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## Thames Flood Prevention

THE remarkable tidal flood which occurred on January 6-7, 1928, in the Thames basin, with disastrous consequences in the districts of Westminster and Chelsea, where, unhappily, a number of lives were lost, has become, perhaps, a dim memory, but the incident is still recallable and again claims attention in the issue recently of the report of the Departmental Committee on Thames Flood Prevention.\* The Committee was appointed in April 1931 with the following terms of reference: "To consider the present organisation for the prevention of damage by floods in the tidal portion of the Thames, and to make recommendations as to the further measures, if any, that may be necessary, as to the Authority or Authorities to which the duty of carrying out any such measures should be entrusted, and as to the basis on which the cost should be distributed."

The problem is undoubtedly one of grave public importance affecting the safety of many inhabitants of the metropolitan area, and its significance was emphasised in 1929 by the publication of a report by Dr. A. T. Doodson of the Tidal Institute, University of Liverpool, whose researches in the matter of ocean surges, undertaken at the joint cost of the London County Council and the Port of London Authority, showed a connexion existing between such surges in the North Sea and abnormal tidal levels in the Thames, an increase in height of so much as 7 ft. being considered possible. The full extent of the implications of this discovery remains to be determined. Undoubtedly, it has a widespread bearing on tidal phenomena which calls for early investigation in the interests of all riverside dwellers and riparian authorities.

Confining attention at the moment to the locality of the Thames valley and to the conclusions of the report under consideration, it is of interest to note that the Committee unanimously advocates the institution of a single authority to exercise control over the measures to be taken to prevent flooding throughout the entire tidal area. At the present time, there is an unco-ordinated 'medley' of bodies entrusted with the duty, with great disparity of powers, consisting of county and county borough councils, catchment boards and commissioners of sewers—the result of haphazard historical development. In place of these heterogeneous units, the Committee recommends the

\* Report of the Departmental Committee on Thames Flood Prevention. (Cmd. 4452.) Pp. 24+1 map. (London: H.M. Stationery Office, 1933.) 6d. net.



formation of a Joint Committee to consist of representatives of the County Councils of Essex, Kent, London, Middlesex and Surrey, the County Borough Councils of East Ham, West Ham and Southend, the Catchment Boards of the Essex Rivers—Lee, Medway and Roding—the Thames Conservancy, and the Port of London Authority.

As to the wisdom of single and centralised control, there can be no shadow of doubt, and the suggested composition of the controlling body leaves little ground for criticism. The county and borough councils, naturally, are to have the preponderant representation (nine members), the catchment boards being jointly represented by two members and the Thames Conservancy by one member out of a total number of fifteen, the remaining three members being nominees of the Port Authority. It is perhaps permissible to observe in this connexion that the functions of the Port Authority are mainly concerned with navigation and commerce, and not necessarily or essentially with land protection, though, if the Authority is willing to add to its responsibilities in this direction, there is no valid objection. Furthermore, there is the consideration that the jurisdiction of the Authority over the bed of the river extends from Teddington Weir to an imaginary straight line drawn from the entrance of Havengore Creek in Essex to Warden Point in Kent, so that the greater part of the area to be controlled by the Joint Committee comes under the daily observation of the Authority's officers. At any rate, the Authority has expressed its readiness to place at the disposal of the Committee the use of the Authority's offices and organisation and the assistance of its staff—a public-spirited offer which is deserving of commendation. A significant omission (in view, no doubt, of their impending dissolution) is that of representation of the two remaining independent commissions of sewers in Kent, which still jointly control some forty miles of river frontage.

The Committee, when formed, is to examine the whole position and to make a survey of the entire area "to see what works of flood defence are necessary". It will be the duty of the Committee to "employ such experts and obtain such advice as they may think necessary with a view to a thorough investigation of the problem of flooding in the tidal basin" and, thereafter, to formulate proposals for remedial works, including restriction on users of land (if any) which may be considered desirable. These proposals are to be submitted

for consultation with the executive local authorities, upon whom will devolve the execution of the various projects. In case of conflict of opinion, any authority persisting in objection to an approved scheme of the Committee would have the right of appeal to a Minister of the Crown.

The question of the distribution of cost of protective works is met in the report by reference to the provisions of the Land Drainage Act, 1930, which govern the situation in catchment areas, and it is recommended that the principles of that Act should, in general, be followed in other areas. "Thus, the cost of construction of flood works included in an approved scheme should be a charge on the County or County Borough Council, with a discretion vested in the County Councils to defray it, either as expenses for general county purposes or as expenses for special county purposes chargeable on such areas as they think fit, or by apportioning it between and charging it on such areas and in such proportions as they think fit or partly by one of these methods and partly by another". Maintenance of works would continue to devolve on the riparian owner, if at present liable; otherwise, it would fall on the county or county borough council. Such is the general outline; there are certain details of incidence and apportionment of cost which need not be particularised here.

An important and justifiable reservation is made in exempting the Committee and the executive local authorities from liability for claims. They are not to be held liable to compensate sufferers from the effects of a flood: "the risks are altogether too uncertain and the possible liabilities too onerous". It will be agreed that in the present state of knowledge respecting the causes and advent of floods, it is impossible within the limits of human foresight to make provision for all contingencies that may arise; and, indeed, unless excessive expenditure is to be incurred, there must continue to be an element of risk of damage, which it will be the Committee's duty to endeavour to reduce to a minimum.

Having, after patient and painstaking inquiry, arrived at its conclusions, the Departmental Committee has incorporated them in a series of recommendations. It now rests with the Government to carry the recommendations into effect. Action in the matter should be taken without delay in order to safeguard the public, and to remove the possibility of another experience so tragic and disastrous as that of January 1928.



### Darwin's Journal

*Charles Darwin's Diary of the Voyage of H.M.S. "Beagle"*. Edited from the MS. by Nora Barlow. Pp. xxx+451+5 plates. (Cambridge: At the University Press, 1933.) 21s. net.

THERE is no book of travels so famous, so instructive or so widely read as the second edition of Darwin's "Naturalist's Voyage round the World". The so-called first edition was published as the third volume of the official narrative of the voyages of His Majesty's ships *Adventure* and *Beagle* in 1839 and although this has been reprinted since, it was the so-called second edition published by Murray six years later that is best known and most usually quoted. Several additions and amendments were made, and some illustrations inserted in this edition, and when it was published Darwin wrote: "I hope and think I have much improved my journal."

Many readers must have wondered how the materials of such a magnificent book were collected, what the original notes were, how far the views of the author changed during the twelve years that had passed, and whether there were any interesting omissions from the original manuscripts.

Fortunately, the eighteen small pocket-books in which Darwin jotted down his daily notes during the voyage were preserved, and, to ensure against possible loss of the original, a typewritten copy of them was made by his son Horace Darwin some years ago; and now, with the help of this copy his granddaughter, Mrs. Barlow, has edited the original manuscript, and published them with many interesting and valuable notes. Darwin's notes were written hastily in pencil, regardless of spelling or punctuation, the writing often illegible, and in many places "a jumble of sudden images". The reading of the "Diary" leaves many strong impressions on the mind, and perhaps the most vivid of these is that of Darwin's personal courage and, what is so often correlated with true courage, his modesty. The agonies he suffered from sea-sickness during the first days of the voyage, of which there is no complete record in previous publications, would have led a man of less determination to leave the expedition when it reached St. Jago, yet we find from notes in the diary that this trouble continued to the end of the voyage whenever the *Beagle* was in rough water.

When on land, no dangers, whether of wild savages, of almost impenetrable jungle, or of the

snows of the Cordilleras, could check him from going where he wanted to go in pursuit of his scientific investigations. Indeed Darwin seems to have possessed all the characters and endurance of the great explorers. Of these dangers he said little and wrote little, and we may be certain gave way to no exaggeration.

It may be said of this book that there is nothing in it of scientific importance that has not already been published, but to those who are interested in the history of the evolution theory, in Darwin's views of the origin of coral reefs and other matters, it is one of the most absorbing interest.

It is well known that when Darwin started on this voyage, he held the prevailing views on creation and the immutability of species, and there is no evidence in this "Diary" that he had formulated in his mind any alternative hypotheses before he returned home. When he found an abundance of petrified shells in a ravine in Chile and was asked whether they were really shells or 'born by Nature', he puts a note in his diary: "My general method of explanation, God made them". At the same time, there is evidence that he found difficulties in giving an explanation on orthodox lines of some of the facts he observed. For example, when reflecting on the strange characters of the animals of New South Wales, he writes, p. 383: "An unbeliever in everything beyond his own reason might exclaim 'Surely two distinct Creators must have been at work . . .' and 'A geologist perhaps would suggest that the periods of Creation have been distinct and remote the one from the other; that the Creator rested in his labor'."

Darwin's interests were not confined to the fauna, flora and the geological formations of the land, as there are many brief notes on the animals he found in the sea whenever the conditions were favourable. There is an interesting paragraph in his diary on the way to the Cape Verde Islands when the sea was calm: "I proved to-day the utility of a contrivance which will afford me many hours of amusement and work, it is a bag four feet deep made of bunting, and attached to a semi-circular bow: this by lines is kept upright and dragged behind the vessel. This evening it brought up a mass of small animals." Is this the first record of the use of the marine tow-net?

It is not generally known that Darwin obtained two very interesting Aleyonaria in the Galapagos Islands, both of which have proved to be new to science. There is no note of the collection of these



specimens in his diary, nor is there any account of his important discovery of the habits of the seapen at Bahia, which are described in the "Voyage of the *Beagle*".

Although Darwin's views on the origin of species were not developed until some years after the voyage was concluded, it is interesting to find in the diary when the *Beagle* was at Keeling Island, that his famous subsidence theory to account for the formation of coral atolls is clearly stated. It concludes with the words: "Under this view we must look at a Lagoon Island as a monument raised by myriads of tiny architects to mark the spot where a former land lies buried in the depths of the Ocean."

Every reader will want to congratulate Mrs. Barlow on her enterprise in having determined to edit and bring out this "Diary" and will be grateful to her for the laborious care with which she has added many useful notes and for the bibliography of publications referring to the "Voyage of the *Beagle*". Special attention may be directed to the reproduction of the very beautiful pencil portrait of Darwin as a young man, which was discovered by Prof. A. C. Seward in the Cambridge Botany School four years ago.  
S. J. H.

### Old and New Scientific Outlook

*Limitations of Science.* By J. W. N. Sullivan. Pp. v+303. (London: Chatto and Windus, 1933.) 7s. 6d. net.

MR. SULLIVAN might well have given a rather more comprehensive and ambitious title to his little book, for it tells us admirably much more than the "limitations" of science. It is really a commentary on his statement in the introduction, that "science has been steadily pursued for many centuries, it has attracted an ever wider extent of attention and is now the dominant intellectual interest of mankind". How has this happened? What are the main branches and largest conclusions of science? How in recent years have these been modified and found not to be so final and all-embracing as they were formerly thought? These are the questions to which Mr. Sullivan's book supplies in small compass clear, well-balanced and well-informed answers. It will be seen that the "limitations" form a subordinate part of his theme; actually they are the subject of one out of the eight chapters into which the book is divided, and not the first.

It will give the best idea of the scope and value of the book if we sketch briefly the contents of its principal chapters. Mr. Sullivan begins by an introduction which describes the emergence of the scientific outlook among mankind. It appears as an autonomous activity with the Greeks. They realised the existence of a rational order in the universe, but "overwhelmed by the almost magical power of their new instrument" (mathematics), they were inclined to exaggerate its power. It should be noticed, in passing, that Mr. Sullivan in this connexion scarcely does justice to the non-mathematical synthesis of Aristotle, whose name only occurs as the master of human reason for the medievalists.

Doing, however, full justice to the coherence and rationality of the scholastic view as a whole, Mr. Sullivan goes on to point out that the modern scientific outlook comes to its first clear expression in Galileo. Galileo and Kepler, faced with the revolution involved in the Copernican hypothesis, felt that "its æsthetic charm considered as a mathematical theory", was sufficient to secure its acceptance in spite of its apparent direct contradiction of our senses. The beauty, as well as the superior simplicity of successive stages, in man's conception of the universe, thus count in the growth of thought, and are elements in the mental aspect of the final result. But even Galileo is not the perfect man of science. This position was reserved for Newton, with whom the sun of science is fully risen.

Having thus in a general sketch set the stage for the contemporary drama, Mr. Sullivan in the next chapter plunges us into the problems of the "expanding universe". He states the case as presented by the second law of thermodynamics—the immense masses pouring out their energy for millions and millions of years and then dying down. It seems to be the true scientific account, but we cannot believe it to be the whole truth.

The basis of this world-view is then examined, and in particular the dominant rôle played by the study of light. The notion that light moves was one of the most amazing and momentous leaps of imagination, and to it, and to the analysis of the light coming to us from every corner of the visible universe, is due the modern structure of our thought about physics. This leads the argument to other forms of radiation, and the ultimate apparent indeterminacy of the quanta. We then turn back, about the middle of the book, to the



question of the scientific account of origins. First the tidal theory for the genesis of planets is shortly but very clearly explained, and the reasons which have compelled its preference to the older nebular hypotheses of Kant and Laplace. A section on the gradual building up of geology follows and the record of life which it unfolds.

The meeting point between the two spheres of physical and biological science is found in the study of the infinitesimal to which the analysis of electrical phenomena has now reached. Here are the new and strange phenomena to which indeterminacy is attributed, and here the link may be found between the living and the inanimate worlds. On this, Mr. Sullivan is wisely reserved. Though vitalism is discredited, it does not follow that the solution of vital problems will come through any extension of mechanical ideas. It may rather be expected from the development of a new range of ideas of biological origin. In this new synthesis the science of mind, at present in a rudimentary state, would take control.

It will be seen that the book is of unusual scope and power. It would be difficult, in fact, to name any other better calculated to give an intelligent layman a just and comprehensive conception of the whole field. It aims at understanding, without controversy. It has the historical spirit, without insignificant detail, and it ends on a note of hope and confidence in science, without exaggeration.

F. S. MARVIN.

### Concrete in Road Engineering

- (1) *Road Engineering*. By E. L. Leeming. (The Glasgow Text Books of Civil Engineering.) New and revised edition. Pp. xx+377. (London: Constable and Co., Ltd., 1933.) 18s. net.
- (2) *Reinforced Concrete Bridge Design*. By C. S. Chetty and Haddon C. Adams. Pp. xviii+400+24 plates. (London: Chapman and Hall, Ltd., 1933.) 42s. net.

**E**VEN to the casual observer, it is evident that road engineering has advanced in recent years, although it may not be so evident that rule of thumb methods are giving place to careful investigation and scientific design. Two commonplace materials may be taken in illustration: cement concrete, familiar in road structures, and the asphaltic concrete which forms the upper crust of many main roads. Both are composed of broken stone fragments of varying sizes held together by a binding material, and it might

appear that casual selection and a few rough trials to fix suitable proportions would suffice. This method has indeed been used, frequently with deplorable results. But care both in selection and proportioning is essential if the product is to be reliable, and it appears that further investigation of the stability of such mixtures at various stages is necessary before complete control of their properties can be attained.

(1) Progress in the science is reflected in the publication of a revised edition of "Road Engineering". The original edition (1924) gave an account of theory and practice up to that date, necessarily brief in some sections, but with adequate references where room could not be found for the detailed treatment of some specialised branch. Additions have now been made to the sections dealing with subsoils, curves, super-elevation, traffic measurement and concrete and rubber roads, and new sections on road emulsions and cement-bound roads have been added. Other new material relates to maintenance, slipperiness, town planning, traffic regulation and administration. It might, however, be remarked that no mention is made of the new British Standard Specification on roads, except for a general reference which appears in the appendix.

(2) Extensive use has been made of reinforced concrete in road structures during the last decade, and although construction on the same large scale has been discontinued for the present, it is probable that the return of better times will bring renewed activity. Much remains to be done in the replacement of obsolete structures, and the subject of bridge design is especially likely to continue as one of special interest to road engineers.

In the work under notice, an exceptionally thorough and well-balanced treatment of the subject is given. In comparison with alternative constructions in steel, concrete structures present much more complex problems in analysis for bending moments, etc., and the methods and formulæ here developed should prove of material assistance. Especial reference should be made to the influence diagrams presented—those for arches covering parabolic, segmental and elliptical shapes in various rise-span ratios. The treatment is clear and direct and unlikely to be regarded as superfluous even by those already in possession of a good textbook on theory of structures. A similar comment may also be made on the section dealing with the proportioning and reinforcement of concrete members. Materials, however, are



treated with a conciseness which on some points borders on reticence.

The principal feature of the book is that it illustrates the faculty possessed by the authors of analysing their very extensive experience of road bridge design and of presenting the results clearly and convincingly. Preceded by a chapter on road bridge loadings, chapters are devoted to beam and slab bridges, both simply supported and continuous, and to arch bridges. A feature of the last is the authors' special system of arithmetical integration for the solutions necessary for influence line construction. Throughout, design methods and arrangements are illustrated by worked examples and drawings. A similar procedure is followed in the succeeding chapters on culverts, substructures and foundations.

A feature of special interest to road engineers is the chapter which deals with the use of reinforced concrete in bridge strengthening and widening.

