions extending beyond the edges of the gauge, these portions being semi-silvered on their inside faces. When placed in a convergent beam of monochromatic light, interference fringes in the form of concentric circles are produced. Measurements of the angular diameter of such fringes in various monochromatic radiations enable the optical length between the two semi-silvered surfaces to be determined. The semi-silvered flats are produced at the Laboratory by the method of cathodic deposition, the glass to be silvered being placed near a silver cathode in a vacuum chamber. The apparatus employed for this purpose was on view. A monochromator, designed and constructed for use in connexion with interference measurements, was also exhibited.

In the workshop was apparatus for the study of the deformation of pivots under load. The pivot to be tested is mounted so that its point can be brought into contact with a flat sapphire by a balance arm. An image of the pivot is projected on to a screen and measurements made without and with a load in the balance pan, the magnification being 200 times.

A very large number of exhibits was shown in the Physics Department. Among these was apparatus for the determination of the thermal conductivities of materials at high temperatures by the measurement of the radial gradient in an electrically heated rod of the material.

A resistance bridge for platinum thermometry, made to the design of Mr. F. E. Smith and capable of measuring temperatures to 0·001° C., was exhibited. To obtain this accuracy special precautions are taken to control not only the temperature of the oil tank in which the coils are immersed but also the humidity of the oil, since this latter factor affects the resistance of the coils.

A new apparatus has also been designed for the purpose of measuring the change of length of 'constant length' type bubbles in spirit-level tubes under extremes of atmospheric temperatures likely to be encountered in surveying practice, namely, −18° C. to 55° C. For this purpose an optical device is used by means of which both ends of the bubble are viewed simultaneously and brought into coincidence, the length being determined in one observation. In this apparatus special attention is given to the geometrical design of the moving parts and to the fine adjustments.

A variety of problems connected with refrigeration were being investigated for the Engineering Committee of the Food Investigation Board. These included apparatus for measuring the heat evolution in fruit by a process which may be compared with that of respiration in animals. In this apparatus a differential arrangement is used in which the heat evolved by apples is balanced by that from an electrical supply. For comparing the relative values of the resistance to indentations of specimens of cork slab and other heat-insulating materials, an apparatus has been constructed in which the depth of penetration of a steel ball about 3 in. in diameter is measured by a dial indicator.

Several forms of the Ewing ball and tube flow-meter were shown. In this instrument a glass or metal sphere is placed in a glass tube of conical bore and the displacement of the ball under the action of the flow of liquid is observed.

In the Optics Section was shown the "Vector" colorimeter, an instrument which enables colour to be specified by measurements involving colour-matching only. In use the colour to be tested is matched first against a mixture of extreme red with some suitable monochromatic light and then against a mixture of spectrum blue with another suitable monochromatic constituent. These matches determine two vectors on a colour chart and the intersection of these determines the unknown colour. Other apparatus included a flicker photometer for heterochromatic photometry and a spectrophotometer not involving polarising constituents.

In the Radiology Section was shown a new X-ray tube with detachable electrodes. In this tube, porcelain is substituted for the glass and the electrodes are fitted with rubber washers. The arrangement allows the tube to be dismantled for cleaning or other purposes and reassembled in a very short time. Apparatus for the study of the wave-forms of high tension generators by oscillographic methods was also shown working. By means of optical trains the wave-forms to be examined, together with a time curve from a tuning fork, are simultaneously recorded on a photographic plate.

In the Electrotechnics Department was shown a method of measuring high voltage dielectric loss. The Schering bridge is a capacity bridge specially suited for measurements of power losses at high voltages and small power factors; it ensures safety to the observer together with the accuracy attainable by other methods. Thus the method is applicable to the study of small phase defects in condensers. Power factors of 1 per cent. can be measured correct to 1 per cent. The dielectric loss in a cable at 20,000 volts was being investigated; in this application the vibration galvanometer and bridge operating arms need never be more than 2 volts above earth potential.

Research work was being carried out in the Direct Current Section on the earthing of electric circuits. Various forms of earthing electrodes suitably spaced are sunk in the ground, and their resistances determined

and compared under varying conditions of soil humidity.

In the Photometry Division a large integrating sphere 10 feet in diameter, constructed by the Metrology Department, was shown in use. It is intended primarily for the photometry of large illumination fittings. Apparatus has also been installed for the purpose of measuring candle-power by means of photo-electric cells. Light from the lamp under test falls on a rubidium cell mounted at one end of a photometer bench. A lamp mounted in a whitened cube, in the floor of which is a second cell screened from the direct light of the lamp, provides a suitable source for comparison. The cells, connected in series, are arranged to form part of a Wheatstone bridge and their currents are balanced by suitable adjustment of the illumination. In the illumination building experimental arrangements were shown for determining the daylight illumination in large or small rooms by means of models. Such information indicates the probable behaviour of their full scale prototypes with regard to daylight and is thus of value in architecture.

In the Wireless Division experience has shown the importance of complete screening of local oscillators and receivers from local electrical disturbances. Several pieces of apparatus, so protected, and including oscillators and receiving apparatus, a variometer and a model frame aerial, were exhibited. The knowledge has been used in the case of amplification tests on valve amplifiers. The amplifier under test and the local oscillator are both carefully protected, the former being placed in a specially screened room. Experimental work in connexion with short wave transmission is also being developed and various transmitting and receiving circuits were on view.