### X-rays and the Digestive Tract

*The Digestive Tract: a Radiological Study of its Anatomy, Physiology and Pathology.* By Dr. Alfred E. Barclay. Pp. xxviii + 395 + 23 plates. (Cambridge: At the University Press, 1933.) 36s. net.

IN spite of its comparative youth, the strides made by radiology since the discovery of X-rays and the demonstration of their properties by Röntgen in 1895, have been most spectacular. As a result, the days when the X-ray department of a hospital was housed in an out of the way portion of the basement have given way to a new era in which, from the diagnostic point of view, this department has become the keystone of the hospital.

In no other branch of medical science has radiology played a more important part than in the diagnosis of disease in the digestive tract. Not only is the surgeon by its aid able to acquire a clearer knowledge of the exact lesion in the abdomen he is about to operate on, but also a new outlook has been attained on the anatomy and physiology of the various parts of this tract.

The book under review is described by the author as "the result of many years groping, often by tracks, now become well-worn highways, with milestones, signposts, and danger signals erected one by one by the pioneers as they passed

forward". A book based on twenty-five years of constant thought on the part of one with the author's experience and active spirit of inquiry is bound to be, as this is, a masterpiece. Not content with merely accepting the findings of others, the author has refused to follow teachings which he has been unable to confirm by his own researches. The book is not merely a prosaic recital of well-known facts, but also abounds in personal experiences which make it all the more fascinating to read and should tend to impress each portion more firmly in the mind of the reader.

Speaking of the necessity for a definite routine on the part of the radiologist in making his examination of the digestive tract, the author emphasises the importance of a certain amount of elasticity, so that digressions may be made, which may prove to be, in any particular case, of paramount importance in the final diagnosis. He follows up this advice by remarking that "these side excursions must never become side-tracks, and the routine must be picked up again, exactly where it was left". Such a procedure has been adopted in the lay-out of the book as a whole. The author's digressions from the beaten track are invariably of the nature of 'side-excursions', never of 'side-tracks'. Such excursions as he has made merely serve to map out more clearly the highway, and to emphasise its landmarks, so that the reader may march on with renewed assurance and enthusiasm.

The author states that the book is mainly concerned with the study of the normal, without a clear knowledge of which the study of the abnormal would be without a proper foundation. Yet the portion dealing with the abnormal is complete, nothing of importance being omitted. He rightly affirms that no real line of demarcation can be established between form (anatomy), function (physiology), and disease (pathology), and that all three merge one into the other; yet he has been able to apportion to each its proper value, and to produce a book which is exceptionally well balanced. All three aspects are dealt with very fully, but nowhere is their important mutual relationship lost sight of.

Though "primarily intended" for the use of members of the medical profession, the book contains much that should attract laymen who are interested in hospital management. The importance is stressed of having qualified radiologists (defined as "clinicians with special knowledge of a particular method of investigation") in control of



X-ray departments rather than, as in the case of some of the smaller hospitals, men without such specialised knowledge. The question of protection from the harmful effects of X-rays, high tension currents and vitiated atmosphere is carefully considered.

Speaking of the responsibilities and risks of the radiologists, the author says that "the radiologist's first object must be to make an efficient examination, and in order to attain it he must, if necessary, take some risk. The difficulty is where to strike a balance between the two factors of efficiency and risk. His first concern must be the patient". Speaking of protection, he says that "no protective devices will save the man who wantonly exposes himself". Speaking of the protection of the X-ray staff he says that "radiologists can take personal risks if they so desire, but neither they nor the governors of a hospital have any right to endanger the health of those who work for them".

Such statements as these should supply much food for thought to those laymen who sit on hospital committees, and are responsible for the health and safety of their X-ray workers. Thanks to the services rendered by the X-Ray and Radium Protection Committee, the recommendations of which are now accepted internationally, the lot of those working with the dangerous X-ray and with radium rays has been very appreciably improved. These recommendations are given in full in one of the appendices.

Taken as a whole the book, beautifully illustrated, is an exhaustive review of the subject. No scientific publication could be more completely informative and at the same time more delightful to read. It is a very worthy monument to the unremitting labours of its author.

### A Russian Treatise on Organic Chemistry

*Traité de chimie organique.* Par Prof. A. E. Tchitchibabine. Vol. 1. Pp. xxviii+562. Vol. 2. Pp. x+xxix+xxxv+563-1024. (Paris: Hermann et Cie, 1933.) Vol. 1, 120 francs; Vol. 2, 100 francs.

SINCE it has appeared hitherto only in the Russian language, Prof. Tchitchibabine's treatise on organic chemistry has remained almost unknown to British chemists, although it was originally published so long ago as 1924. The author, who formerly held a chair in the University of Moscow, is a member of the Academy of Sciences

of the U.S.S.R., and he has a distinguished record of research in organic chemistry.

In his preface to the first edition, Prof. Tchitchibabine writes: "Le but poursuivi était non seulement de présenter un manuel de chimie pour des étudiants des écoles supérieures de chimie, mais également de donner un ouvrage didactique capable de développer chez les futurs chimistes cette indépendance d'esprit, qui leur est nécessaire pour remplir leur mission de chercheurs et, en plus, servir de ferment pour le développement de la science et de l'industrie chimique." It is not difficult to agree with Prof. Grignard, who has written a short introduction to this translation, that the author has achieved his aim, and that his text offers a clear and logical account of present-day organic chemistry. He has provided a comprehensive exposition of the subject, which will prove attractive to honours students and advanced workers who may desire to use a French text. The work may, indeed, be ranked with some of the best treatises of the kind in other languages.

There is no outstanding novelty which calls for comment in the treatment or subject-matter. The first volume contains a general introduction (78 pp.) followed by a systematic survey (484 pp.) of aliphatic compounds, proteins and purines, together with a treatment at appropriate points of such subjects as co-ordination compounds, the relationships between physical properties and chemical constitution, and X-ray analysis in organic chemistry. The second volume treats of cyclic compounds, arranged under the headings of carbocyclic compounds (43 pp.), aromatic series (203 pp.), terpenes and their derivatives (35 pp.), and heterocyclic compounds (143 pp.).

The most striking feature of this work is the astonishing circulation which has been attained by its more recent Russian editions. The first edition, "malgré la défectuosité de sa présentation extérieure," was taken up in less than three years. The "unexpected success" of the second edition necessitated the immediate preparation of a third edition. The third Russian edition of 30,000 copies was absorbed in a few months! The author observes that this result testifies to a vigorous growth of chemical education in the U.S.S.R. Such a demand for an elementary school-text would be remarkable; but that it should exist for a work of this advanced and specialised character is more than remarkable—it is revolutionary.

JOHN READ.



## Short Reviews

*The Origin of Living Matter.* By Dr. H. A. Gray and N. M. Bligh. Pp. vi+27. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1933.) 1s. 6d. net.

ARGUING from the fact that the moon's mass bears a higher ratio to that of the earth than does the mass of any other satellite in the solar system to that of its planet, Dr. Gray and Mr. Bligh contend that the earth-moon binary system is due to an encounter with some third body, that a great quantity of energy was made available at the time of the encounter, and that this energy was converted into sub-atomic energy, the energised atom being vital. Vital atoms have the power of vitalising other atoms. A detailed structure is proposed; the vital atoms are a binary system of two or more protons, surrounded by appropriate electron shells. The chemistry of these vital atoms is extremely complex—more so than that of the non-vital atoms. The authors attempt to disarm criticism by printing on the cover the statement that “a proof of that degree and kind that the scientific world rightly demands of all theories, it is maintained, applies only to materialistic phenomena, and insistence on such proof when dealing with animate matter cannot be sustained”. We imagine that this point of view will not find much favour with biochemists, and we had imagined that the identification of animate with non-animate chemistry was as old as the synthesis of urea.

It is clear that these authors must suppose that only a very small amount of the matter in any living organism is vital. They postulate, of course, that the atoms become devitalised at death; if not, we should detect some remarkable spectroscopic phenomena in freshly killed tissue. But on their theory, should not death itself be a luminous phenomenon, giving rise to a remarkable spectrum, the quanta, perhaps, being in the ultra-violet or X-ray region? If the number of vital atoms is very small, it should be possible to detect some tiny photoelectric effect. Many other objections will, no doubt, occur to our readers. These authors—and all others—should be warned against basing theories on current astronomical descriptions of the origin of the solar system, or of the galaxy, which are usually tentative and have a habit of changing completely within a decade.

*Symmetrical Components: as Applied to the Analysis of Unbalanced Electrical Circuits.* By C. F. Wagner and R. D. Evans. Pp. xvi+437. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1933.) 30s. net.

It was in 1918 that Prof. C. L. Fortescue published his now classic paper on “The Method of Symmetrical Coordinates Applied to the Solution of Polyphase Networks”. A considerable literature dealing with the solution of unbalanced polyphase circuits by his method has resulted; and indeed the

present authors claim that it is the only practicable method of solving unbalanced electric circuits. The method has also been applied to all manner of problems in power distribution, particularly to the investigation of unsymmetrical transient disturbances. The present volume claims to be the first which gathers together the fundamental theory on which the method is based and discusses the principal applications.

It is fitting that an introduction is written by Prof. Fortescue, the originator of the method, who still prefers the term ‘symmetrical coordinates’ to the more commonly used expression ‘symmetrical components’. The introduction is interesting in its explanation of the mathematical history of complex numbers, the usefulness of which was a comparatively late discovery.

The earlier chapters cover the more essential phases of the fundamental theory and the principal application of the method: the determination of voltages and currents under unbalanced faults. Separate chapters are given for the calculation of the constants of synchronous machines, transformers, short lines with and without earth wires, long lines and cables. The second half is devoted to more specialised problems and to measurements. An appendix contains many useful data.

The book can be thoroughly recommended. It will be a boon to those seeking a textbook on symmetrical components, and a revelation to those hitherto unaware of the extent to which this powerful method can be applied.

*Elements of Engineering Thermodynamics.* By James A. Moyer, Prof. James P. Calderwood and Andrey A. Potter. Fifth edition, rewritten and reset. Pp. xiv+192. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1933.) 15s. 6d. net.

In their preface to the new edition of this book, the authors indicate that it is intended for use in those technical colleges where special courses are held in the subjects of advanced thermodynamics as well as in steam turbines, internal combustion engines, refrigeration, and other applications of thermodynamics. To this end they claim to have stressed the fundamental principles of engineering thermodynamics as a foundation for the more advanced and practical applications of the theory.

While there can be little complaint over the general arrangement of the subject-matter, it is felt that the amount of information offered in some of the branches is scarcely adequate to enable the student to proceed directly to the more advanced applications. In the chapter dealing with internal combustion engines, no mention is made of the Atkinson cycle, or of the dual combustion or mixed pressure cycle. Comparatively simple accounts of vapour reheating and regenerative cycles take about six pages, but the more difficult case of the combined reheating and



regenerative cycle is dismissed in six lines, and the description of the binary vapour engine occupies only one page. In view of the excellent textbooks on engineering thermodynamics that are already available in Great Britain, it is doubtful whether this American work will find a place in the list of books recommended for students in engineering.

*Introduction to Internal Combustion Engineering.*

By Dr. J-B. O. Sneedon. Pp. ix+268. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1933.) 6s.

THIS book not only deals adequately with the elements of internal combustion engineering but contains, in addition, a large amount of valuable information generally found only in the more expensive textbooks. The subject has been carefully developed, both on the theoretical and the practical sides, with descriptive and mathematical matter so well balanced that the book can be recommended to any student wishing to acquire a sound knowledge of fundamental principles.

The work contains a large number of problems and numerous diagrams and illustrations. A very useful feature is the frequent reference to published papers, modern research work and standard works on the more highly specialised part of the subject.

The contents embrace thermodynamics of gases, ideal and actual engine cycles; gaseous and liquid fuels; combustion; and the more practical aspects—charging and exhausting the cylinder; ignition of the charge; cooling systems; testing of internal combustion engines; and air compressors.

A few pages are devoted to supercharging, but, even at the expense of increasing the size of the book, it is felt that a fuller treatment might have been given to this part of the subject. The application of the oil engine to road vehicles might have been given a place at least equal to that devoted to the application of town and producer gas to road traction.

*Cancer: Civilization: Degeneration: the Nature, Causes and Prevention of Cancer, especially in its relation to Civilization and Degeneration.* By John Cope. Pp. xvii+293. (London: H. K. Lewis and Co., Ltd., 1932.) 15s. net.

It is extremely doubtful if the fear of cancer will be a sufficiently powerful deterrent to make the average man and woman conform to the suggestions for a simpler and nobler way of life which commend themselves to Dr. John Cope. His book is much more a sociological essay than a contribution to the cancer problem, for the nature and causes of cancer are assumed throughout to be well-known degenerative conditions, due to civilisation's flouting of natural law. All the well-worn fallacies of the predisposing factor of age, the healthiness of savage peoples and their freedom from cancer and constipation, and the greater incidence of cancer in women than in men (on the same page as a table showing the contrary)

pass like a stage army more than once across the scene. The fact that cancer of the uterus has not increased in Great Britain during the last forty years is ignored, with the same insouciance as is meted out to the laborious but precise findings by the experimental induction of malignant growths in animals.

Whether one agrees with Dr. Cope's views on diet, infant feeding and birth control, or not—and much that he writes and figures in vigorous sketches can be conceded as well and worthily done—it is legitimate to protest against the *ad hoc* 'facts' of the biology of cancer which act the scarecrow in his pages.

*Crime, Law and Social Science.* By Prof. Jerome Michael and Prof. Mortimer J. Adler. (International Library of Psychology, Philosophy and Scientific Method.) Pp. xxix+440. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., 1933.) 15s. net.

THE authors of this volume, which, in so far as it is affected by practical considerations, is based more particularly on conditions in America, examine minutely the precedent conditions of a science of the criminal from every point of view—behaviour, environment, treatment and the administration of the law. They are severely critical of existing studies in criminology, pointing out in which respects they fall short of compliance with the canons of an empirical science. There neither is, they maintain, nor can be a science of criminology until the studies upon which such a science is dependent, namely, psychology and sociology, are themselves placed upon a scientific basis, a point not yet attained. They bring their thesis to a close with a proposal for an institute and system of study of the criminal from every point of view. As a critical study the book is illuminating and suggestive, as well as constructively helpful.

*Practical Physiological Chemistry.* By Sydney W. Cole. Ninth edition. Pp. xii+419. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1933.) 12s. 6d. net.

IN the new edition of this well-known and deservedly popular manual, some changes have been made in the methods for estimating urea and reducing sugars, and the chapter on the coagulation of the blood has been omitted as, in the author's opinion, unsuitable in the present state of the subject for a book of this kind. The treatment of pH has been introduced earlier and somewhat expanded. Further exercises on colloids are added. In view of recent progress, the chapter on oxidations has been remodelled so as to bring it into line with the modern position and many other minor improvements have been made.

In its new form the book will without doubt prove as popular with students and teachers as the eight previous editions published since 1904. The publishers have done justice to the merit of the work by good printing, paper and binding.



## A Survey of Progressive Science\*

By SIR FREDERICK GOWLAND HOPKINS, PRES.R.S.

AMONG the many aspects of progress in physics which tempt reference is that concerned with cosmic rays, so fascinating to most minds are speculations concerning their nature. Thinking of the more recent developments in this subject, one would like to express admiration of the enterprise which has enabled Prof. E. Regener to obtain records from many miles up in the atmosphere and deep below the surface of Lake Constance for measurements of their varying intensity; admiration no less for the similar enterprises of Compton and Kolhörster. It is interesting to learn that Regener, as the result of the most recent researches by himself and colleagues, has formed the personal opinion that a part at least of cosmic radiation is electromagnetic.

It is difficult even in the briefest of references to the scientific progress of the year to ignore the claims of 'heavy hydrogen' and 'heavy water'. We knew that there was yet something to learn concerning the molecular species present at any moment in the liquid we daily handle under all sorts of varying conditions, but to learn that so familiar a friend as water should have kept hidden from us until now so deep a secret is almost disconcerting. The recognition of the hydrogen isotope  $H^2$  and the realisation that we have been in constant contact with  $H^2O$  as well as  $H^1O$  shakes our scientific complacency, as did the proof forty years ago that the familiar atmosphere contained a gas until then unknown. Moreover, just as Lord Rayleigh's attention to a very small difference in the density of pure nitrogen and residual nitrogen from air led to the isolation of argon, so a small discrepancy between the chemical values for atomic weight of hydrogen and Aston's mass-spectrograph determinations (when in the latter allowance has been made for the existence of the oxygen isotopes) led Birge and Mengel to the suggestion that ordinary hydrogen might contain a heavier isotope. Once again an important discovery has followed from a firm faith in the great accuracy of modern physical measurements.

The brief history of our knowledge of heavy hydrogen assuredly illustrates the enterprise in research which is characteristic of to-day. The bare suggestion for its existence only arose in 1931, and it is scarcely more than a year since spectroscopic evidence provided by Urey and others made it sure. Yet already heavy hydrogen and heavy water have a big literature. Advances have been rapid; Lewis and Macdonald, for example, have already prepared and studied nearly pure  $H^2O$ , and many of its properties have been studied by them and by others. We learn, for example, that its freezing point is  $+3.8^\circ C.$ , and its boiling point  $101.42^\circ$ , that ionic mobility in it is smaller

than in  $H^1O$ , and many other of its constants have been determined.

Remembering that living cells and tissues contain 70-80 per cent or more of water, and recalling its all-important biological functions, it is not surprising that much curiosity has been awakened concerning the relations of  $H^2O$  to life. There seems to be evidence already that, when nearly pure, it is unable to maintain living organisms, though we do not know at what concentration it proves, if at all, to be actually toxic. We shall want to know to what degree living cells are permeable to it, and whether they have any selective power as between  $H^1O$  and  $H^2O$ . It is sure that many studies to determine such points will soon be made.

The suggestion that there may arise a new organic chemistry involving a synthesis of all known types of molecule with (if it prove possible)  $H^1$  replaced by  $H^2$  is intriguing, but, as others have remarked, somewhat alarming. There is at any rate much more yet to be done with compounds containing  $H^1$ .

All concerned with the chemistry of living things must feel satisfaction in the help that is now forthcoming in full measure from distinguished organic chemists towards the elucidation of the molecular constitution of such substances as vitamins and hormones, with their great biological importance. Professed biochemists are naturally making their own efforts in such directions, but they have their own problems to face in the study of events in the living plant and animal, and in that of biochemical reactions in general. The special experience and the developed intuitional skill of those whose minds are more continuously devoted to the art of synthesis cannot fail greatly to accelerate progress in this field.

I might illustrate this by several advances which have occurred during the year, but will be content with referring to the work upon vitamin C. No one acquainted with the dramatic history of scurvy in the past can fail to feel interest in the molecular constitution of a substance, the absence of which from the food involves the onset of that most serious malady. I think the history of recent dealings with this vitamin are of sufficient interest to bear recapitulation. Albert Szent-Györgyi, interested primarily in the oxido-reduction systems of animal tissues, was led, while working at Cambridge, to attempt the isolation of the substance responsible for the highly reducing properties of the adrenal cortex. He successfully obtained it from the gland in crystalline form, and afterwards separated it from orange juice. Its presence in the latter and certain of its properties made him suspect from the first that it might be related to vitamin C, but the amount available at the time was too small for successful biological tests.

\* From the presidential address to the Royal Society, delivered on November 30.



Szent-Györgyi then went to the United States, where adrenal glands can be had in great abundance, and at the Mayo Clinic prepared the substance in relatively large amounts. On account of its acid character, strong reducing power, and colour reactions, recalling those of carbohydrate, he at first called it hexuronic acid, but later studies having shown that it did not belong to the uronic class, it now carries the name of ascorbic acid, based upon its biological properties.

Szent-Györgyi, returning to his chair at Szeged, in Hungary, soon became convinced that his substance possessed strong anti-scorbutic properties. His conviction that it was related to carbohydrate led him wisely to seek the help of Prof. W. N. Haworth at Birmingham, in the determination of its constitution. The amount of material available was at first very small, but Szent-Györgyi, seeking for fresh sources of the substance, had the remarkable good fortune to find that in *paprica*, a plant very common in Hungary, and used there as a condiment, ascorbic acid is present in relatively large amounts. Adequate material for study thus at once became available.

Much time has been devoted to constitutional studies in the Birmingham laboratory with conspicuous success. It is interesting to note that the methylation of hydroxyl groups, which has been of such value in carbohydrate research generally, has been also of service in this case. I must not, of course, stop to deal with the experimental steps, or the considerations which have led to the structural formula indicated by the work of Prof. Haworth and his colleagues. They have shown, in brief, that ascorbic acid is a derivative of the hexose sugar, 1-*gulose*; and that it is the lactone of a six-carbon acid with a five-membered ring. When in solution it is present as the enolic form of 3-keto-1-gulofuranolactone. It is right to say that certain Continental workers have come to somewhat different conclusions in detail, but the evidence for the above constitution as recently presented by a group of Prof. Haworth's colleagues is very convincing. The biological evidence for the normal activity of synthetic products is not yet complete, but it seems sure that the exact nature of vitamin C cannot fail to be known shortly. To the biochemist it is of much interest to learn that a substance with such specific activity in the animal body should be a relatively simple derivative of a sugar.

I will now direct attention to remarkable progress in another and quite different region of contact between organic chemistry and biology. The quest into the nature of the pigments of flowers is no new one, and most will know of the brilliant researches of Richard Willstätter which carried us so far into their secrets. Yet we owe to Prof. R. Robinson highly important recent additions to our knowledge. I have chosen this field partly because the successes reached in it demonstrate impressively enough how sure is the constructive skill of the modern organic chemist,

and also because it is a field in which chemistry, by joining hands with cytology and genetics, is giving its indispensable assistance to our understanding of the mechanisms of inheritance. Of much interest surely is the realisation that the infinite variety displayed in floral coloration is based essentially on variations within one fundamental chemical scheme. By contriving a variety of different substitutions in phenolic hydroxyl groups arranged round a common central aromatic structure, Nature has provided herself with a palette which provides all that is required for her gorgeous floral colour schemes. The central structure is that of a benzo-pyran to which a phenolic ring is attached.

These pigments are collectively known as anthocyanins or, when sugar residues have been removed from their several molecules, as anthocyanidins. For in every case the central structure of the pigment molecule is associated with one or more sugar molecules; the nature of the sugar varying from case to case. Several different monoses and also bioses find a place in the molecule of one or other of these pigments. This peculiar association of carbohydrates with functional pigments is among the most striking facts of plant biochemistry. By determining the nature of the sugars and the exact position of each in the molecular architecture of individual anthocyanins, as well as by many successful new syntheses in the group, the Oxford School has greatly advanced knowledge in this interesting field. Prof. Robinson has also developed a remarkable technique for the qualitative recognition of the nature of the anthocyanins present in this or that flower, and with his method he has explored the factors of pigmentation in nearly two hundred species or varieties. This technique, apart from the preliminary guidance it gives to chemical research, will prove of the greatest value to the geneticist who studies the inheritance of floral colours.

Until modern physical methods lent him their aid, the chemist's thought-models were, as he well knew, incomplete. As an architect he built successfully in many styles without knowing precisely why the bricks he used held together. The bonds he so usefully pictured had no physical meaning. The development of the theory of electronic valency, however, has in the course of a few years carried thought surprisingly far towards an understanding of the forces which hold atoms together in organic molecules. It is only with brevity that I can refer to these advances, in which Prof. P. Debye has played so distinguished a part.

We have first to recognise the established distinction, clear if not absolute, between electrovalence and covalence. It is the form of atomic linkage denoted by the second of these terms which applies when electrons are shared by adjacent atoms, rather than transferred from one atom to the other, that is the special, though not the sole, concern of organic chemistry. With this conception of electron-sharing as a foundation,



a remarkable structure of fact and theory has arisen. The properties of the so-called covalent bond are indeed revealing themselves to ingenious experimentation with remarkable rapidity. The dimensions and strength of such bonds, and their heats of formation, have been measured by physical methods, and, moreover, by a variety of such methods, giving closely concordant results. One among the important conceptions which have emerged is that of the dipole moment. If at any locality in a molecule electrons are shared unequally by adjacent atoms, as, for various structural reasons, they often are, the molecule will be polar; the atom which has the larger share of the two binding electrons being the negative end of a bipole. The molecule as a result orientates itself in any electric field, and a measurable moment is involved. This dipole moment is one of the most fundamental characteristics of the covalent link.

I have ventured to say this much about polar factors in molecular structure because their recognition and their measurement have thrown much light on many constitutional problems both of structure and behaviour in the field of organic chemistry. In the elucidation of some aspects of isomerism, in determining the special configuration of the benzene ring and of condensed rings, and in aiding crucial decisions concerning the constitution of molecules like those of the oximes, azides, and other difficult cases, the recognition of polar properties has been of much service. In stereochemistry it has also greatly helped progress, and with the further all-important help of X-ray analysis this branch of structural chemistry has greatly advanced of late.

I have chosen the elucidation of the dipole moment as a single illustration of the value of modern applications of physical methods in chemistry. It is clear that studies of molecular structure will for the future be in the hands of the physicist no less than in those of the chemist, and that striking progress is thus assured. Aspects of the problems now arising, unlike those successfully faced at earlier stages, call for the aid of mathematical treatment. There is no suggestion, however, that pictorial thought about the organic molecule is failing in usefulness, or that modern investigators when using thought-models believe them to lack all relation with the actual.

The subject of biochemistry is likely to gain greatly from every advance that takes us further into the details of molecular structure: for in the crowded events in the living cell we may well believe that exact particularities of shape—the ability to fit with accuracy on this or that patterned surface—is prominent among the factors which determine the functions and fate of the biologically active molecules. X-ray studies and studies of surface orientations are already justifying this belief. In illustration let me remark on the interesting light which X-ray photography has thrown upon the structure of animal and vegetable fibres: silk, hairs, cellulose, and the like.

Observations made by several investigators, among whom I may mention Mr. W. T. Astbury, have shown that the basal structure of such fibres consists of bundles of long chain molecules which, as molecules, can undergo reversible or irreversible stretching. In general, they are formed by the polymerisation of relatively simple structural units and so in X-ray photographs display periodicity along their length due to the repetition of the unit in question. I will refer to silk and hairs alone. In the former the fibres are built of extended polypeptide chains consisting, for the most part, of united residues of glycine and alanine; the unit of pattern repeating itself along the fibre axis at an interval of  $2 \times 3.5$  Å. The molecular chains in silk are, in the natural state, already fully extended; there is no significant change in their X-ray photograph when the fibre is stretched. Hair, on the other hand, and also horn, nails, etc., are composed of the protein,  $\alpha$ -keratin. It would appear that the polypeptide chain of the keratin molecule in hair is not extended, but is, as it were, folded on itself. The molecules become fully extended, however, when the fibre is stretched. The photograph of stretched hair becomes then analogous to that of unstretched silk. This, however, is a reversible change.

The folding of the molecule protects elements in its structure from chemical attack. The unextended chain, for example, resists the action of steam, while the extended chain loses its power of recovery when steamed, being 'set' in the extended form. Hence the permanent wave produced by the modern hairdresser. A point of much interest is that though all have been wrongly looked upon as composed of the same keratin, the X-ray pattern which is common to feathers and tortoiseshell is quite different from that displayed by mammalian hair. "Thus the recognised affinity between reptiles and birds and their differentiation from mammals is confirmed by the methods of molecular physics."

I will refer to but one other illustration of progress in biochemistry from the application of physical measurements. Monomolecular films on air-water surfaces change the phase boundary potential. During the last few years Rideal and his co-workers have determined the alteration in the apparent molecular moment in a film when molecules with different polar 'heads' are compared, and when the film is compressed or expanded. Upon this basis they have developed investigations dealing with chemical reactions as they occur in these two-dimensional films; obviously a study of great interest. It would seem, indeed, that film reactions differ in important respects from bulk reactions. In illustration of this I may mention a study recently published of the rate of oxidation of monolayers of unsaturated fatty acids, which may well contribute to an understanding of oxidations in the living cell. The authors are also studying enzyme catalysis in films.



## The Status of Psychology as an Empirical Science\*

By PROF. F. AVELING

## SCIENCE OF EXPERIENCE

WE turn now to psychology, the most empirical of all the sciences in the sense that it deals directly with experience as such, makes no partial selection, but embraces all experiences alike indifferently, and at their face value. Here I wish to show how scientific explanatory concepts, together with concepts which the physical and biological sciences other than psychology usually reject, are all derived from immediate experience.

Perhaps one of the best ways of developing this thesis is to consider first the historical evolution of the notion of causality, which was invoked to account for movement or change in the physical universe. An analysis was made by Aristotle, as a consequence of which five explanatory concepts were considered necessary to show how any change or movement could come about. There were the two intrinsic principles constituting the thing to be changed—'matter' and 'form'. Change means that a new form comes to actuate the matter; and it involves also the negative concept of 'privation', since before the change the alterable thing is 'deprived' of the mode of being it will exhibit after the alteration has taken place. Further than this, there are the two concepts of the agent which brings the change about, the 'efficient' cause extrinsic to the thing changed, and the reason why the agent acts, the end, goal or 'final' cause, towards the realisation of which the action is directed. Like earlier attempts, this exceedingly acute analysis of causation, applied as it was to events in the external world, is an entirely anthropomorphic one. It reads into physical phenomena, in a conceptional manner, experiences which are wholly subjective. This is at once apparent in all the examples that are brought forward to substantiate it.

Now, in the course of the development of scientific thought, first the concept of finality was jettisoned as not applicable to events in the physical universe. In the physical phenomena alone there is no indication of goal-seeking. The next concept to be dropped was that of efficiency, in the sense that one thing actually produces changes in others; for efficiency also is in fact nowhere to be found in the phenomena. We are left, then, with sequences of antecedent and consequent, conceived as equivalent in amount of energy. To be sure, temporal sequences, as well as spatial relations, are to be observed in the phenomena themselves, and even similarities that can be *interpreted* as equivalences; but they do not display energy, any more than teleology or efficiency. Most men of science go no further than this in their rejection of the concepts originally invoked to account for physical causality. Others, more mathematically and philosophically minded, substitute equations for equivalences, and

causal indeterminism for rigid determinism. The history of the successive modifications of the theory of causality, thus inadequately outlined, is evidence of the de-anthropomorphisation of physical science. At every step, however, in the refinement of the physical concept, one fact emerges—namely, that at no point is it possible to dispense with concepts derived from experiences other than those actually to be explained. Aiming at ends, efficient action, energy, equations, are not found in the phenomena in question, any more than thinghood and unity, which are necessarily involved in any and every conception of causality. What, then, are those other experiences in which we have the concrete facts from which we abstract the concepts that we apply to the phenomena?

## ORIGIN OF SCIENTIFIC CONCEPTS

Beginning with the last named, the notions of 'thing', 'same thing', and of 'unity' are derived, and can only be derived, from the immediate awareness we have of ourselves as unitary, existent and self-identical beings. When I see and handle any object, such as a book, I have visual and tactile impressions which I refer to an extra-mental thing. The visual impression, however, is not the tactile one; and neither is the book, nor are both together. Sensorially, I do not apprehend the book at all, but only 'properties' of the book. Why, then, do I think that there is a book? I interpret the phenomena, analogically with my immediate awareness of myself as affected by states, and posit a physical book with physical properties to account for the phenomena. Only later do I refine my notions of physical 'properties', and conceive them, together with the book, not as like but as very unlike the original sensory data.

The kind of mental process that occurs here is even more strikingly illustrated by another consideration. I put the book aside, and busy myself with some other matter. Then I pick it up again, and see and handle it afresh. I believe it to be the same book. But on what grounds? On the grounds of the similarity of the previous and present phenomena. To apprehend a relation of similarity between phenomena, however, is not to apprehend identity either between the phenomena or between the physical book previously posited and again posited now. There is *no* sensorial way of apprehending or of establishing identities. What happens is that again I interpret the similar phenomena, on analogy with my immediate (non-sensorial) experience of self-identity, and posit a selfsame physical book enduring in time. Finally my notion of unity also is derived from the same source of immediate, non-sensorial experience of myself, and analogically applied to sensed-things and thought-things alike.

Passing to the explanatory concept of energy,

\* Continued from page 843.



still in general use in the sciences of Nature, we find that this also is not to be discovered among the particular selected sensory phenomena with which they deal. This concept of physical energy refers to a postulated persistent entity ('same thing'), constant in amount, which may be transformed from one state to another, and is capable of doing work in bringing about physical movements. To what source in experience can we trace this notion? It is not sensorially apprehended in the physical phenomena observed. It might at first sight seem that it should be traced to kinæsthetic experience, or the sense of effort in bodily activity by which different kinds of work are done; that we read this analogically into the physical phenomena, and project the result into a 'physical' world. But this cannot be a true explanation, because, like the properties of the book just considered, the sense of effort experienced in one case is only similar to the sense of effort experienced in another. It can in no sensory way be shown that they are identical. Likewise, the body, in the same way as the book, in any successive pulses of sensorial apprehension, displays no more than a relation of likeness. Accordingly, I appeal again to my immediate non-sensorial experience of self-identity, in which I discover an active self energising in one way or another. It is true I do not find any perpetual and unbroken continuity of self-consciousness; but, whenever I am conscious, notwithstanding all the changes that take place in the phenomenal world, including those of my own body, I am conscious of the same unitary and self-identical I. Can we find the basis of the concept of energy here? I maintain that we can, in the sense that this self does actualise, or energise, in different ways, now perceiving, now judging, now resolving, now enjoying, and the like. From this I infer that a self which does all these things can do any one of them, even if it is not actually doing that one at the moment. Here I find, in immediate living experience, the source from which the abstract concepts of energy and dynamism are drawn; and these concepts, applied to the phenomena of motion or change, become those of kinetic and potential energy, and are projected upon an extra-mental world of things which we have conceived on analogy with ourselves.

There are other lines of approach to the development of the thesis I am maintaining than the one I have taken; but I have chosen this because it most readily allows me to stress my point. Had we worked backward in the history of the evolution of the notion of causality, instead of forward as we have done, we should have found that we were leaving the region of remote inference for that of proximate inference, and this again for that of experience pure and simple, until at last we reach the immediate experience of the self as actively engaged with its mental objects. We should have reached then the central core, so to speak, of all experience. Here we find, not merely a concept nor a phenomenon, but an actual thing, or active substance existing in itself, from which the notions of thinghood, substance and activity are abstracted; we find here an efficient cause actually producing its effects, such as remembering a forgotten event or altering the character of phenomena by willing to do so, and from this the concept of efficiency is derived; we find a substantial cause in multiform relations with sensed-things and thought-things, among which is the goal relation, whence the idea of finality or teleology arises.