In the Electrical Measurements Department, in addition to the usual equipment, were various quartz piezo-electric resonators for use as radio frequency standards. These, on account of their constant frequency, are very suitable for the control of oscillators. One such oscillator with amplifying valves designed to produce radio frequency oscillations of great power and extremely constant frequency has been installed. L. J. C.

University and Educational Intelligence.

BIRMINGHAM.—The annual degree congregation was held on July 3. There were 6 successful candidates for the degree of Ph.D., 9 for M.Sc., 77 for the degree of B.Sc. with Honours, 48 for the ordinary B.Sc., and 24 for M.B., Ch.B. The degree of Doctor of Medicine was conferred on Gladys Mary Evans and Mr. Victor Goode Williams.

Dr. Laurence Ball, assistant to the chair of medicine and physician to the Queen's Hospital, has been appointed joint professor of medicine to fill the vacancy caused by the resignation of Prof. Kauffmann.

BRISTOL.—Sir George Wills, Pro-Chancellor and chairman of the Council of the University, has given 25,000*l.*, to be used with the 110,000*l.* which he presented two years ago, for the erection of a residential hall for students.

CAMBRIDGE.—The Mayhew Prize in applied mathematics has been divided between J. A. Gaunt, Trinity College, and A. H. Wilson, Emmanuel College. The Rex Moir Prize in mechanical sciences has been awarded to H. L. Cox, Emmanuel College, and the John Bernard Seely Prize in aeronautics to R. E. Stevenson, St. John's College.

DURHAM.—Dr. Arthur Holmes, hitherto reader in geology, has recently been made professor of geology at Durham. Two new lectureships have been filled by the appointment of Dr. R. K. Schofield (physics), and of Dr. G. H. Christie (chemistry).

LONDON.—A University post-graduate travelling studentship of the value of 275*l.* has been awarded to Miss C. L. T. Lucas. Miss Lucas obtained the B.Sc. with honours in zoology as an internal student of Bedford College in 1923, and has worked since at the London School of Tropical Medicine. She proposes to carry out research on Amœbæ living in insects, chiefly at the Johns Hopkins University, Baltimore.

ST. ANDREWS.—The degree of D.Sc. in engineering has been conferred upon Mr. William John Walker for a thesis entitled "Developments of Engineering Thermodynamics. Analysis for Variable Specific Heat Conditions." Dr. Walker has resigned the post of lecturer in mechanical engineering and machine design held by him in University College, Dundee, having been appointed professor of mechanical engineering at the University of the Witwatersrand, Johannesburg.

PROF. A. E. MORGAN, professor of English language and literature in the University of Sheffield, has been appointed principal of University College, Hull.

DR. W. E. CURTIS has been appointed professor of physics and director of the Physics Department at Armstrong College, Newcastle-on-Tyne, in succession to Prof. Henry Stroud, who retires at the end of the present session. Dr. Curtis, who is at present reader in physics in King's College, London, was educated at the Imperial College of Science and Technology, London, and was for a time lecturer in physics in the University of Sheffield. He is the author of important papers on spectroscopy.

THE third Congress of the Universities of the Empire will be in session at Cambridge on July 13–16. The subjects for discussion and the names of the chairmen are as follows: "The State and the University," Lord Balfour; "The Desirability of establishing in London a School of Advanced Legal Studies," the Lord High Chancellor; "Co-operation in Research throughout the Empire," Lord Londonderry; "Mutual Recognition of Examinations and of Time spent in Study Elsewhere," Sir Matthew Nathan; "The Desirability of making Provision for the Physical Welfare and Training of Students and the Organisation of Athletics with a View to securing more general Participation," the Duke of Devonshire; "The Actual Working of the Ph.D. Scheme," Viscount Cecil of Chelwood; "The Desirability of Articulating other Pension Schemes with the Federated Superannuation System of Great Britain and Ireland," Lord Haldane. Among the invited speakers on "Co-operation in Research" are Sir Thomas Holland, Sir John B. Farmer, Sir Arthur Shipley, and Dr. Andrew Balfour; on the Ph.D. scheme, Mr. R. A. Priestley, Prof. Wenley, of the American University Union, Prof. Dobson of Bristol, and Prof. H. P. Newton, of King's College, London. Representatives of India, Australia and Canada, as well as Sir Alfred Hopkinson and Sir Theodore Morison, are among those who have promised to contribute to the discussion on "The State and the University." The sessions at Cambridge will be preceded by series of visits by delegates from overseas to all the other universities of Great Britain and Ireland. On July 12 there will be a Government luncheon in honour of the delegates, at which Lord Peel will preside, and in the evening they will have an opportunity of meeting the members of the second Anglo-American conference of professors and teachers of history at a reception given by the University of London.

Contemporary Birthdays.

July 10, 1854. Dr. George Lindsay Johnson.
July 11, 1857. Sir Joseph Larmor, F.R.S.
July 12, 1863. M. Léon Charles A. Calmette, For. Mem. R.S.
July 12, 1869. Prof. Charles Riborg Mann.
July 13, 1869. Prof. Frederick W. Gamble, F.R.S.