From such experiences as these, to which we apply relations likewise experienced, we derive proximate inferences such as those of retentiveness or mental energy. From them also, as well as from our immediate experiences of the apprehension of relations and the production of correlates, we infer the proximate principles of noetic education. And, lastly, from them again, by further applications of relations to them, to phenomena, and to correlates already produced in our thought, we reach the far more remote inferences of which use is made in the sciences of Nature; for here we refer our experiences to transexperiential, extra-mental causes. But the grandiose system of the natural sciences as a whole stands in virtue of these original experiences; and it would crumble away into less than dust did they not guarantee it.

It is for this reason, provided the meaning of the term be not limited to sensory experience only, but be extended to all and everything that may be experienced, that I maintain that psychology is the most empirical of all the sciences.

### Kinematic Design in Engineering

**F**EW if any of the mechanical engineers of last century can have imagined that the academic kinematic theories of Willis, Reuleaux and Maxwell would ever be applied to machinery. Strength and solidity was their ideal, and when portions of structures were to be united, large areas of contact with numerous strong bolts formed their standard practice. The same idea was followed in moving mechanisms, as shown in large flat lathe beds and crosshead guides, and long, closely fitting, rigid bearings. Realising that this practice necessitated

very perfect fitting, they developed the art of producing large flat and cylindrical surfaces to a very high pitch of perfection, and their success has been shown by the accuracy and endurance of early British machine tools.

Modern mechanical construction has called, however, for constant increase of accuracy, and the limitations of the old method began to be revealed by the distortions produced by the forces required to secure contact over large areas, and by the stresses resulting from temperature changes.



In consequence, machine designers have been obliged more and more to adopt the teachings of kinematic theory, and in the twentieth Thomas Hawksley lecture to the Institution of Mechanical Engineers delivered on November 3, Prof. A. F. C. Pollard has given a very complete account of these principles and of their practical application.

As was natural, the first practical application of kinematic principles was to scientific instruments, and Lord Kelvin was probably the pioneer with his well-known hole, slot and plane device, providing the six points of contact necessary to restrict the six degrees of freedom of a single element. The equivalent and nearly equally effective three-slot device has also come into general use in the tribrach supports of modern levels and theodolites, superseding the old four-screw device, which caused strain and sometimes damage. Either the hole, slot and plane or the three-slot device ensures perfect location without high accuracy of workmanship, and avoids all distortion by temperature changes, provided that the pressure on the contacts is not too great to prevent easy sliding. For heavy loads, ball-ended feet may be substituted, as in the 18-ft. measuring bench at the National Physical Laboratory, the surfaces of which could not be accurately trued until the friction of the contacts was reduced. Large surfaces can be supported without distortion on multiple systems of tribrachs as first introduced by Lord Rosse, followed by Sir Howard Grubb and Parsons, for the specula and polishing tools of reflecting telescopes.

Kinematic design has been adopted to an ever increasing extent in modern lathes, grinding machines and other machine tools, and has recently begun to find its way into the automobile industry; the engines of many cars being now mounted on three supports, two of which are usually in front and one behind the engine, thus preventing it from being strained by distortions of the chassis, and diminishing the effects of its own vibration.

The late Sir Horace Darwin was the great pioneer of kinematic design in instrument construction, and the numerous instruments he designed for the Cambridge Instrument Co., Ltd., commencing with the well-known rocking microtome, and proceeding to reading microscopes, comparators, the optical components of string galvanometers, etc., are outstanding examples of its application. Messrs. Adam Hilger, Ltd. have adopted it for their interferometers, comparators, and spectrographs; Mr. Wm. Taylor for his screw-gauge measuring machine, in which ball slides were first used, and Messrs. A. C. Wickman, Ltd. for a universal gauge measuring machine; while Messrs. E. Leitz were the first to employ kinematic ball bearing slides for the fine adjustments of microscopes.

Systems having one degree of freedom—sliding, turning, or screwing—constitute the most important class of mechanisms. A cylinder resting

on four points has two degrees of freedom, which can be reduced to one of pure rotation by a single axial end contact, or to one of pure translation by providing it with a transverse arm bearing on a plane parallel to its axis, as in the Cambridge Instrument Company's reading microscope. If a helical groove is cut along the central portion of the cylinder, and the smooth portions rest on three points, and the groove on a single spherical point, we have the elementary kinematic screw. For a pure turning pair, the best practical construction is probably two self-centring conical bearings each having three balls, and at a sufficient distance apart to prevent rotations about transverse axes, one of the bearings being provided with an axial pressure spring.

The construction of accurate screws and nuts has probably always been the most difficult of mechanical operations. The methods of Profs. Rowland and Rogers of correcting the errors of the lead screw and of lapping by a split nut still remain unimproved, but Mr. R. S. Whipple has recently described an excellent method of constructing the nut by casting white metal round the finished screw, after which the nut is split into halves and the thread is cleared away so as to leave four portions in the guiding half, and two portions in the other half which apply the necessary pressure to ensure contact without backlash.

When the mechanism is completed, the most valuable test is the 'hysteresis loop' obtained by traversing it slowly forwards and backwards over its whole range and observing its indications at intervals. This reveals the amount of backlash or lost motion at every part of its range, and the great superiority of good kinematic design.

It cannot be doubted that the introduction of ball and roller bearings has been a most powerful influence towards the adoption of kinematic design, by showing that point or line contacts are capable of dealing with heavy running loads for long periods without undue wear. Maximum surface hardness as measured by the Brinell test appears desirable, and nitriding or chromium plating may probably prove advantageous. Sapphire or even diamond jewels and pivots, suitably cut with respect to their cleavage planes, are employed for small instruments. The Hertzian theory of the stresses and deformation of point contacts appears to give sufficiently reliable data for design, and 700 tons per square inch seems to be about the maximum safe stress for steel ball contacts. One trouble with such contacts has been their rusting, but Messrs. Keenock Gears have recently discovered that lubrication with oil mixed with 50 per cent of zinc oxide entirely eliminates rusting by depositing a film of zinc of molecular thickness on the surfaces.

Prof. Pollard has described a large number of kinematically designed instruments in detail. His lecture will probably remain a classic on the subject for many years to come, and should provide a valuable stimulus to the widespread adoption of kinematic design.

C. V. D.



## Obituary

DR. ÉMILE ROUX, For.Mem.R.S.

BY the death on November 3 of Dr. Émile Roux, the director of the Institut Pasteur in Paris, France and the rest of the world have lost a great man of science who was the last and most famous of the assistants and co-workers of Pasteur. Dr. Roux was, by common consent, the most respected figure in the bacteriological world to-day and it will be almost impossible to fill the post which he had so long held in France.

Pierre-Paul-Émile Roux was born on December 17, 1853, at Confolens (dep. Charente), the son of the principal of a college in that small town. Émile went to school at Confolens and finished his early education at Aurillac and Le Puy, where he took his degree of bachelor of sciences. Shortly afterwards he began the study of medicine at Clermont-Ferrand where he first came into contact with Émile Duclaux, who afterwards was to have a great influence on Roux's career. At that time Duclaux was acting as *suppléant* of the chair of chemistry at Clermont and filled his classroom with students whose imaginations were fired by hearing from Duclaux the wonderful fields which had been opened up for medicine by the researches of Pasteur on fermentations. It was in Duclaux's laboratory that the young Roux carried out his first research in 1873.

Later Roux went to Paris to complete his medical education, and having done so he entered the military hospital of Val-de-Grâce. The military regime was not altogether to Roux's liking and he attached himself to the Hôtel Dieu, where he was *aide-de-clinique* from 1873 until 1877. By that time his old Clermont teacher Duclaux had been transferred to Paris as professor of meteorology in the Institut Agronomique and also lectured at the Sorbonne. Duclaux also worked in Pasteur's famous laboratory at the École Normale Supérieure in the Rue d'Ulm. Roux became *préparateur* to Duclaux and attracted the attention of Pasteur, with whose subsequent career he was closely united first as assistant and then as *sous-directeur adjoint* of Pasteur's laboratory, being junior to Charles Chamberland, who was Pasteur's chief assistant.

Chamberland and Roux played a leading part in the researches of Pasteur on anthrax (1879-1882) and they were honourably designated by the master as his collaborators and not merely as assistants. Chamberland and Roux were also the principal workers in the famous series of researches on hydrophobia which Pasteur in their joint names published in 1881-1886 and which led to the discovery of the prophylaxis by the attenuated virus of rabies. In 1883 Roux was sent by Pasteur to Egypt to study cholera, the cause of which was unknown at that time.

When the Institut Pasteur was opened in the Rue Dutot in Paris in 1888, Roux was appointed *chef de service* (1888-1897), *sous-directeur* (1897-

1904), and on the death of the *Directeur* Duclaux in 1904, Roux became director of the Institut Pasteur and he occupied this important position until his death twenty-nine years later.

From the time of the opening of the Institut Pasteur, Roux published many important researches in his own name alone but more frequently with his assistants. To this period belong his papers on bacteriological technique, the passage of the virus of rabies along the nerves, and the pathology of experimental lockjaw. In association with Alexandre Yersin, Roux carried out extensive researches on the nature of diphtheria (1888-1890), and they made the important discovery of the existence of diphtheria toxin. These researches of Roux and Yersin aroused great interest and they directly led to the discovery by Émil Behring of diphtheria antitoxin, which discovery was announced on December 4, 1890. Roux at once saw the fundamental importance of Behring's discovery and set to work to devise a suitable technique for the purpose of producing antitoxin on a large scale. He was the first to employ the horse as a suitable animal for antitoxin production, and his methods are in use to-day. With the antitoxin he prepared he carried out a long series of observations on children treated with antitoxin. The lecture on his results at the eighth International Congress of Hygiene and Demography in Budapest in September 1894 aroused world-wide interest and inaugurated a new era in the therapeutics of diphtheria.

In addition to his research work, Roux founded and conducted a course on microbiology at the Institut Pasteur, and during his lifetime taught something like three thousand students of all nations. In this course he revealed himself as a teacher of the first rank and held his audiences spellbound by his eloquence.

In 1903-1906 Roux, in conjunction with Metchnikoff, carried out fundamental experiments on syphilis and showed that this mysterious disease can be communicated to anthropoid apes.

From 1906 Roux's energies were almost completely absorbed in the direction of his Institute. For many years he was a sickly man and suffered from some malady believed, probably incorrectly, to have been some chronic form of tuberculosis. He was thin and emaciated and appeared to suffer from exposure to cold, for he was rarely seen, even in summer, without his long pelerine, with a woollen muffler round his neck. All the cold in the world could, however, not destroy the indomitable spirit of this great Frenchman, who was game to the end and from whose worn-out body radiated the enthusiasm of youth.

Roux was an abrupt man in his intercourse with strangers, but everyone who came for long into his atmosphere left it with a lifelong feeling of reverence and devotion. He was devoid of vanity and as a character sound to the core. Throughout his life he was an ardent student of science. His



salary as director of the Institut Pasteur was trifling, for he had little use for it. He was a bachelor and lived in two small rooms in the hospital of the Pasteur Institute where he was devotedly cared for and nursed by one of the sisters.

All his old friends and early contemporaries were dead and when his last old colleague, Calmette, died, on October 29, this broke Roux up, and he survived only another four days and passed away on November 3 in his eightieth year.

Roux was elected a foreign member of the Royal Society in 1913, and was awarded the Copley medal of the Society. He also held the much coveted 'Grand-croix de la legion d'honneur'. Roux was held in such esteem in France that he was awarded an imposing national funeral which, personally, it is certain he would not have desired. His remains are to be finally deposited in the garden of the Institut Pasteur which he had loved so much.

W. B.

#### PROF. W. MIELCK

PROF. W. MIELCK, director of the Biological Station at Heligoland, who died on October 5, was educated at Hamburg, Göttingen and Kiel, and carried out his first research work at Kiel under Prof. K. Brandt. In 1907 he was appointed to the staff of the Biological Station at Heligoland, with which institution his life-work was bound up. From 1910 he was associated with the late Prof. Heincke in fishery investigations, especially in relation to the plaice and the over-fishing problem, carrying on, however, at the same time the plankton researches which he had commenced at Kiel.

During the War, Mielck's duties kept him in Heligoland, where he not only continued such research work as was possible, but also organised a successful local fishery. This direct experience gave him much interest and insight into the effect of the War on the stocks of fish, a question which was energetically studied by the Heligoland staff in the ensuing years. He succeeded Prof. Heincke

as director in 1921 and threw his whole energy into the rebuilding and reorganisation of the Biological Station, which has become the most important institution in Germany for marine biological research.

When Germany rejoined the International Council for the Exploration of the Sea in 1926, Mielck was appointed one of the two delegates from that country, and played an important part in the organisation and direction of his country's share in the international investigations. In 1928 he succeeded Mr. Borley as chairman of the Southern North Sea Committee, and carried out the duties attached to this post in a manner which at once earned for him the respect and support of his foreign colleagues. It was characteristic of Mielck's thoroughness and strong sense of duty that he set himself to master the English language in order to preside more effectively over his Committee.

Mielck was a hard worker and found time to carry out intensive researches on herring larvae in addition to his onerous official duties as director of the Biological Station. His premature and sudden death at the age of fifty-four years has robbed Germany of a first-class worker, the International Council of a valued collaborator, and his co-workers of a staunch friend. His British colleagues on the International Council, of whom the present writer was one, regarded Mielck with admiration and affection, and deeply mourn his loss.

E. S. R.

WE regret to announce the following deaths:

Dr. G. S. Coleman, director of the Department of Municipal Engineering in the College of Technology (University of Manchester), on November 7.

Mr. R. B. Mellon, who, with his brother, Mr. Andrew Mellon, formerly American Ambassador in London, founded the Mellon Institute of Industrial Research, Pittsburgh, on December 2, aged seventy-five years.

### News and Views

#### Heavy Hydrogen and Heavy Water

IN connexion with the forthcoming discussion on December 14 at the Royal Society on "Heavy Hydrogen" and the letter by A. and L. Farkas in this issue of NATURE, p. 894, it is interesting to have the results of additional experiments with heavy water, containing the hydrogen isotope  $H^2$  (isohydrogen or deuterium) reported from the United States (Harkins and Doede; Barnes; H. S. Taylor, Caley and Eyring; Selwood and Frost; G. N. Lewis and Macdonald; Olson and Maroney: *J. Amer. Chem. Soc.*, Oct.-Nov.). An apparatus for the separation by electrolysis is described in which an alkaline solution is electrolysed between concentric nickel tubes. The solubilities of a few salts are found to be distinctly less in heavy water

than in ordinary distilled water, the difference in the case of barium chloride being 19 per cent. Various physical properties such as density, refractive index, viscosity, surface tension, dielectric constant and magnetic susceptibility have been measured with specimens of heavy water containing 31, 63.5 and 92 per cent of the hydrogen in the form of  $H^2$ . Previous results are confirmed in general, and some additional information obtained. The viscosity is larger, and the dielectric constant smaller, than for ordinary water. The molar magnetic susceptibilities are equal. An advance report through Science Service, Washington, states that heavy water is lethal to fish, tadpoles and worms, but paramecia resisted it for twenty-four hours.



### Protection of the Fauna and Flora of Africa

REFERENCE has already been made in NATURE to the recent international conference on this subject held in London (Nov. 18, p. 776). At a general meeting of the Society for the Preservation of the Fauna of the Empire on December 4, the president, the Right Hon. the Earl of Onslow, discussed in some detail the convention which has been agreed on as a result of the international conference. Lord Onslow said that in the first place the convention lays down as a principle that it is desirable to establish in all territories if possible national parks or strict natural reserves. A national park is a permanent institution such as the Kruger Park in South Africa, where fauna and flora may be strictly preserved for the benefit of the general public. A strict natural reserve is a similar area but it is devoted purely to scientific purposes, that is to say, it is primarily for the preservation of various species. With reference to the protection of special animals, in the annex to the convention there are two classes: animals the protection of which is of special urgency, and those which do not require such rigorous protection but need a modified form of protection under which they cannot be hunted without a special licence. On the question of trophies, the convention lays down a method of controlling by means of the Customs in each territory the export and import of trophies, trophies meaning heads, horns, tusks, eggs and so forth, in fact anything which is produced by an animal. Certain methods of hunting are prohibited, notably by the use of motor-cars and aircraft. Similarly, poisons or explosives for killing fish are prohibited, and also dazzling lights or nets and pits.

THE convention does not come into force until it has been ratified by four powers, but owing to the proposal of the vice-president of the conference, the Belgian Ambassador, a protocol has been signed which does not need ratification and which binds the contracting parties who have signed it, namely, all the powers represented except, so far, Abyssinia, to call another conference in four years time. This will prevent the question lapsing into oblivion, but it is sincerely to be hoped that before another conference takes place, a substantial portion of the powers that signed the convention will be carrying it into force, so that the experience gained in working may suggest modifications for the conference to discuss. Lord Onslow said that the dedication of national parks has been urged by the Society for the Preservation of the Fauna of the Empire for some time past, and he considered it a matter for congratulation that the British Government has not only adopted the idea but also has taken such strong action as to facilitate a conference being called whereby the present convention was evolved.

### River Flow Records

It is appropriate that the recent issue of the report of the Research Committee of the British Association on Inland Water Survey should be followed by the publication of a paper on practical river flow measurement such as that presented at the winter meeting

of the Institution of Water Engineers on December 1. Capt. W. N. McClean, the secretary of the Research Committee, has for several years past, at his personal charges, instituted and maintained a system of river gauging and measurement in the Ness Basin, Inverness-shire, the results of which have been noticed from time to time in these columns. On December 1 he gave a detailed account of the system in a comprehensive paper which reviewed the physical and meteorological conditions in the Ness Basin and dealt with the various features of the work carried on by the organisation known as River Flow Records which is directed by himself. The catchment area of the Basin is 692 square miles down to Dochfour Weir, which holds up the level of Loch Ness in order to provide navigable depth in the Caledonian Canal. Loch Ness is roughly 24 miles in length and has a depth exceeding 550 ft. over about one half its area of 22 square miles. A regular sway of 31 minutes duration, induced by wind, produces a variation in water level, sometimes amounting to six inches or more, which persists long after the wind has ceased, and is attributable in Capt. McClean's opinion to a pendulum effect maintained by the great depth. The greater part of the flow into the loch comes from the rivers Garry and Moriston, and the gauging of these streams formed the subject of the investigations described in the paper. Details of the apparatus employed and the methods adopted are given in supplementary notes by Mr. H. Chapman, the author's chief assistant.

In the ensuing discussion, Mr. G. J. Griffiths emphasised the importance of river gauging operations, instancing the precautions thereby enabled to be taken in the Thames basin during the recent period of drought, as a result of which there was no shortage of water supply. He put forward a plea for co-operation between catchment boards and water authorities so that the information obtained might be pooled in the interests of the community. As regards the Thames Valley, the subject is discussed in more detail elsewhere in this issue of NATURE (p. 869). Prof. S. M. Dixon described apparatus used on the River Severn, which he considered simpler and for that reason preferable to the apparatus illustrated in the paper. The Severn apparatus has been used for velocities up to 5 ft. per sec. in depths up to 12 ft. The estimated accuracy of the gaugings is to within 3 per cent of error. Other speakers dealt with various aspects of the subject and Mr. O. Borer cited instances of low flows of the Great Ouse—0.09 cusecs. per thousand acres. Capt. McClean, in his reply to the discussion, said that simpler apparatus had been tried on the Ness Basin Rivers without satisfactory results, and he did not think an estimated ratio of error could be confidently accepted when the recorded values of the meters had themselves to be corrected for positioning.

### High-Speed Diesel Engines for Marine Service

THE history of ship propulsion records many revolutions in types of machinery and their application, and in the plan proposed by Mr. H. R.



Ricardo in his Thomas Lowe Gray lecture to the Institution of Mechanical Engineers delivered on December 1, marine engineers will see yet another great change. Though he could not make out a case for a Diesel engine of any sort in really large or very fast vessels, Mr. Ricardo urged that for ships up to 6,000 horse-power, the power plants might well consist of a very large number of light high-speed Diesel engines, driving electric generators supplying the current necessary for the propulsion motors and for auxiliary purposes. One of the outstanding features in engineering practice of recent times is the marked success of the high-speed Diesel engine for road transport. During the last two years, some 20,000 engines aggregating more than 2,000,000 horse-power have been put into service on the roads of Europe. These engines range up to 150 horse-power, and 70-80 such engines could easily be installed in groups and tiers for a vessel of 6,000 horse-power. The fuel supply, the circulating water and lubricating oil could be supplied from a central station and engines could be started and stopped from a central control. Mr. Ricardo sees no difficulty in the maintenance of such a plant, for the units could be easily disconnected and hoisted out and the engines overhauled regularly at a shore depot. To overcome the noise difficulty, each unit would be enclosed in a double-walled wooden sound-proof box. "Thus enclosed, the generating sets will sound like bees on a summer's afternoon, and the solitary engine room clerk will be able to smoke his pipe of peace." Fanciful as the scheme appears to be, it is by no means an impossible one and it would be of interest to see it put to the test.

#### Slaughter-House Reform

PROF. J. H. JONES delivered the twelfth annual Benjamin Ward Richardson Memorial lecture on November 30 before the Model Abattoir Society, his subject being slaughter-house reform. He said that slaughtering is at present conducted in small private slaughter-houses or in municipal slaughter-houses. The former are often inefficient inasmuch as the scale of organisation prevents the proper utilisation of by-products and in other ways adds to expenses. There are also serious disadvantages connected with municipal slaughter-houses, as not only are they on too small a scale, but also they are merely a collection of stalls for private butchers. In view of the wastefulness of the present system, the Committee of the Economic Advisory Council on the Slaughtering of Livestock, of which Prof. Jones is a member, has recommended a scheme based on regional monopoly. It has recommended the appointment of a National Slaughter-Houses Board, that is, a statutory non-profit-making body to prepare regional schemes to be operated by regional authorities, which might be either joint boards of local authorities or existing associations prepared to provide their own finances. The regional authority would provide the service of the slaughter of animals and the transport of meat to the centres of retail distribution. It would not itself purchase animals and sell meat; on the other hand, it would

purchase and itself work up the by-products. It might appear at first sight to create a new departure by establishing a monopoly of slaughtering within each of the selected regions, but monopoly is already a privilege of the municipal slaughter-houses of Scotland and in a few of them a serious attempt is being made to utilise by-products. The recommendations appear to be in line with modern British development and to provide a scheme which would be both efficient on the technical side and likely to improve the inspection of meat and humane slaughter. The scheme would not apply to the trade in Kosher-killed meat.

#### International Committee on Intellectual Co-operation

THE report of the International Committee on Intellectual Co-operation on the work of its fifteenth plenary session, which contains extracts from the general report of the director of the International Institute of Intellectual Co-operation, indicates the work done in this field, alike in the service of the various States, of the League of Nations, and of intellectual activities for their own sake, the service of ideas, of the mind. During the year, the Institute has continued to concentrate on the collaboration of qualified experts or competent international committees. Thus, arising out of Prof. Shotwell's proposal, a preliminary inquiry has been commenced on collective security and on the collection of data regarding the progress in various countries towards the encouragement of the study of legal, social and political sciences, which should issue in a scientific contribution to the work of the League. The material required for the publication of a repertory of scientific laboratories has been collected. The committee of experts dealing with the co-ordination of scientific terminology has examined in detail various terms responsible for misunderstanding or controversy between chemists and physicists, and established definitions which will be communicated to the International Unions of Physics and Chemistry and to the International Council of Scientific Unions for final approval. Technical recommendations relating to neologisms have also been formulated and various steps taken towards collaboration between science museums, including the publication of a periodical information bulletin, *Scientific Museums*, while the inquiry on documentation has been vigorously pursued.

#### Effect of Economy Cuts in the United States

A RECENT article in *Industrial and Engineering Chemistry* (News Edition, Nov. 10, p. 315) reviews the results of the recent economy cuts in chemical research at Washington. On the whole, the results of the Economy Act have been less devastating than at first threatened. Most bureaux were able to continue on a reduced scale; the danger of dilution of personnel with political nominees has been entirely avoided in the scientific branches; the chief effect has been the dropping of less essential projects, and a retardation of progress, with drastic reductions in only one or two departments. Chemical research is centred mainly in the Department of Agriculture and in the



Bureau of Standards, Department of Commerce. The latter was the hardest hit of all scientific organisations affected, the Congress appropriation for 1933-34 of 2,056,000 dollars having been reduced to 1,336,000 dollars, less than one half of the 1931-32 expenditure. Part of the reduction was automatically covered by the President's 15 per cent reduction of all salaries of Government employees, but the personnel displaced amounted to 350, and one of the research projects on which they were engaged remains a total loss. Among the discontinued projects are the investigations on the manufacture of fructose, the sensitivity of photographic emulsions, soil erosion of pipes, and testing methods for paper.

THE research work of the Chemical Division was practically paralysed, and really important researches on rubber, including a basic study of its electrical properties which was nearing completion, as well as on lubricants, were brought to a standstill. Fundamental work at the Bureau of Mines has been seriously reduced, while the organic research carried out at Pittsburg has been completely eliminated by the closure of the laboratory. Much research on explosives, fuels and physical chemistry has also been discontinued at Pittsburg, and the petroleum and other field stations have similarly been affected. In the Department of Agriculture, reductions have been much less serious. The only major activity discontinued under the Bureau of Chemistry and Soils is the operation of a blast furnace for the recovery of potash and phosphorus. The study of a poison weed in Texas under the Bureau of Animal Industry has been seriously curtailed, but elsewhere chemical work under Government agencies has involved, it is stated, no essential curtailment of activities.

#### Exploration of Kharga Oasis, 1932-33

A SUMMARY report of the expedition of the Royal Anthropological Institute to Kharga in 1932-33 appears in *Man* of November. This report covers the third and final season's work of the expedition as originally planned. Miss Caton-Thompson did not accompany the expedition on this occasion and Miss Gardner's attention was devoted mainly to the further geological exploration of the oasis and also to clearing up certain points from previous years' work. More than two hundred miles were carefully surveyed and in addition comparative studies were made in the Nile Valley from three bases. One of the most important of the results in relation to the main object of the expedition was the dating of the top tufa terrace at Refuf both by advanced Acheulean hand-axes in a scree deposit beneath the tufa and by core and flake tools without hand-axes interbedded in the tufa itself. This is the first time that implements have been found in such a situation. A number of shells new to Kharga were collected. An unmapped pass was discovered in lat. 25°5'. In a note commenting on the work of the expedition and the results, Miss Caton-Thompson directs attention once more to the difficulties attendant on archaeological work in Egypt owing to the unsatisfactory

state of the antiquities laws. In this instance, the difficulty arises from the fact that the Egyptian Department of Antiquities has enforced on an expedition for geological and prehistoric research conditions which were framed to meet the requirements of dynastic and predynastic excavation. The Kharga expedition has provided unprecedented material for the typological study of early palaeolithic industries, but as Miss Caton-Thompson points out, their scientific value is entirely destroyed if picked specimens from a series forming a related whole are selected for retention in Egypt. She urges the immediate introduction of fresh regulations permitting the temporary export for purposes of study of such series, unmutated by capricious selection.

#### Southern Railway Electrification

SIR HERBERT WALKER, general manager of the Southern Railway Co., has contributed a paper on the economic results achieved by the Southern Railway electrification to *World Power* of November, which proves that this scheme was a sound railway development. He points out that at the time of the amalgamation of the L. and S.W.R. and the L.B. and S.C.R. in 1923, the success of the electrification of their suburban lines had been already proved. The electrification of the Brighton-Worthing line in 1932 confirms the success of the earlier electrification schemes. Immediately the section of line to Brighton and Worthing was electrified, the number of passengers carried began to grow. At the end of six months the number carried was 22 per cent larger than the corresponding period of the preceding year. This is due partly to the introduction of a service of trains of much greater frequency than formerly, and partly to the shortening of schedule times owing to the increased powers of acceleration and to the higher speed up steep gradients. Notwithstanding the lower fares brought into operation between many of the stations, the increase in receipts for the first six months was nearly 18 per cent. The development of the passenger traffic is shown by the fact that the number of people who travelled to Brighton during the Easter holiday period of last year was nearly 150,000, and exceeded the population of Brighton itself. The percentage increase in the issue of season tickets on the Brighton and Worthing extension has increased from month to month. The increased annual cost to the railway of the interest on all the capital charges due to the electrification has been covered in the first six months of working.

#### History of the Public Lighting of Paris

IN the *Revue Scientifique* of October 28, M. R. Boutville gives an interesting account of the public lighting of Paris from the earliest times until the end of the nineteenth century. He points out that the first public lamp was the famous candle lantern placed in front of the Grand Chatelet in 1318. An ordinance of Louis XIV in 1667 increased the number of lamps in the streets and insisted that they should be lit 'even in moonlight' from November 1 until March 1. A medal was struck in 1669 to commemorate



the securing of the safety of the city at night. The next step in advance was the invention in 1774 by the Abbé Matherot de Perigny of an oil lamp with a silvered reflector. The way in which this reflector distributed the light led some to think that nothing better could be invented in the future. During the Revolution, some of these lamps were suspended by pylons and some by span wires fastened across the street at a height of about 16 ft. The lamps obstructed the traffic when they had to be trimmed and their containers replenished. By the use of Argand burners in 1821, the lighting was improved. The first gas lamps were placed in the Place du Carrousel in 1829. The number of flat-flame gas lamps, each burner giving a modest light of about 10 candle power, increased from 14,000 to 21,000 between 1839 and 1870. Jablochhoff electric candles were used in 1878 to light the Avenue de l'Opéra, and people still living can remember the spluttering carbons and the fluctuating light they gave. At the Paris Exhibition of 1900, it was still doubtful whether lighting by incandescent gas mantles or open arc lamps was the better. At that date there were 50,900 street lamps in Paris. It would be unsafe to prophesy how it will be illuminated twenty years hence.

#### Decreasing Barn-Owls

ONE of the outcomes of the census of barn-owls (*Tyto alba alba*) in England and Wales (Blaker, *Bird Notes and News*, 15, 7) is substantiating the fears that this useful bird is on the decline in Britain. Northumberland, Cumberland and Durham were the only counties to report an increase. The areas of maximum population (41-50 pairs per 100 sq. miles) appear to be Anglesey, Devon, Durham and parts of Essex, Suffolk and Hertford, and that of minimum population (0-5 pairs per 100 sq. miles), a mountainous area of north-east Lancashire and north-west Riding. About 4,000 naturalists took part in this census, organised by the Royal Society for the Protection of Birds, and found about 12,000 breeding pairs for England and Wales in the summer of 1932, non-breeding birds averaging one per 50 sq. miles. Some 45,000 eggs were laid in 1932, of which 35,000 hatched and 33,000 owlets left the nest, when the country would contain 55,000 barn-owls, which, by the following spring, would be reduced to 24,000. The species seems to have declined 50 per cent in the past ten years, and is declining at about 1,000 a year, or four per cent. Of 214 nests examined, 807 eggs were laid, 174 of which failed to hatch, and of the 633 owlets, 594 left the nest. There is a marked spreading over the countryside at the end of the nesting season, which accounts for the presence of the birds in areas otherwise rarely inhabited. Mr. Blaker considers that the decline of the species could be averted if four per cent of the death-rate was stopped. The Royal Society for the Protection of Birds is to issue the complete census results in pamphlet form. The barn-owl, which was once the commonest owl in Britain, is nowhere now so numerous as the tawny-owl, nor in many places as the alien little owl. The

food of the barn-owl consists of 69 per cent voles and mice (Collinge).

#### Ceylon Fisheries

THE administrative report of the Marine Biologist of Ceylon (Dr. Joseph Pearson) for 1932 shows that the work of the Department has been greatly restricted for lack of funds. No oysters were seen on the pearl banks during the January-March survey. All the potential paar areas are surveyed at least once in three years. The isolated patches of young oysters found in the Gulf of Manaar show little promise for fisheries in the near future. The window-pane oyster fishery in Lake Tamblegam should do well if no fishery is held this year and provided that no abnormally heavy rains occur during the intervening north-west monsoon. There are also oysters in the lake which should be fishable in 1936 and 1937, and as there are many brood oysters the chances of new spatfalls are hopeful. The chank fishery was carried on in the Palk Strait but the average of chanks exported was much less in 1931-32 than in 1930. With regard to the development of the fishery industry, there is still the question of modern boats and gear. It is now proposed to enlist the services of a master fisherman skilled in small boat fishing with modern apparatus, for the purpose of making initial investigations, and to train a local crew in the proper use of the boat and gear, instead of appointing a new marine superintendent who would not be so skilled in this type of work. It is also proposed to purchase a small boat, suitable for the use of the fishermen, to serve as a model for adoption. The purchase of this boat would, however, not be possible until the investigations have been carried far enough to indicate the type most suitable.

#### Vibrations due to Traffic in Oxford

THE Milne-Shaw seismograph has lately been employed for the purpose of estimating the amount of vibration caused by the passage of heavy traffic along the main streets of Oxford, and the consequent damage likely to result to the buildings of the city. A comparison of the readings of seismographs in position at the University Observatory and in the High Street respectively, taken at the same time and for the same duration, showed in the former case an almost imperceptible amount of vibration, but in the latter a record of disturbance which clearly indicated a serious menace to the stability of buildings along the route, especially of the older structures belonging to the University and Colleges.

#### Tables of Alcoholic Strength

THERE has been recently issued by H.M. Stationery Office new tables correlating percentages of proof spirit and percentages of alcohol by weight with specific gravity at 80° F., compiled by Mr. Francis G. H. Tate, of the Government Laboratory (2s. 6d. net), whose well-known book on the British system of alcoholometry entitled "Alcoholometry: an Account of the British Method of Alcoholic Strength Determination" was noticed in our columns in March 1931.