Dr. LINDSAY JOHNSON, whose studies in ophthalmology have had practical issues in South Africa as well as in England, was educated at Owens College, Manchester, and Caius College, Cambridge. He has written memoirs on the refraction and vision of the seal's eye; and on the pupils of the Felidæ. A monumental paper, brilliantly illustrated in colour, appeared in the *Philosophical Transactions* for 1901, entitled, "Contributions to the Comparative Anatomy of the Mammalian Eye, chiefly based on Ophthalmoscopic Examination."

Sir JOSEPH LARMOR was born at Magheragall, Co. Antrim, and educated at the Royal Belfast Academical Institution, Queen's College, Belfast, and St. John's College, Cambridge, of which College, since 1880, he has been a fellow. Following professional teaching in Ireland, he was for eighteen years a lecturer in mathematics in the University of Cambridge and in 1903 was elected Lucasian professor of mathematics. From 1901 until 1912 Sir Joseph was one of the secretaries of the Royal Society, a period of fruitful activities. In 1915 he was awarded the Royal Society's Royal medal at the hands of Sir William Crookes, who remarked that the recipient's chief claim lay possibly in the establishment of the theory that radiant energy and intramolecular forces are due to the movements of minute electric charges. The theory was sustained in his treatise "Æther and Matter." In 1921 Sir Joseph was awarded the Copley medal. Mention should be made of his extended and masterly obituary notice of Lord Kelvin, published by the Royal Society in 1908.

M. CALMETTE, the accomplished assistant director of the Pasteur Institute, Paris, was born at Nice. Honorary professor of bacteriology and hygiene in the University of Lille, he is a commander of the Legion of Honour. In 1921 M. Calmette was elected a foreign member of the Royal Society of London. He is Hon. LL.D., Cambridge.

Prof. CHARLES R. MANN was born at Orange, New Jersey. After graduating at Columbia University he studied at the University of Berlin. John Tyndall fellow in physics at Columbia, 1892–95, he was afterwards professor of physics in the University of Chicago from 1896 until 1914. Prof. Mann acted as special investigator (1914–19) of engineering education for National Engineering Societies, and the Carnegie Foundation for the Advancement of Teaching. Author of several standard works on optics, he has written "The American Spirit in Education" (1919).

Prof. GAMBLE, a Manchester man, was educated there at the Grammar School, and at the University, serving after graduation on its zoological staff for some time. In 1909 he was appointed to the chair of zoology in the University of Birmingham. President of the Zoology Section at the Toronto meeting of the British Association in 1924, he gave an address on "Construction and Control in Animal Life."

Societies and Academies.

LONDON.

Geological Society, June 9.—W. D. **Lang**: *Naos pagoda* (Salter): the type of a new genus of Silurian corals. The detailed structure of the hitherto overlooked species *Ptychophyllum pagoda* Salter is described; it is intermediate between Ptychophyllum and Chonophyllum (in their proper interpretation), and the new generic name Naos is proposed.—J. F. **Jackson**: The junction-bed of the Middle and Upper Lias on the Dorset coast. Deposits of *Harpoceratoides hemera* have been traced throughout the 'Western Cliffs' and a richly-fossiliferous representative of part of the 'transition-bed' of the Midlands has been found at Doghus Cliff. A compact limestone crowded with well-preserved fossils in the marlstone at Thorncombe Beacon appears to be transitional from the sandy clay below the junction-bed, but it is probably a case of pseudo-sequence due to deposition on a sea-bottom of incoherent materials. The strata at Watton Cliff were measured and photographed *in situ*. All the evidence indicates slow accumulation under perfectly tranquil conditions. The massive lithographic limestones contain redeposited matter, and were formed under much less tranquil conditions.—P. G. H. **Boswell**: A contribution to the geology of the eastern part of the Denbighshire moors. The eastern part of the area, about 72 square miles in extent, between Llanefydd, Denbigh, Ruthin, and the centre of the moors is discussed. The greater part of the area consists of Upper Salopian strata, comprising rocks belonging to the zones of *Monograptus nilssoni*, *M. scanicus*, and *M. tumescens*, but the succession is much obscured by a thick mantle of glacial drift. The sediments are all of shallow-water facies, increasing in coarseness as they become younger, and this is attributed to the filling-up and shallowing of the geosyncline. Tectonically, the area constitutes the north-eastern part of the syncline of the Denbighshire moors, pitching north-eastwards. The dominant faults are of north-and-south trend, but swing north-north-westwards in the northern part, and apparently south-south-westwards south of the district. The structure is interpreted as the result of successive upthrows towards the west, but some lateral movement is probable. Numerous cross-faults, usually antedating the north-and-south faults, carve the country into blocks. While much of the faulting is of pre-Carboniferous age and related to the folding, movement on the north-and-south faults was, at least in part, renewed in post-Carboniferous times.