It is understood that these tables are to be legalised for use in Great Britain. They should prove very helpful both in England during the summer months and throughout the year in those countries where the minimum temperature approximates more closely to 80° F. Proof spirit was legally defined so long ago as 1816, though it was not until 1847 that Joseph Drinkwater determined the relative proportions of alcohol and water in it. The Fahrenheit temperature then selected was 51°, which is proving often to be inconvenient in practice. At the temperature of 80° F. now chosen, proof spirit has a specific gravity of 0.913162; it contains 49.28 per cent of alcohol by weight, or 57.25 per cent by volume. Absolute alcohol at this temperature is equivalent to 175.35 per cent of proof spirit.

#### Harnack House, Berlin-Dahlem

THE colony which has grown up at Dahlem in the suburbs of Berlin, consisting of the various departments of the Kaiser Wilhelm Gesellschaft, from which researches in all branches of science have added significantly to knowledge, is now a large one. The growth of the purely scientific laboratories has naturally brought with it other needs, for example, suitable lecture and meeting-rooms, a club-house and even residential facilities. These have been provided in the form of Harnack House, named after the first president of the Kaiser Wilhelm Gesellschaft, which is now responsible for no less than thirty research institutes it has called into being. Harnack House is essentially a co-operative concern; the German State provided the money for the building, the Prussian State presented the land, and individuals, industrial associations and public bodies all gave liberal assistance. It consists of large and small public rooms named after celebrities in the sentimental German manner, a canteen and a number of bedrooms. These are in the first place available for foreign men of science who are working at the Institute, and also for other foreign scientific workers of repute who are visiting it or are specially recommended. The terms are moderate and as the journey by the 'underground' takes less than half an hour, residence there for a single night or for a longer period may prove attractive to scientific workers visiting Berlin, particularly as Harnack House is a centre of research activity.

#### Yellow Sodium Light for Detecting Colourless Details

DR. M. LUCKIESH and Dr. F. K. Moss, of the Lighting Research Laboratory of the General Electric Company of America, reported at a meeting of the Optical Society of America on October 17 an interesting property of the new sodium vapour lamp which will shortly be upon the market. According to Science Service, they stated that for revealing the details of small colourless objects the yellow single colour light from sodium vapour is definitely and markedly better than the light emitted by ordinary incandescent tungsten filament lamps. In addition to revealing the details of small objects better, the speed of retinal impression is also higher. On the average,

the proportion of the light reflected by a large number of coloured specimens is much the same for both illuminants, although there is wide variation for individual colours. Sodium light enhances brightness contrast between various pairs of colours in more cases than tungsten light does, but some of the exceptions are important. To eyes accustomed to white light, the yellow sodium light sometimes produces curious phenomena. Experiments were made to find out if there was a difference in the nervous muscular strain produced by reading under white light and under sodium light respectively, but no difference could be detected in the human eye after subjection to the two illuminants.

#### Developments in Industrial Research

MUCH good work is being done in industrial research by the Mellon Institute of Pittsburgh. In the *Shoe Factory* and in the *Starchroom Laundry Journal* of October 1933 interesting tests are described on shoe leather and on 'Calgon', a special form of sodium metaphosphate for use in laundering. In introducing a new special leather, it was found necessary to supplement actual wearing trials by laboratory tests. The 'Vici' leather, produced by a new method of tanning, was exposed in an oxygen bomb and in a fadeometer, and it was tested for use as a water bag. But these methods were not sufficient. It was necessary to test the resistance of the leather to 'scuffing', that is, to surface disfigurement by a sharp, cutting blow. Shoes made from various leathers were enclosed in a wooden drum with buttons on the inside. The air in the drum was kept at a temperature of 100° F. and it was rotated at 18 revolutions per minute. Five sample shoes are placed in the drum with a moist abrasive and the test is completed when the counter shows that 700 revolutions have been made. The samples are then carefully wiped and dried and are graded on the basis of the number, area and depth of the scuffs. This test gave satisfactory results. The story told in the *Laundry Journal* of the technical development of sodium metaphosphate from being merely a laboratory curiosity to being a valuable commercial product is most interesting. Calgon dissolves soaps in the washer, shortens the time required, is not harmful to the materials or injurious to colours. It has excellent emulsifying properties, as shown by its successful use in the laundering of greasy overalls.

#### Re-Afforestation in Mexico

ACCORDING to a Mail Report from Science Service (Washington, D.C.), Mexico is undertaking a re-afforestation programme. It is stated that the Mexican Ministry of Agriculture is now putting into force a programme of reafforestation of areas that have been denuded since the Spanish Conquest, which turned many parts of Mexico into semi-arid regions. "Local detachments of soldiers all over the country have been ordered to co-operate with government agricultural agents in their reforestation work. During the last five years new trees have been planted on many of the naked slopes of the



Valley of Mexico, which was a richly wooded zone when the white men came. Charcoal, the great fuel of modern Mexico, has been made at the expense of the forests, and the first wood-burning railroads and timber-cutters of mines destroyed forests in many regions. Modern regulations require miners to get permission to cut timber, and to plant new trees for every old one cut."

#### Soldering and Brazing

THE issue of the *Journal of Scientific Instruments* for November contains an illustrated article on soldering and brazing by A. S. Newman and Dr. R. S. Clay, which will be found most useful by workers in scientific laboratories. It describes the conditions under which soft and hard soldering can be carried out most successfully, the best fluxes to use, and the proper way to apply them and the solder. Special methods for tubes and for manganin wires are described, and handy forms of burners, clamps and cutting tools are shown.

#### Dairy Herd with a Long History

THE dairy herd of the Cornell University has been in existence for more than forty years, and a full history of it has been issued by the Cornell University Agricultural Experiment Station, Ithaca, N.Y. (Bull. 576). The pure-bred Holstein-Friesians of the herd, the descendants of one cow, "Glista", are noteworthy, and "Glista Ernestine" the most remarkable individual. Born in 1908, she died at the age of sixteen years, having produced thirteen calves, all of which except one reached maturity. She was amiable and affectionate and always healthy, and her average yearly production of milk reached the remarkable total of 14,878 pounds.

#### Announcements

It is announced in *Science* of November 17 that Mr. Knowles A. Ryerson has been appointed chief of the U.S. Bureau of Plant Industry as from January 1, in succession to Dr. W. A. Taylor who retires after forty-two years' service with the Department of Agriculture.

THE Council of the Iron and Steel Institute is prepared to make annually a number of grants from the Andrew Carnegie research fund in aid of metallurgical research work. The object of the scheme is to enable students who have passed through a college curriculum or have been trained in industrial establishments, to conduct researches on problems of practical and scientific importance relating to the metallurgy of iron and steel and allied subjects. Candidates, who must be less than thirty-five years of age, must apply before the end of next February on a special form to be obtained from the Secretary of the Institute. The value of the grant will depend on the nature of the proposed research work, but the maximum amount granted in any one year will, as a rule, not exceed £100. Further information can be obtained from the Secretary, Iron and Steel Institute, 28, Victoria Street, London, S.W.1.

THE annual Congress of the Royal Institute of Public Health will be held at Norwich on May 15-20, 1934, under the presidency of Alderman H. N. Holmes. The Congress will be divided into five sections: State medicine and industrial hygiene; women and children and the public health; tuberculosis; veterinary medicine and agriculture; pathology and bacteriology. Further information can be obtained from the Secretary, Royal Institute of Public Health, 23 Queen Square, London, W.C.1.

THE fourth International Congress of Radiology will be held at Zurich on July 24-31, 1934, under the presidency of Prof. H. R. Schinz. At this meeting Prof. Gösta Forssell will report on the organisation of cancer campaigns in general. Other speakers will report upon the measures in their own countries. The programme includes the discussions on various medical aspects of radiology, radiation genetics, mitogenetic radiation, structure analysis, identical physical measurement of the dose in X-ray and radium treatment, hard gamma-rays, cosmic radiation, earth radiation. Further information can be obtained from Dr. H. E. Walther, secretary of the Congress, Zurich, Gloriastrasse, 14.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Two temporary civil engineering assistants for the Directorate of Works, War Office—The Under-Secretary of State (C.5), The War Office, London, S.W.1 (Dec. 11). An executive engineer in the Public Works Department, Electricity Branch, of the Government of the Punjab—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (Dec. 15). A junior investigator for the Royal Commission on Historical Monuments (England)—The Secretary, 29, Abingdon Street, London, S.W.1 (Dec. 16). An assistant vocational guidance officer for the Kent Education Committee—The Director of Education, Springfield, Maidstone (Dec. 16). An assistant education officer (general purposes) for the London County Council—The Education Officer (Establishment), County Hall, London, S.E.1 (Dec. 16). A junior assistant (woman) in the Science Museum Library—The Director, Science Museum, South Kensington, London, S.W.7 (Dec. 21). A Leon fellow for research (preferably economics or education) in the University of London—The Principal, University of London, South Kensington, S.W.7 (Jan. 1). A marketing expert to advise the Imperial Council of Agricultural Research in India—The High Commissioner for India, General Department, India House, Aldwych, London, W.C.2 (Jan. 1). A research assistant to the Burden Mental Research Trust for work at Stoke Park Colony, Bristol—The Secretary, B.M.A. House, Tavistock Square, London, W.C.1 (Jan. 9). A headmaster of the Secondary School, The Polytechnic, Regent Street, London, W.C.1—The Director of Education (Jan. 20). An assistant chemist in the Research Department of the South Eastern Agricultural College, Wye, Kent—The Secretary.



## 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.]

## Stopping of Fast Particles with Emission of Radiation and the Birth of Positive Electrons

WE have used Dirac's theory of the electron to calculate (1) the probability that a fast electron, passing through matter, emits a quantum of radiation with energy comparable with its own, and (2) the probability that a quantum of radiation, colliding with a nucleus, gives birth to a positive electron. We use Born's approximation for both processes. Provisional estimates for these two probabilities have been given by Heitler<sup>1</sup> and by Oppenheimer and Plesset<sup>2</sup>.

We find for the cross-section for the former process a complicated formula; if, however, the energy  $E_0$  of the particle is much greater than  $mc^2$ , the formula reduces to

$$\sigma_{\text{rad}} = \frac{Z^2}{137} \left( \frac{e^2}{mc^2} \right)^2 \left[ 4 \log \frac{2E_0}{mc^2} - \frac{4}{3} \right], \quad (1)$$

where  $Z$  is the nuclear charge. This differs in the logarithmic term from the cross-section mentioned above. The cross-section should therefore increase with the energy.

The accompanying table shows the range  $R_{\text{rad}}$  of an electron in water, calculated from (1), assuming that the loss of energy is all due to radiation. (The range in this case is the distance in which the intensity of the beam is reduced by 1/e.) This is compared with the range  $R_{\text{ion}}$  due to loss of energy by excitation and ionisation.

$E_0$	10	100	1000	10 <sup>6</sup> volts
$R_{\text{rad}}$	62	37	25	cm. in water.
$R_{\text{ion}}$	5	39	320	

For energies  $E_0 \sim mc^2$  the radiative stopping power is negligible. For  $E_0 \sim 100 \times 10^6$  v.,  $R_{\text{rad}}$  is of the same order of magnitude as  $R_{\text{ion}}$ . For higher energies,  $R_{\text{rad}}$  is much smaller than  $R_{\text{ion}}$ . According to the theory, therefore, no particles of any energy can have ranges greater than about 20 cm. of water. But if the cosmic ray particles consist partly of electrons, we know that particles exist with ranges up to 100 metres of water.

The theory seems to be here in disagreement with experiment. On the other hand, perhaps one should not expect the theory to give correct results for energies greater than  $137 mc^2$ , since the wave-length then becomes smaller than the classical electron radius  $e^2/mc^2$ , and Dirac's wave equation probably no longer applies.

One can also consider the case in which the electron makes a transition to a state of negative energy  $E$ . On Dirac's hole theory, this can only happen if a hole of energy  $E$  was previously present. Assuming that a hole is a positive electron, we have simply the recombination of a positive electron with energy  $E$  and a negative electron with energy  $E_0$  to form a light quantum of energy  $h\nu = E_0 + |E|$ . This is the inverse process to the production of a pair of

electrons by a light quantum in the presence of a nucleus. This process has been detected by Blackett and Occhialini and has been calculated by Oppenheimer and Plesset. We find the cross-section for such a process, for a quantum of energy  $h\nu \gg mc^2$ , to be

$$\sigma_{\text{pos. El.}} = \frac{Z^2}{137} \left( \frac{e^2}{mc^2} \right)^2 \left[ \frac{28}{9} \log \frac{2h\nu}{mc^2} - \frac{218}{27} \right] \quad (2)$$

This differs from Oppenheimer and Plesset's formula by the  $\log h\nu$  and the numerical factors.

The cross sections in water and lead calculated from (2) are as follow, the first two values being obtained by numerical integration from the exact formula:

$h\nu$	3	6	100	$mc^2$
H <sub>2</sub> O	0.32	3.3	32	$10^{-26}$ cm. <sup>2</sup>
Pb	0.33	3.4	33	$10^{-24}$ cm. <sup>2</sup>

The values for 3 and 6  $mc^2$  seem to be roughly in agreement with the experimental results for  $\gamma$ -rays of these energies.

The complete calculations will appear later.

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<sup>1</sup> *Z. Phys.*, **84**, 145.

<sup>2</sup> *Phys. Rev.*, **44**, 53.

## Inheritance of Egg-Colour in the 'Parasitic' Cuckoos

THE interesting suggestion recently made by Mr. Wynne-Edwards in these columns<sup>1</sup> with respect to the inheritance of egg-colour in the 'parasitic' cuckoos calls for a few remarks from the genetical point of view. Granting for the moment that the various types of egg-coloration in a polymorphic species such as *Cuculus canorus* are dependent upon a series of multiple allelomorphs, the location of such a series in the X-chromosome means that the nature of the egg laid by any hen must always depend upon the nature of the X-chromosome which she receives from her father. It is, therefore, rather misleading to state that the male cuckoo does not belong to the *gens* (in the Newtonian sense) at all. True, he may carry X-chromosomes characteristic of two distinct *gentes*, but since he must be supposed to determine the *gens* of all his daughters, it seems rather harsh to ostracise him as Mr. Wynne-Edwards would have us do.

There is, however, another possibility which would theoretically depose the male to the status for which Mr. Wynne-Edwards argues, namely, the location of a series of multiple allelomorphs for egg-colour and pattern in the Y-chromosome of the hen. On this hypothesis every daughter of a hen cuckoo would resemble her mother in the character of the eggs laid by her, no matter who her father was. On general grounds there are no reasons why the Y-chromosome should not carry genetical factors. Indeed, some years ago, P. G. Bailey and I<sup>2</sup> showed that the simplest explanation of hen-feathering in the cocks of certain breeds of poultry involved the existence of a factor for hen-feathering in the Y-chromosome of the hens of all breeds. Moreover, the work of Schmidt and of Winge<sup>3</sup> on *Lebistes*



*reticulatus*, where the male is the heterogametic sex, shows that a whole series of colour factors may be carried in the Y-chromosome.

On the other hand, I feel rather sceptical as to the existence of a series of multiple allelomorphs for egg-colour and pattern such as Mr. Wynne-Edwards postulates. Recent work on the domestic hen<sup>4</sup>, also highly polymorphic for egg-colour, has shown that the series depends upon several factors which exhibit neither sex-linkage nor linkage with one another. Of course, it is hazardous in the matter of sex-linked characters to argue from one species of birds to another; for a character which exhibits sex-linked inheritance in one species may exhibit normal inheritance in a second. Silky plumage in pigeons<sup>5</sup> and fowls<sup>6</sup> is a case in point.

Nevertheless, I feel that what is known of the genetics of egg-colour in other species must cause us to hesitate before we can accept the ingenious suggestion of Mr. Wynne-Edwards, with its necessary corollary of the existence of a series of multiple allelomorphs for egg-colour and pattern.

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Nov. 27.

<sup>1</sup> NATURE, 132, 822, Nov. 25, 1933.

<sup>2</sup> J. Genetics, 11, 52; 1921.

<sup>3</sup> J. Genetics, 18, 1; 1927.

<sup>4</sup> R. C. Punnett, "The Blue Egg", J. Genetics, 27, 465; 1933.

<sup>5</sup> D. G. Steele, J. Heredity, 16, 321; 1925.

<sup>6</sup> R. C. Punnett, "Heredity in Poultry", London, 1923, p. 99.

### Atomic Transmutation and Stellar Temperatures

GAMOW and Landau<sup>1</sup> suggest either that lithium of mass 7 can be present only occasionally on a star's surface, or that no regions with temperatures of more than several millions of degrees can exist in the interior of a star; their argument is that at higher temperatures lithium could not find its way by diffusion from "the internal regions of the star, where the production of different elements takes place" to the surface, before being disintegrated. Eddington<sup>2</sup> has replied by noticing that the presence of ascending currents may decrease the time required for the ascent of the lithium, so as to remove the difficulty in accepting the central temperatures of the order of  $2 \times 10^7$  found for his models, "whilst negating any suggestion of considerably higher temperatures".