Linnean Society, June 10.—J. G. **Dollman**: Exhibition of a supposed new 'mutation' in the rabbit. The specimen showed the fur thickly interspersed with what appeared at first glance to be 'bristles' an inch or more in length. The 'bristles' were the awns of an Australian grass of the genus Stipa, the fruits of which had implanted themselves in the fur of the rabbit.—I. H. **Burkhill**: Exhibition of Hawaiian volcano plants. Eight mature vascular plants from the surface of one-year-old lava in the crater of Kilauea, Hawaii, three being sedges and five grasses, were found in cracks of the lava-flow of 1924 at places where steam issued. Within the steam-cracks was a mass of the genus Trematodon, its capsules weighted down with condensed water; algæ were observed, as well as a number of sporeling ferns and three small dicotyledons, but none of them were mature enough for identification. On lava three years older isolated plants of *Vaccinium penduliflorum* Gaudich, and *Cyathodes tameiameiæ* Cham. existed where, steam

being absent, the surface was sheltered by boulders from the perennial north-east trade-wind. But neither of these two species, which seem to be the most xerophytic of the local plants, nor any other broad-leaved plants were observed upon the 1924 lava, which lava alone was hot enough to return rain as steam. The drying is obviously a greater hindrance to encroaching vegetation than the sterility of the lava.—T. A. **Sprague**: The taxonomic position of the Adoxaceæ. The position of Adoxa depends primarily on the interpretation placed on the two perianth whorls, those who regard these as 'calyx and corolla' or 'involucre and corolla' placing the genus near the Caprifoliaceæ, whereas those who regard them as 'involucre and calyx' place it next the Saxifragaceæ or Araliaceæ. The former hypothesis involves fewer assumptions than are required by the other hypothesis, and the evidence from abnormal or rarer types is greatly in its favour. It is suggested that the Adoxaceæ should be placed in Rosales — Saxifragineæ beside Saxifragaceæ. — S. K. **Mukerji**: The vegetation of Kashmir: a contribution to the ecology of the Kashmir Himalayas. Investigation of the plant communities of the Kashmir Himalayas was undertaken during the years 1918–24. Three regions are recognised: the aquatic and marsh vegetation of the Dal Lake of Kashmir; the plant communities of the temperate region of the Kashmir Himalayas (5000-9000 ft.); the sub-Alpine and Alpine vegetation of the Kashmir Himalayas (9000-18,000 ft.).

Physical Society, June 11.—J. H. **Awbery** and Ezer **Griffiths**: The latent heat of fusion of some metals. The method of mixtures was used and refinements were introduced, of which the chief were the use of fairly large charges of metal (of the order of 2 kilograms), and a device by which the hot charge was not allowed in contact with the water of the calorimeter until the latter was completely closed. This device consisted in the provision of a sheet-metal vessel suspended by threads from the main lid of the calorimeter. The aperture through which the charge was introduced was closed by a rotating lid, in the main lid, and the crucible being introduced, was submerged after the closing of this smaller lid by means of a wire passing through an eyelet in the base of the calorimeter, and out at the top.—D. W. **Dye**: The piezo-electric quartz resonator and its equivalent electrical circuit. Such a resonator can be represented by an inductance, a resistance and a capacity all in series. These are pictured as in parallel with another small condenser and the whole is in series with a third condenser, the additional condensers representing air-gaps. The agreement between theory and experiment holds for longitudinal resonators of a frequency so low as 44,000 and for transverse resonators with a frequency up to 15,000,000 periods per second. The temperature coefficient of frequency of a considerable variety of resonators is examined over a range of temperatures up to 40° C.; very diverse results are obtained. The effects of displacement of the resonator from the position of centrality are small but not quite negligible. —Evan J. **Evans**: The current-voltage characteristics of electrostatic machines when supplying current to non-inductive loads and to a Coolidge X-ray tube. A large electrostatic machine was used as a source of potential for the discharge through (*a*) a Coolidge X-ray tube, and (*b*) a non-inductive resistance. In the former case, above a certain critical voltage the discharge is intermittent, while in the latter case the discharge is continuous for all voltages. The intermittence observed is due to the operation of the Pearson-Anson effect, and this implies that the effect of the residual gas in such tubes is not completely insensible above a certain voltage.

DUBLIN.

Royal Irish Academy, June 14.—J. **Doyle**: The ovule of Larix and Pseudotsuga. The ovule of all species of Larix is provided with a large outgrowth on the cone-axis side of the micropilar edge. It is definitely one-sided, and covers the mouth like a hood; the other edge of the slit-like micropilar mouth is unchanged. The outgrowth has a stigmatic function, receiving the pollen and afterwards bending over and in, thus bringing the pollen into the micropilar canal. In Pseudotsuga the micropilar mouth is more slit-like and both edges are differentiated, the cone-axis side being prolonged into a large mass as in the Larix, the scale side forming a second lip very much smaller. Though thus two lipped, it is only the larger one which functions as a pollen-receiving device in a manner strictly similar to Larix. The natural and very close relationship in most characters, except habit, between Larix and Pseudotsuga is again emphasised.

EDINBURGH.

Royal Society, June 21.—W. H. **Lang**: Contributions to the study of the Old Red Sandstone flora of Scotland. (iii.) On *Hostimella* (*Ptilophyton*) *Thomsoni*. A new specimen of the fossil, originally named by Dawson *Ptilophyton Thomsoni*, is described. The investigation of this has shown that the linear bodies are sporangia, enclosing large winged spores. The specimen by which Kidston demonstrated that this fertile tip terminated a frond-like branch-system is described. The genus, Milleria, is founded to include *M. Thomsoni* (Dawson) and *M. pinnata* (Lang). (iv.) On a specimen of Protolepidodendron from the Middle Old Red Sandstone of Caithness. A unique specimen from the Thurso flagstones, which was referred by Kidston to *Protolepidodendron karlsteini*, P. and B., is described; it is the first record of this genus from British rocks. (v.) On the identification of the 'Large Stems' in the Carmyllie beds of the Lower Old Red Sandstone as Nematophyton. The striated incrustations, so common in the Carmyllie beds, have been critically investigated. They prove to have the characteristic structure of Nematophyton, which must have been a very abundant plant at this period. Two types are distinguished, the commoner constituting a new species (*N. caledonicum*), while another, with wider tubes, is compared with *N. Forfarense*, Kidston sp.— S. **Williams**: A critical examination of the Vittarieæ. The genera Vittaria, Monogramma (limited to the Eumonogramme section), Antrophyum, Hecistopteris and Anetium, form a natural group. All are tropical epiphytes with creeping dorsiventral rhizomes. The fronds are simple in outline except in Hecistopteris, where they are dichotomously branched. The venation is typically reticulate, but in some species of Monogramma lateral veins are entirely absent. The central type of stele is the dorsiventral dictyostele. The dermal appendages are always clathrate scales, and the epidermis of the fronds is characterised by the presence of spicule cells. The sporangia are constant in structure throughout the group, and the origin of the sorus is probably always intramarginal. The spore output varies from 32 to 64. The gametophyte, where known, is always divergent from the common cordate type. The prothalli are deeply lobed and multiply rapidly by

vegetative means. From a general survey of the structural characters it is concluded that the Vittarieæ must be placed in any natural classification along with the complex of genera containing Adiantum, Cheilanthes, Pellæa, Gymnogramme and Ceratopteris. —F. R. Cowper **Reed**: Some new Ordovician and Silurian fossils from Girvan. Two new trilobites, one belonging to a genus (Glaphurus) hitherto known only in America, and some other new forms, are described.—Graham **Kerr**: A gigantic poison fang of a snake obtained from the (?) pleistocene of the Gran Chaco. The name *Bothrodon pridii* has been given to the specimen. The fang measured nearly 65 mm. along the convex side, and has a deep poison-groove along its outer side. The uniform curvature, forming practically a semicircle, suggests that the fang was not adapted for striking but rather for the retention of struggling prey while the poison took effect.—G. Donald **M'Intyre**: Development of the vascular system in the human embryo prior to the establishment of the heart. A detailed account of early stages of vascular formation in some embryos, such as have not been hitherto published, and a summary from the original descriptions of the vessels in a number of young human embryos.—J. M. **Whittaker**: On a polarised light quantum. The refraction and frequency of the light quantum of Sir J. J. Thomson and Prof. Whittaker are discussed analytically, and a modification of it is proposed to explain the phenomena of polarisation.—W. W. **Taylor**: (1) Ferric hydroxide sol and the lyotrope series. The concentration of the univalent salts of potassium which just completely precipitates ferric hydroxide sol in twenty-four hours under strictly comparable conditions has been determined. The order is—acetate, thiocyanate, chloride, bromide, nitrate, iodide, chlorate, the concentrations rising from 0·01 *n* to 0·083 *n*. (2) Note on a theory of von Weimarn. According to von Weimarn's theory of the colloid state, the duration of life of a sol is longer when a precipitating ion contains the same element, as the sol. Ferric hydroxide sol is completely precipitated in twenty-four hours by the same concentration of ferricyanide as of the trisulphonates, but the zone of partial precipitation is prolonged. With ferrocyanide the corresponding concentration is the same, and the zone of partial precipitation is also similar; there is in this case, however, at higher concentrations a second zone of precipitation, separated from the first by one of no-precipitation.

PARIS.