Most will agree with Eddington that temperatures of only some few millions of degrees are too low for the liberation of sufficient energy; his central temperatures are about the lowest which will yield the correct rates of liberation. But it appears from our present knowledge of disintegrations that an Eddington star would be violently over-stable, unless there were some other important source of energy than transmutations. Stellar matter at his central temperatures would behave not merely like gunpowder, but like gunpowder at just so high a temperature as to be deteriorating steadily, with any decrease in temperature stopping its liberation of energy, and any increase causing it to explode! Eddington shows<sup>3</sup> that one of his stars will be over-stable if the rate  $\epsilon$  of liberation of energy increases more rapidly than about  $T^3$ , unless there is a delay of the order of months or years between an increase in  $T$  and the resulting change in  $\epsilon$ . The most important contribution to the total energy liberated by

transmutations comes from the disappearance of hydrogen because of its large packing fraction, and the rate at which the speed of disappearance of hydrogen increases with the energy of the collisions can be calculated by Gamow's theory<sup>4</sup> of the nucleus. Except for a constant factor, the calculated speeds appear to be in satisfactory agreement with the observed speeds<sup>5</sup>; the factor does not particularly concern us because we are interested in the exponent,  $s$  say, of  $T$  for that temperature at which  $\epsilon$  is of the right order of magnitude to agree with  $L/M$ . One can calculate  $s$ , considering the statistical distribution over all energies of collision at a temperature  $T$ , and it is found<sup>6</sup> that  $s$  lies between 9 and 30. There is no delay, and an Eddington star with  $\epsilon$  varying like  $T^{15}$  would be violently over-stable. These figures refer to the disintegration of lithium;  $s$  is increased, and matters are made considerably worse, if elements other than lithium are being disintegrated. The possibility that there may be another important source of sub-atomic energy, "annihilation", cannot be disproved, but there is not the least experimental evidence for the occurrence of any kind of annihilation that could supply useful energy to a star. The creation and disappearance of positive electrons would serve merely to increase the specific heat of the material, while at Eddington's temperatures even this increase would probably be trivial.

It is difficult to see how more than traces of elements like lithium could be formed at temperatures no higher than Eddington's, but if the temperatures are considerably higher than his, then the lithium can be made<sup>7</sup> as well as disintegrated, and by the aid of ascending currents some of it could perhaps appear on the surface. Since it would not be subjected to disintegration *alone* throughout the trip to the surface, for a time the abundance might even increase. If elements are being made as well as being disintegrated, the difficulty of over-stability is avoided, for there is no longer an  $\epsilon$  which increases rapidly with  $T$ , but merely an  $\epsilon$  which depends upon the rate of loss of energy by radiation into space.

There is still another way out of the difficulty raised by Gamow and Landau, and that is that lithium may have been present from the beginning in the star's atmosphere, while diffusion and currents may not yet have carried all of it into the far interior where transmutations occur. This is consistent with Eddington's calculations<sup>8</sup>, for the vertical current of 60 metres a year which he found was an upper limit which applied to the neighbourhood of the surface only; at a place where  $\epsilon$  and the mean value of  $\epsilon$  interior to this are nearly equal (as presumably they are in regions where transmutations occur frequently) the vertical velocity by Eddington's calculations is considerably less. In this case the internal temperatures could well be as high as Eddington's, or higher. The considerations of over-stability suggest the higher temperatures.

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Nov. 6.

<sup>1</sup> NATURE, 132, 567, Oct. 7, 1933.

<sup>2</sup> NATURE, 132, 639, Oct. 21, 1933.

<sup>3</sup> "Internal Constitution of the Stars", § 136.

<sup>4</sup> Z. Phys., 52, 510; 1928.

<sup>5</sup> Lawrence and others, Phys. Rev., 42, 150; 1932. Henderson, Phys. Rev., 43, 98; 1933.

<sup>6</sup> A paper of the author's on this and allied topics is published in the Mon. Not. R.A.S., 93, No. 9; Oct. 1933.

<sup>7</sup> A paper of the author's on the equilibrium of transmutations is in the Mon. Not. R.A.S., 93, No. 9; Oct. 1933.

<sup>8</sup> Mon. Not. R.A.S., 90, 54; 1929.



### Some Experiments on Heavy Hydrogen

THE micro method for the determination of concentrations of para-hydrogen recently described by one of us<sup>1</sup> has been used to determine the concentration of ordinary hydrogen and its heavy isotope in their mixtures.

Calibration experiments were carried out on samples of hydrogen prepared by decomposing water of known H : D ratio (where D, deuterium, is used to designate the heavy isotope H<sup>2</sup>) by a hot tungsten wire<sup>2</sup>. The water samples, ranging from 3 per cent to very nearly 100 per cent D<sub>2</sub>O content, were very kindly presented by Dr. P. Harteck (Cavendish Laboratory).

The determination of the concentration of the isotope in hydrogen by means of this thermal conductivity method can be performed with an accuracy of  $\pm 0.2$  per cent in a few minutes, requires only 0.002 c.c. of gas at N. T. P. and allows not merely the total ratio H : D to be determined, but actually the percentages of the three components, H<sub>2</sub>, HD, and D<sub>2</sub> in the sample may readily be found. By these means the following experiments have been carried out :

(1) The formation of the mixed molecule HD when mixtures of ordinary H<sub>2</sub> and D<sub>2</sub> (of at least 95 per cent purity) are in contact with a hot nickel wire has been studied. From this change to the equilibrium mixture of the three molecules, the equilibrium constant  $K$  of the reaction  $H_2 + D_2 \rightleftharpoons 2 HD$ , where

$$K = \frac{(H_2) \cdot (D_2)}{(HD)^2}$$

may be determined. At temperatures higher than room temperatures we find  $K$  to be about  $\frac{1}{3}$ , and independent of temperature, in agreement with the theoretical value given by Urey and Rittenberg<sup>3</sup>. This means that the reaction proceeds with a negligible heat of reaction. The accompanying table shows the calculated values for the equilibrium concentrations of HD formed in samples of hydrogen of known D<sub>2</sub> content, compared with the experimental results.

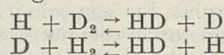
D <sub>2</sub> (per cent)	HD formed (per cent)	
	calc.	observed
11	19	22
35	42	44
40	45	44
54	47	49
60	45	46
82	27	22

These experiments should be carried to lower temperatures, when the determination of the equilibrium constant should allow conclusions to be drawn as to the spin and the statistics of the D-nucleus.

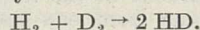
(2) The diffusion of hydrogen through palladium has been studied and we find that, at lower temperatures, the gas diffusing from a thin palladium tube has a higher H : D ratio (at 150° C. by some 50 per cent) than that of the original gas, but at higher temperatures the gas becomes 'heavier'. The residual gas is naturally concentrated. The gases recovered contain the equilibrium mixture of the three molecules. The simplest conclusion is that the energy of activation for the D-diffusion is somewhat greater than that for the H-diffusion, but the problem is complicated by the different solubilities of H and D. It may also be mentioned that some separation of the two isotopes is always obtained when they diffuse

through a small nozzle at low pressures, as for example when they are being pumped through a valve.

(3) The formation of the equilibrium mixture from H<sub>2</sub> and D<sub>2</sub> proceeds in the homogeneous gas phase above 600° C.; it takes place not only by the mechanism involving the atoms :



but perhaps also by the molecular exchange reaction :



The activation energy of this reaction must be higher than 60 kcal. The reaction involving the atoms has an activation energy of the same order as that of the thermal ortho-para-hydrogen conversion<sup>4</sup>. The formation of HD does not occur at -195° C. on charcoal. With water vapour at higher temperatures, a similar molecular exchange reaction is found to occur with a collision efficiency of the same order of magnitude as that between H<sub>2</sub> and D<sub>2</sub>.

We wish to thank the Central British Fund for German Jewry for a financial grant, and both Prof. E. K. Rideal and Dr. O. Wansbrough-Jones for the facilities provided and their assistance in the work.

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<sup>1</sup> A. Farkas, *Z. phys. Chem.*, B, **22**, 344; 1933.

<sup>2</sup> Cf. Urey, Murphy and Brickwedde, *J. Chem. Phys.*, **1**, 512; 1933.

<sup>3</sup> *J. Chem. Phys.*, **1**, 137; 1933.

<sup>4</sup> *Z. phys. Chem.*, B, **10**, 419; 1930.

### The Unimolecular Film in Heterogeneous Reactions

THE formation of unimolecular films on solid surfaces has been demonstrated by Langmuir<sup>1</sup> for gases and by Carver<sup>2</sup> for toluene, but others employing different materials have obtained results interpreted as indicating an adsorbed layer of multi-molecular character. At the moment the position is such that "definite agreement about the validity of direct experimental evidence is hardly reached"<sup>3</sup> and for this reason it may be of value to record the discovery of two unimolecular films made during our most recent work on the combination of hydrogen with sulphur in Pyrex glass. For the first time, so far as we are aware, this reaction has now been studied at low hydrogen pressures of the order of 3 mm. at the temperature employed, namely, 343° C. In the light of previous experience<sup>5</sup>, the most rigid precautions were taken to ensure the absence of oxygen or moisture from the reactants.

It has already been established<sup>4</sup>, in this laboratory, that sulphur vapour and hydrogen at pressures up to 760 mm. combine with a velocity which is proportional to the pressure of hydrogen and to the square root of the sulphur concentration, but independent of the area of glass surface. This rule is strictly followed down to pressures of hydrogen of the order of 40 mm. at 343° C., at which point there is still no evidence of anything except the pure homogeneous reaction. Below this pressure, however, the velocities become higher than would be expected from the gaseous reaction, and, furthermore, increase as the area of glass surface is extended.

An investigation of the reaction under these conditions, the experimental details of which would be out of place here, has shown that two reactions



are now occurring which, at pressures of hydrogen of the order of 3 mm., may be identified as (1) the ordinary homogeneous gas reaction with the characteristics already described, and (2) a reaction on the glass surface. This newly observed heterogeneous reaction is characterised by having an initial velocity (a) independent of sulphur concentration over a wide range, (b) proportional to the hydrogen pressure, and (c) proportional to the area of glass surface. Its real interest, however, lies in the fact that it ceases completely when it has produced an amount of hydrogen sulphide sufficient to cover the surface of glass with a unimolecular layer, and, furthermore, that its velocity, high at first, falls off rapidly with time, becoming zero when the surface concentration specified has been reached. From this it appears that a unimolecular layer of hydrogen sulphide effectively prevents the glass surface from promoting further combination of the two elements, either under these conditions or at pressures of hydrogen up to 760 mm. By comparison with that from the homogeneous reaction, the actual contribution of hydrogen sulphide from this surface reaction is exceedingly small and thus its presence is disclosed only at low pressures.

The experiments furnish results from which further deductions may be made:

1. Since the surface reaction is independent of the sulphur concentration and the gaseous reaction is related thereto, the two processes must proceed independently, otherwise the hydrogen sulphide formed in the gaseous phase, if adsorbed on the surface, would decrease the velocity of the surface reaction.

2. Independence of sulphur concentration also implies that the heterogeneous reaction is between sulphur already present on the surface and bombarding rather than adsorbed hydrogen molecules. When, however, reaction takes place on the surface of liquid sulphur, there is no inhibition by the product, hydrogen sulphide continuing to be produced so long as there is liquid sulphur available. The two processes are evidently manifestations of the same reaction, because they have the same temperature coefficient and the ratio between the effective collisions of the hydrogen molecules in the two cases is approximately unity. Since, however, the film of sulphur produces only a single layer of hydrogen sulphide molecules and these adhere to the surface, it appears extremely probable that the sulphur film is itself unimolecular. That such a sulphur film should cover the glass completely is readily understood from other evidence which shows that hydrogen is not adsorbed by glass and therefore would not seriously compete for the surface.

3. The molecules in the film are likely to be specifically oriented, and since those in an ordinary liquid surface behave similarly, support is lent to the view that such surfaces are formed of definitely disposed molecules.

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Nov. 3.

### X-Ray *K*- and *L*-Spectra of Aluminium

IN our recent letter<sup>1</sup> on the *L*-series of the lighter elements, we pointed out that the characteristic feature of the lines of silicon, aluminium and magnesium, showing very broad lines with a sharp limit at the side of the short wave-lengths, may be interpreted as due to the transition of electrons from the free electronic levels (the conduction electrons) to an empty *L*-level. Independently, analogous results and this explanation have been put forward by T. H. Osgood and by O'Bryan and Skinner<sup>2</sup>.

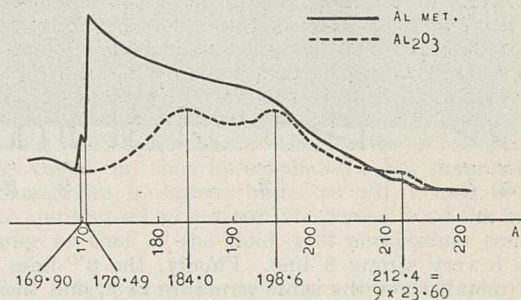


Fig. 1.

It was of interest in further verification of this interpretation to study the structure of the *L*-line with a non-conducting compound. As shown by the photometer curves (Fig. 1), the *L*-line of aluminium from the oxide,  $\text{Al}_2\text{O}_3$ , is not only displaced towards longer wave-lengths but has also quite a different structure without the sharp edge. (The small maximum at 212.4 A. is the oxygen *K*-line in the 9th order.)

The photometer curve of metallic aluminium also shows a fainter edge (169.90 A.) just in front of the main one (170.49 A.). From the difference in wave-lengths it is obvious that these correspond to the *LII*- and *LIII*-levels respectively.

MANNE SIEGBAHN.

TORSTEN MAGNUSSON.

Nov. 2.

<sup>1</sup> NATURE, 132, 750, Nov. 11, 1933.

<sup>2</sup> Phys. Rev., Oct. 1933.

IN connexion with the results given in the above letter by Siegbahn and Magnusson on the *L*-spectrum of aluminium, we have made a study of the *K*-series of the same element to see if analogous effects are to be found here, and also of course at the  $\beta$ -line. The two spectrograms reproduced in Fig. 2 of metallic aluminium and aluminium oxide,  $\text{Al}_2\text{O}_3$ , were obtained with a bent crystal of gypsum as grating, radius of curvature 0.5 metre. As seen from these spectrograms, the same characteristic differences appear in the *K*-series (at about 8 A.) as had been found in the *L*-series (at about 200 A.). The aluminium metal gives a  $\beta$ -line, corresponding to a transition from the free electron levels to the *K*-level, with a sharp edge at the side of the short wave-lengths, which is not formed by the oxide, where the corresponding line is more symmetrical.

The agreement is not only qualitative. The width of the *L*-line as shown in Fig. 1 is about  $13 \pm 2$  volts; in the *K*-series; from Fig. 2 it is about  $12 \pm 2$  volts. The displacement of the centre of the line for the

<sup>1</sup> J. Amer. Chem. Soc., 40, 1361; 1918.

<sup>2</sup> *Ibid.*, 45, 63; 1923.

<sup>3</sup> Hinshelwood, "Kinetics of Chemical Change in Gaseous Systems," Oxford, 1933, p. 306.

<sup>4</sup> NATURE, 131, 471, April 1, 1933.

<sup>5</sup> *Ibid.*, 132, 101, July 15, 1933.



oxide from the edge of the line for the metal is in both cases found to be about 7.5 volts.

As the two spectrograms reproduced in Fig. 2 were taken under identical instrumental conditions, they show the relative position and intensity of the lines of the  $K$ -series. All the lines of the  $\alpha$ -group are for  $\text{Al}_2\text{O}_3$  displaced towards shorter wave-lengths, as was first shown for the  $\alpha_{12}$ -line by Bäcklin<sup>1</sup>.  $\text{Al}_2\text{O}_3$

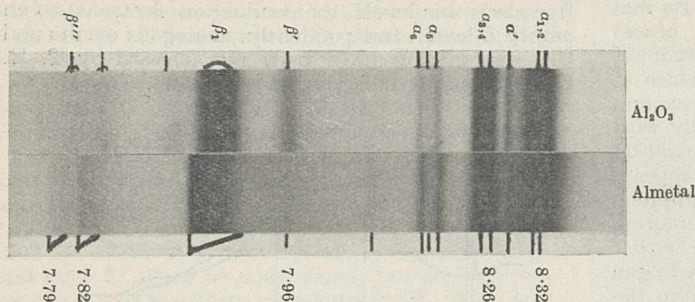


FIG. 2.

has a very strong  $\beta'$ -line. Finally, the  $\beta'''$ -lines of Al (metal) show the same structure as  $\beta$ , and therefore probably are transitions from the free electron levels. The corresponding lines with  $\text{Al}_2\text{O}_3$ , which do not show this feature, are displaced towards longer wave-lengths.

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Nov. 3.

<sup>1</sup> E. Bäcklin, *Z. Phys.*, **33**, 547; 1925. *Z. Phys.*, **38**, 215; 1926.