Academy of Sciences, May 31.—H. **Deslandres**: The distribution in time of terrestrial magnetic perturbations and the corresponding distribution in the sun of the regions which emit a corpuscular radiation. In an earlier communication it has been suggested that the magnetic storms occur at intervals which are multiples of $R/6$, R being the mean duration of the synodic rotation of the spots. A detailed examination of the data for 1882, 1925 and 1926 is made, and the results exhibited in tabular form; they generally confirm the above view.—Gabriel **Bertrand** and M. **Mâchebœuf**: The relatively high proportion of nickel and cobalt in the pancreas. It has been shown that animal tissues normally contain minute amounts of nickel and cobalt. The distribution of these metals varies with the nature of the tissue, being lowest in muscle and highest in the liver and pancreas. The original figures were obtained from the ox, but examination of the pancreas from several animals (ox, calf, horse, sheep, pig) proves that the pancreas is one of the organs always richest in nickel and cobalt. It has also been found that preparations of insulin contain several hundred times more nickel and cobalt than the glands from which they are extracted. This raises the question whether these two metals intervene in the remarkable action of insulin, and further work on this is in hand.—H. **Vincent**: The general properties of the cryptotoxins, in particular of tetanus cryptotoxin. The name cryptotoxin has been applied to microbial poisons which, in contact with certain substances, lose entirely under this influence their toxic power, keeping, however, some of their properties, in particular their immunising power. Sodium palmitate has been used as the modifying agent, and this salt rapidly neutralises, *in vitro*, microbial toxins. Experiments with guinea-pigs show that this animal can be injected with tetanotoxin 600 times the fatal dose without inconvenience if the toxin has been previously mixed with a suitable proportion of a solution of sodium palmitate. Similar effects are observed with the toxins of diphtheria, dysentery, typhoid, and *B. œdematiens*. The toxins are not really destroyed, since the sodium palmitate complex treated with hydrochloric acid and filtered from the palmitic acid gives a solution producing, in large doses, symptoms of tetanus in a guinea-pig.—Bertrand **Gambier**: The deformation of a surface with conservation of a conjugated network.—Gaston **Julia**: The conformal representation of areas.—Rolin **Wavre**: The construction of a class of functional automorphs relating to a symmetrical nucleus of Fredholm.—G. **Cerf**: The transformation of certain systems in involution of partial differential equations with two independent variables into an equation of the first order.—E. **Gau**: The transformation of a partial differential equation of the second order into an equation of the first order.—André **Roussel**: An extension of the method of Weierstrass.—**Riabouchinski**: Remarks on the problem of cavitations.—Emile **Belot**: The probable limits of the age of the planetary system, according to the theory of radiation and cosmogonic data.—Mlle. M. **Hanot**: The enlargement by absorption of lines of Balmer's series.—Jean **Dufay**: The spectrum of lightning. A study of the part of the spectrum with wave-lengths less than 3850 Å.U.—C. G. **Bedreag**: The complex structure of the spectrum of copper.—P. **Vaillant**: The passage of the (electric) current in solid salts.—F. **Holweck**: Discussions and recent experiments on the soft X-rays. A discussion of the results obtained by M. Dauvillier and the author.—P. **Lebeau** and A. **Damiens**: Carbon tetrafluoride.—Mme. **Ramart** and Mlle. **Amagat**: Molecular transpositions in the series of the α.α.α.-alkyl-diaryl-ethanols.—René **Souèges**: The embryogeny of the Liliaceæ. The development of the embryo in *Allium ursinum*.—J. **Beauverie**: The cytological bases of the theory of mycoplasma.—G. **Ollivier**: *Thalassoascus Tregoubovi* (new genus, new species), a marine pyrenomycete, parasitic on the Cutleriaceæ.—Théodor **Lippmaa**: Hematocarotinoids and xanthocarotinoids.—A. **Quidor** and Marcel A. **Hérubel**: The simultaneous and monocular perception of two different images of the same object.—Jules **Amar**: Radiations and chlorophyll. The green pigment of leaves holds back the red radiations, the complementary colour, and red rays are most compatible with the persistence of chlorophyll.—P. **Vignon**: The anatomy of the organs of flight in the Phasgonurideæ of the present time and in the Protolocustideæ of the coal measures.—Robert **Weill**: The cnidome of the Trachylideæ (Trachymedusa and Narcomedusa).

Official Publications Received.

Práce Moravské Přírodovědecké Společnosti, Brno, Československo (Acta Societatis Scientiarum Naturalium Moraviae, Brno, Čechoslovakia.) Svazek 1, Spis 1-10 (Tomus 1, Fasciculus 1-10), 1924. Pp. iii+618+11 tab. (Brně: A. Píša.) 100 Kč.

Spisy Lékařské Fakulty Masarykovy University, Brno, Československá Republika (Publications de la Faculté de Médecine, Brno, Tchécoslovaquie). Svazek 1, Spis 1-10 (Tome 1, Fascicule 1-10), 1922-23. Pp. vi+265+14 tab. 40 Kč. Svazek 2, Spis 11-21 (Tome 2, Fascicule 11-21), 1923-24. Pp. ii+312+11 tab. 40 Kč. Svazek 3, Spis 22-32 (Tome 3, Fascicule 22-32), 1924-25. Pp. ii+258+5 tab. 40 Kč. (Brně: A. Píša.)

Biologické Spisy Vysoké Školy Zvěrolékařské, Brno, Československá Republika (Publications biologiques de l'École des Hautes Études vétérinaires, Brno, Tchécoslovaquie). Svazek 1, Spis 1-20 (Tome 1, Fascicule 1-20), 1922. Pp. xv+386. 50 Kč. Svazek 2, Spis 21-40 (Tome 2, Fascicule 21-40), 1923. Pp. iii+343+6 tab. 40 Kč. Svazek 3, Spis 1-10 (Tome 3, Fascicule 1-10), 1924. Pp. iii+276+1 tab. 40 Kč. (Brně: A. Píša).

Agricultural Research Institute, Pusa. Bulletin No. 160: Bot Flies of the Punjab. By Capt. H. E. Cross. Pp. 16+8 plates. (Calcutta: Government of India Central Publication Branch.) 14 annas; 1*s.* 6*d.*

The Indian Forest Records. Vol. 12, Part 4 (Silviculture Series): Yield Table for clear-felled *Sal* Coppice (*Shorea robusta*). By S. H. Howard. Pp. v+19+6 charts. 8 annas; 10*d.* Vol. 12, Part 5 (Silviculture Series): Yield and Volume Tables for *Chir* (*Pinus longifolia*). By S. H. Howard. Pp. iv+21+10 charts. 1 rupee; 1*s.* 9*d.* Vol. 12, Part 6 (Silviculture Series): Yield and Volume Tables for Deodar (*Cedrus Deodara*). Pp. iii+23+10 charts. 8 annas; 10*d.* Vol. 12, Part 8 (Entomology Series): On some Indian Cleridae (Coleoptera). Part 1: New Species of Cleridae from British India and Burma. By J. B. Corporaal. Pp. 15. 5 annas; 8*d.* (Calcutta: Government of India Central Publication Branch.)

R. Osservatorio Astrofisico di Catania. Catalogo Astrofotografico Internazionale 1900-0. Zona di Catania fra de declinazioni +46° e +55°. Vol. 1, Parte 2ª: Declinaz. da +46° a +48°, ascens. retta da 3ʰ a 6ʰ. Pp. xii+49. (Catania.)

Norman Lockyer Observatory. Director's Annual Report, April 1, 1925–March 31, 1926. Pp. 8. (Sidmouth, Devon.)

The British Institute of Philosophical Studies. Annual Report and Statement of Accounts for the Year ended 31st March 1926, to be Presented at the First Annual General Meeting of the Members to be held at The Royal Society of Arts, 18 John Street, Adelphi, London, W.C.2, on Friday, 18th June 1926. Pp. 16. (London: 88 Kingsway, W.C.2.)

Koninklijk Nederlandsch Meteorologisch Instituut. No. 104a: Supplement; Oceanographische en Meteorologische Waarnemingen in den Indischen Oceaan, Juni, Juli, Augustus (1856–1908). Tabellen. Waarnemingen Noord van 5° N.B. (1856–1923). Pp. iv+24. 1.25 fl. No. 106a: Ergebnisse aerologischer Beobachtungen. 11, 1923. Pp. iv+42. 2.50 fl. (Utrecht: Kemink en Zoon.)

Littlehampton, Sussex. Official Guide, 1926. Pp. 100. (Littlehampton: Urban District Council.)

University of Leeds. Report on the Department of Mining, Session 1924–1925. Pp. 10. (Leeds.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 7, 1925. ii: Nederbörden i Sverige. Pp. 159. (Stockholm.) 5 kr.

The Sir John Cass Technical Institute, Jewry Street, Aldgate, E.C.3. Report on the Work of the Department of Petroleum Technology, Session 1925–1926. Pp. 4. (London.)

Report on the Health of the Army for the Year 1924. Vol. 60. Pp. iv+146. (London: H.M. Stationery Office.) 3*s.* 6*d.* net.

University of California Publications in American Archaeology and Ethnology. Vol. 21, No. 7: The Uhle Pottery Collections from Chancay. By A. L. Kroeber. Pp. 265-304+plates 80-90. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 60 cents.

Diary of Societies.

SATURDAY, JULY 10.

BIOCHEMICAL SOCIETY (in Biochemical Department, Museum, Oxford) at 2.30.—H. W. Buston and Prof. S. B. Schryver: The Isolation of a Hydrolysis Product of the Proteins Hitherto Undescribed.—L. G. McGuire and Prof. S. B. Schryver: The Isolation of a Hydrolysis Product of the Proteins Hitherto Undescribed.—L. F. Hewitt: The Rotatory Power and Dispersion of Proteins.—H. A. Abramson, P. Eggleton, and M. G. Palmer: The Fate of Sodium Lactate Injected Intravenously.—C. E. Grover and A. C. Chibnall: Preparation of Asparaginase from the Rootlets of Germinating Barley.—Prof. J. C. Drummond and G. F. Marrian: Relation between Vitamin B and Metabolism.—V. B. Reader and Prof. J. C. Drummond: Relation between Vitamin B and Protein in the Diet.—J. Needham: The Non-protein Nitrogen in the Developing Avian Embryo.—H. W. Dudley, O. Rosenheim, and W. W. Starling: The Constitution and Synthesis of Spermine.—C. G. Douglas: The Ferricyanide Method of Blood-Gas Analysis.—F. Hawking: Synthesis of Antineuritic Factor by Yeast.—V. B. Reader: Effect of the Interfacial Tension of the Medium on the Growth of Streptothrix.—H. W. Kinnersley and R. A. Peters: A Case of Inactivation of Torulin.—Demonstrations by V. B. Reader: Abnormal Growth of *Streptothrix corallinus*; and A. E. Garrod and L. Mackey: Congenital Porphyrinuria.

PHYSIOLOGICAL SOCIETY (in Department of Physiology, University, Sheffield), at 3.—Prof. H. S. Raper and E. C. Smith: Insulin and Acetone Production in the Perfused Liver.—Prof. H. S. Raper and E. J. Wayne: A Quantitative Study of β-oxidation.—H. Florey: The Function of the Lacteals.—A. S. Parkes and C. W. Bellerby: The Œstrus-inhibiting Hormone of the Corpus Luteum.—May Mellanby and C. Lee Pattison: Diet in relation to the Onset and Spread of Caries in Children.—E. Sudie and Prof. E. Mellanby: The Influence of Light on the Antirachitic Action of Foods.—M. H. MacKeith: A Note on the Action of Alcohol on the Perfused Isolated Rabbit Heart.—M. Hurst and C. G. Imrie: Nitrogenous Metabolism in Post-encephalic Rigidity.—C. Tingle and C. G. Imrie: Effect of Pituitrin on Blood Sugar Curves.—E. C. Eaves: Changes in the Pituitary following Repeated Insulin Injections.—E. C. Eaves and G. A. Clark: Changes in the Pituitary after Section of the Right Vagus.—G. A. Clark: Antagonism of Insulin and Pituitrin.—W. H. Newton and B. A. McSwiney: The Reaction of Smooth Muscle to Changes in the H-ion Concentration.—E. N. Wilmer: The Influence of Glucose on the Survival of Cells *in vitro*.—A. Hemingway and Prof. R. J. S. McDowall: The Acid-Base Control of the Capillaries.—C. A. Mills: The Rôle of Tissue Fibrinogen in Blood Clotting.—F. W. Lamb and K. R. Fraser: Oxygen Tension in Mixed Venous Blood.—J. P. Hoet: The Action of Pilocarpine on the Spleen.—W. Smith: Insulin and Diastase.—J. C. Bramwell: Analysis of the Phonoarteriogram.—J. C. Bramwell and B. A. McSwiney: Hot-wire Record of the Venous Pulse.—Demonstrations by E. C. Eaves: Changes in the Human Pituitary associated with Abnormalities of Growth.—M. Croll and E. C. Eaves: (*a*) Ductless Glands of a Cretin; (*b*) Changes in the Pituitary produced experimentally in the Rabbit.—G. Wilkinson: The Mechanism of the Cochlea: the Influence of Fluid Load on the Vibration Period of Immersed Membranes.—F. W. Lamb and G. J. Woolham: Records of Muscle Tremor and Muscular Balance.

TUESDAY, JULY 13.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section—Visit of American and Canadian Anæsthetists) (at 1 Wimpole Street, W.), at 10 A.M.—Papers by Prof. J. S. Haldane, T. P. Dunhill, and Dr. J. Blomfield.

WEDNESDAY, JULY 14.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section—Visit of American and Canadian Anæsthetists) (at 1 Wimpole Street, W.), at 10 A.M.

THURSDAY, JULY 15.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section—Visit of American and Canadian Anæsthetists) (at 1 Wimpole Street, W.), at 10 A.M.—American Session.

SATURDAY, JULY 17.

SOCIETY FOR EXPERIMENTAL BIOLOGY (in Department of Natural History, University of Edinburgh), at 10 A.M.—Dr. F. A. E. Crew: The Developmental Capon and Poulard.—E. A. Spaul: The Metamorphic Principle of the Anterior Lobe of the Pituitary.—W. P. Kennedy: Diet and Reproduction in the Rat.—Prof. J. H. Priestley: The Perception and Transmission of Stimulus in the Coleoptile of the Grass Seedling.—L. A. Harvey: The Relation of Cell Inclusions to Cell Metabolism.

MONDAY, JULY 19.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at the Botanical Gardens, Edinburgh), at 10 A.M.—J. Gray: The Growth of Fish.—E. Philip Smith: The Effect of Acidity on Regeneration in Coleus.—J. W. Gregor: The Influence of Environment on the Formation of definite Habitat Types.—K. B. Blackburn: Some Observations on Sex and Chromosomes in Plants.—(In Department of Natural History, University of Edinburgh), at 2.30.—A. Walton: The Survival of Fertilising Capacity of Rabbit Spermatozoa *in vitro*.—A. D. Hobson: The Formation of the Fertilisation Membrane in *Echinus esculentus*.—E. Ponder: The Kinetics of Hæmolytic and Bacteriolytic Reactions.—T. Rettie: Demonstration of a Histological Method for the Early Stages of Cell Injury.

CONFERENCES.

JULY 13 TO 16.

ROYAL MEDICO-PSYCHOLOGICAL ASSOCIATION (at House of British Medical Association).

CONGRESS OF THE UNIVERSITIES OF THE EMPIRE (at Cambridge).—Subjects for discussion and names of chairmen: The State and the University (Earl of Balfour); The Desirability of establishing in London a School of Advanced Legal Studies (the Lord High chancellor); Co-operation in Research throughout the Empire (Marquess of Londonderry); Mutual Recognition of Examinations and of Time spent in Study Elsewhere (Sir Matthew Nathan); The Desirability of making Provision for the Physical Welfare and Training of Students and the Organisation of Athletics with a View to securing more general Participation (Duke of Devonshire); The Actual Working of the Ph.D. Scheme (Viscount Cecil of Chelwood); The Desirability of Articulating other Pension Schemes with the Federated Superannuation System of Great Britain and Ireland (Lord Haldane).

JULY 15 TO 17.

OXFORD OPHTHALMOLOGICAL CONGRESS.

JULY 15 TO 19.

JOURNÉES MÉDICALES DE PARIS (at Paris).

JULY 20 TO 23.

BRITISH MEDICAL ASSOCIATION (at Nottingham).

JULY 22 TO 28.

INTERNATIONAL CONGRESS ON ALCOHOLISM (at Dorpat).

JULY 26 TO 31.

FRENCH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Lyons).

AUGUST 16 TO 23.

INTERNATIONAL BOTANICAL CONGRESS (at Cornell University).