### Spectrum of Sulphuryl Chloride

KRONIG, Schaafsma and Peerlkamp<sup>1</sup> have recently described measurements on the absorption spectrum of chromium oxychloride, which exhibits a somewhat unusual system of diffuse narrow bands in the region of 6000 Å. The absorption spectrum of the closely related compound sulphuryl chloride has been studied using pressures of 1–100 mm. with an absorbing column of 50 mm. and over the range 5000–2000 Å., and indicates certain features not unlike those reported in the case of chromium oxychloride. Between 3170 and 2800 Å. a succession of about twenty narrow diffuse bands is observed (region A). These bands are not, except in the region of longer waves, equidistantly spaced, different intervals varying between 180 and 250  $\text{cm}^{-1}$ . In the intervals between the bands 1/2, 2/3, 3/4 (numbering from the long wave end), about four very faint absorption lines are visible, with equidistant spacing. There may be some definite pattern in the region as a whole, which more accurate analysis should reveal. From 2790 to 2730 Å. there is a series of about eight similar absorption strips (region B) with markedly different frequency interval (c. 100  $\text{cm}^{-1}$ ) from those in region A. From 2700 to 2620 Å. occurs another much less intense series of some fifteen or more diffuse strips, with frequency separations of the order 100  $\text{cm}^{-1}$  (region C). It is probable that the regions A, B and C are all related to the same electronic process. There are certain similarities in the system to that described in the spectrum of chromium oxychloride.

A system of bands degraded to the red and of much larger frequency intervals (c. 450  $\text{cm}^{-1}$ ) begins at 2300 Å. Thirteen of these bands have so far been observed. Numbering from the long wave end, the first few of these bands appear to show fine structure, but from the fourth onwards (c. 2200 Å.) they are diffuse. This is an interesting result in connexion with the mechanism of the photochemical decomposition of sulphuryl chloride into sulphur dioxide and chlorine, a process which takes place under the influence of light of wave-length less than about 230  $\text{m}\mu$ .<sup>2</sup>

It is hoped to make more accurate measurements using greater dispersion and with a wider range of temperature and pressure, from which it seems probable that information will be gained in regard to the potential energy curves of the various levels in the sulphuryl chloride molecule and the mechanism of its photochemical decomposition.

The spectrum of thionyl chloride is also being studied in relation to the above.

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Nov. 8.

<sup>1</sup> *Z. phys. Chem.*, **B**, **22**, 323; 1933.

<sup>2</sup> Andrich, Kangro and Leblanc, *Z. Elektrochem.*, **25**, 229; 1919. Tramm, *Z. phys. Chem.*, **105** A, 356; 1922.

### Ecology of Tropical Swamps

IN a recent issue of *NATURE*<sup>1</sup>, R. M. Bond has published determinations of the dissolved oxygen in the water of a swamp in Haiti, and has attributed the contrast between the high values obtained and the low concentrations which L. C. Beadle and I found in swamp waters in the Paraguayan Chaco<sup>2</sup> to the results of differences in the amount of calcium carbonate in the soil below the swamps.

To me, such an explanation seems unnecessary. It appeared to me<sup>2</sup> (p. 251) that the lack of dissolved oxygen in the Paraguayan swamp waters was the result of several conditions, acting in combination. Among these must be included the hot climate, as Beadle has later shown<sup>3</sup> (p. 148), and this is confirmed by experience in temperate climates, possibly with the reservation that temperate waters of similar types may become deoxygenated in very warm, calm weather. Of the other conditions which cause the lack of oxygen in the tropical waters, it seemed clear that two, protection of the water from disturbance by wind and the absence of active photosynthesis, are necessary. They may be also sufficient. In the Paraguayan Chaco the first of these conditions is brought about by the dense growth of aerial plants at and above the surface of the water, and the second by the low concentration of phytoplankton in the water and by its slight illumination. This last condition itself results from the shade of the aerial plants and from the dark colour of the water. In the occasional places where these conditions did not hold, oxygen was found even in the lowest layers of the water<sup>2</sup> (p. 228).

Bond states that the water of the Haitian swamp was shaded in many parts by tall rushes and sedges, but that there was no growth of floating plants at its surface. It is also noted that the water was clear. In such a swamp it is to be expected that disturbance



would occur in the open parts, and photosynthesis would be active wherever the shade was not too dense to allow it. There is therefore no reason to be surprised that the water of the open parts had a high oxygen content. Further, unless it can be shown that the shade was dense enough to prevent photosynthesis, there seems no more reason to be surprised that oxygen was present in the shaded water. Certainly, the clarity of the water, whatever its cause, would allow the light to penetrate to a greater depth, but we cannot estimate the importance of this condition unless we know the amount of light on the surface of the swamp.

Some observations which I have recently made in British Guiana confirm the belief that, in undisturbed and heavily shaded tropical swamps, the oxygen content of the water is often low. The swamps in which these observations were made were shaded by a very thick growth of plants and ferns above the surface. The light at the surface of the water, as measured by a Bernheim photoelectric cell, was about 3 per cent of direct sunlight. The water was yellow and therefore somewhat opaque, and the light was reduced to 1 per cent of sunlight at a depth of about 6 in. In these swamps, the oxygen content at a depth of 6 in. was very frequently less than 0.5 c.c. (0.72 mgm.) per litre, often less than 0.2 c.c. and sometimes below the limits of measurement. At a depth of 1 in. it was often found that there was not more than about 0.5 c.c. per litre.

These determinations were made by Alsterburg's modification of the Winkler process<sup>4</sup>, and are therefore not subject to errors due to the presence of organic matter in the water. They were confirmed, in some instances, by extraction in a van Slyke apparatus. It is true that, owing to the climatic conditions, these swamps are more frequently disturbed (most frequently by heavy rainstorms) than are those of the Paraguayan Chaco, and that after disturbance the oxygen content of the water may rise to 2 c.c. per litre. But this only emphasises the conclusion that, unless disturbed, such tropical waters become deoxygenated, for in the intervals between the times of disturbance the oxygen content of these waters is, as we have seen, low.

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<sup>1</sup> NATURE, 132, 277, Aug. 19, 1933.

<sup>2</sup> J. Linn. Soc., London, 37, 205-258; 1930.

<sup>3</sup> J. Linn. Soc., London, 38, 135-155; 1932.

<sup>4</sup> Biochem. Z., 170, 30; 1926.

### Oxygen Affinity of Muscle Hæmoglobin

THE fact that the hæmoglobin within red muscle is a substance different from the hæmoglobin in the circulation, has now been definitely established. The pigment has been isolated and prepared in a crystalline condition by Theorell<sup>1</sup>, and measurements by Svedberg showed a molecular weight of half that of the blood pigment.

It is therefore interesting to consider properties indicating the function of this pigment in red muscle. It can be shown by a simple experiment that muscle hæmoglobin has a higher affinity for oxygen than the hæmoglobin of blood. Muscle hæmoglobin shows its sharpest absorption band ( $\alpha$ ) at 5800 Å., that of ordinary blood being at about 5770 Å. A mixture of the two pigments in dilute solution is subjected to different tensions of oxygen

under physiological conditions of temperature and pH. At higher oxygen pressures the  $\alpha$  band occupies an intermediate position characteristic of the mixture; as the oxygen tension is lowered, the  $\alpha$  band approaches 5800 Å. There must therefore be a considerable difference in affinity for oxygen between the two pigments under physiological conditions.

By means of a rapid spectroscopic method of measuring dissociation curves, the oxygen affinity of muscle hæmoglobin has been compared with that of the hæmoglobin of blood in a borate buffer at pH 9.3 and 17° C. The method consists in introducing different amounts of a dilute ( $10^{-4}$  M.) hæmoglobin solution into an evacuated vessel. The fluid is previously saturated with air, and the total amount of oxygen introduced into the vessel can be calculated. The percentage of oxyhæmoglobin is estimated using the principle of Krogh's method, by comparison with optical mixtures of oxyhæmoglobin and hæmoglobin. The tension of oxygen in the vessel can then be calculated. For mammalian hæmoglobin in borate buffer at pH 9 and 18° C., the unoccupied volume of the vessel is of the same order as that of the fluid, and equilibrium can be

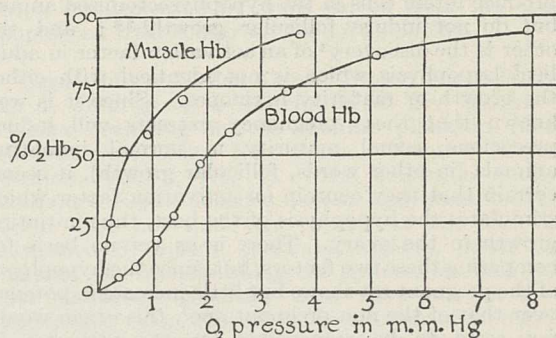


FIG. 1.

quickly established. Such a rapid method is essential when dealing with hæmoglobin under conditions in which it is likely to change to methæmoglobin, this being apparently the case with muscle hæmoglobin.

Fig. 1 shows two dissociation curves; one being that of the hæmoglobin of ox blood, the other that of the muscle hæmoglobin extracted from the perfused ox heart at pH 9.3 and 17° C.

That the distinctive properties of muscle hæmoglobin are due to its protein, globin, can be shown. If the globin is separated and combined with pure hæmin from blood, the  $\alpha$  band of the resulting oxyhæmoglobin, like the original muscle hæmoglobin, still appears in the position 5800 Å. The combination of muscle globin with mesoporphyrin has a very sharp absorption spectrum identical in quality with that produced from globin of blood; the sharp band in the red region is, however, 15 Å. displaced toward the red end of the spectrum. Thus the specificity of the globin is shown both in the case of the oxyhæmoglobin and after its reaction with porphyrin.

It seems clear that the presence of muscle hæmoglobin within the muscle cells will be of definite advantage in oxygen transport. The actual amount of hæmoglobin in the heart muscle is of the same order as the amount of hæmoglobin in the capillaries. The dissociation curve is decidedly less inflected than that of the blood pigment. (This is in accord with the measurement of the molecular weight given in Theorell's paper.) In the middle range of the



dissociation curve there is a large difference in the relative saturations at equilibrium, which will allow the muscle pigment to take up the oxygen from the blood. The respiration of the cells, containing in the case of red muscle a large amount of the oxidase-cytochrome system, can continue at very low pressures of oxygen. The muscle hæmoglobin, with its relatively high affinity for oxygen, can be the intermediate carrier of molecular oxygen from the blood to the oxidase-cytochrome system in the cells.

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Nov. 3.

A. H. T. Theorell, *Biochem. Z.*, 1, 252; 1932.

### Lack of Maturity Hormone in the Hypophysis of the Infantile Rat

RECENT work on endocrines has brought out two facts interesting in their implications. One is that pregnancy urine, blood serum and placental extracts produce lutein cells in the hypophysectomised animal but do not induce follicular growth<sup>1,2,3</sup>; and the other is the discovery<sup>4</sup> of an activation factor in adult beef hypophysis which is not identical with either the growth or maturity hormones. Since it is well known that these pregnancy extracts will induce precocious sexual maturity in normal immature animals (in other words, follicular growth), it seems certain that they contain an activation factor which stimulates the hypophysis of the host, thus initiating growth in the ovary. There is as yet no basis for comparing these two factors, but, since the hypophysis of the pregnant rat shows but little increase in potency over that of the non-pregnant one<sup>5</sup>, this organ would not seem to be responsible for the activator in pregnancy extracts, this probably coming from the placenta.

A similar condition is found when the hypophysis of the infantile rat is implanted into an older host. There is no evidence of the action of the maturity hormone in the ovary before about the eighteenth day<sup>6</sup>, yet when the hypophyses of such rats are implanted into older rats or mice<sup>7</sup>, they induce maturity hormone effects. Like the action of pregnancy extracts, this must be due to some factor which stimulates the hypophysis of the host and not to gonad-stimulating hormones in the implants, and can only be tested in the hypophysectomised animal. A series of such tests, reported elsewhere, do show that implants of hypophyses of male rats 1-13 days old had no reparative effects on the gonads of hypophysectomised male rats, though a satisfactory increase in body weight was obtained in each case, while implants of hypophyses of one day old rats into normal rats 21 days old gave effects equal to those from normal adults.

The hypophysis of the rat up to day 13 thus seems to contain only two hormones, so far as present data go, the growth hormone and a factor which is able to stimulate the hypophysis of an older rat to complete, though precocious, maturity hormone production. Further tests are needed to show which of the other hormones are present during this period. Between this time and day 21, the hypophysis of the rat comes to its fullest capacity of maturity hormone production, since implants of hypophyses of rats 21 days old into litter-mates give greater effects, per

unit weight of implants, than do adult hypophyses. This is also true when implanted into hypophysectomised males, and agrees with the recent work of Lipschütz<sup>8</sup>, who found that the potency of the hypophysis of the female rat of 24-30 days was much greater than that of adult hypophyses. This change in the hormone content of the hypophysis comes at the time when precocious sexual maturity may be induced for the first time. Since the gonads of the rat of this age, and for some days following, show very slight maturity hormone effects, such as follicular growth but little greater than may be found in the hypophysectomised rat, there must be an inhibiting factor which holds the hypophysis in check. There is some evidence<sup>6</sup> that this is, if not the growth hormone itself, at least closely associated with it.

OLIVE SWEZY.

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Berkeley.  
Oct. 20.

<sup>1</sup> Noguchi, *Jap. J. Med. Sci. Pharm.*, 5, 104; 1931.

<sup>2</sup> Collip, Selye and Thomson, *NATURE*, 131, 56, Jan. 14, 1933.

<sup>3</sup> Leonard and Smith, *Proc. Soc. Exp. Biol. Med.*, 30, 1248; 1933.

<sup>4</sup> Evans, Simpson and Austin, *J. Exp. Med.*, 57, 897; 1933.

<sup>5</sup> Evans and Simpson, *Amer. J. Physiol.*, 89, 579; 1929.

<sup>6</sup> Swezy, "Ovogenesis and the Hypophysis", Science Press; 1933.

<sup>7</sup> Smith and Engle, *Amer. J. Anat.*, 40, 277; 1927.

<sup>8</sup> Lipschütz, *Endokrin.*, 13, 90; 1933.

### De Moivre's "Miscellanea Analytica"

In the interesting historical note on De Moivre's "Miscellanea Analytica" in *NATURE* of November 4, p. 713, it is said that many copies have attached to them a *Supplementum* with separate pagination, ending in a table of 14-figure logarithms of factorial.

It may be added that in my copy of this book, after the 22 pages of the supplement, there is an *Addenda Praeli erratis* of two pages, and an interesting "List of the Subscribers" (four pages). Amongst the names of the subscribers are those of J. Bradley, de Maupertuis, J. Stirling, C. MacLaurin and other mathematicians and astronomers, and one Italian, the Marquis Visconti.

VITO VOLTERRA.

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Nov. 9.

### The Exponential Integral and Cosmical Radiation

My letter in *NATURE* of October 21<sup>1</sup>, communicating Mr. Booth's correction on this subject, has elicited the information that the exponential integral solution for the absorption of the rays was given in 1926 by Edward Condon<sup>2</sup>, to whom the priority is due. He pointed out that the effect of the atmosphere would work towards making the residual radiation more nearly a parallel beam, for which the simple exponential law applies, but not that the correction for the atmosphere can be applied in the same way for the correct formula as it has been for the incorrect.

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Nov. 24.

<sup>1</sup> *NATURE*, 132, 638, Oct. 21, 1933.

<sup>2</sup> *Proc. Nat. Acad. Sci.*, 12, 323; 1926.



## Research Items

**Racial Affinities in Ontong Java.** Ontong Java, which is situated to the north-east of the Solomon Islands, about 150 miles from Ysabel, has usually been regarded as one of the Polynesian outliers in Melanesia, among others being Tikopia, Sikiana and Rennel Island. The significance attached to these outliers is that they are thought to represent colonies dropped by the Polynesians in the course of migration from south-eastern Asia to their final destination in the Pacific. Dr. H. L. Shapiro, having this theory in view, has recently examined a series of measurements of the inhabitants of Ontong Java made by Dr. Ian Hogbin. The results of this examination are published in *Oceania*, 3, No. 4. The first comparison made was with the Polynesian series in the studies published by the Bernice P. Bishop Museum. This showed that on the physical side there is no support for the hypothesis of a Polynesian origin, nor did a comparison with the Fijians and the coastal New Hebrideans from Eromanga and Tanna, who represent Melanesian strains crossed with Polynesian, support the view that the original Polynesian strain of the Ontong Javanese had been blended with Melanesian characteristics. Comparison with other groups in turn led to the conclusion that the affinities of Ontong Java are with Micronesia. The Caroline Islanders in particular revealed considerable evidence of kinship. On the other hand, Dr. Hogbin's examination of social structure has revealed a number of Polynesian forms; but it has been pointed out that their language is not an archaic form of a Polynesian language, as might have been expected had they been an early colony. It seems rather to be modern Samoan or Maori. The indubitable evidence of physical characters suggests a revaluation of the cultural traits to which a Polynesian character has been attributed.

**Embryology of Monkey and Man.** Further observations on the early cleavage of the primate ovum appear in the latest number of the Carnegie Institution "Contributions to Embryology", 24, 187; 1933. Drs. W. H. Lewis and C. G. Hartman, employing the method first used by Prof. G. W. Corner in 1923, have succeeded in obtaining four living fertilised ova from the colony of monkeys (*Macacus rhesus*) belonging to the Department of Embryology of the Carnegie Institution of Washington. The youngest ovum was in a 2-celled stage; it was kept alive until it passed into the 8-celled stage. In a second case the ovum had reached the 4-celled stage, the third ovum was in the 8-celled stage while the fourth case, known to be about four days old, was in the 16-celled stage. From the data at their disposal, Drs. Lewis and Hartman infer that in monkeys and probably also in man, the ovum reaches the 2-celled stage in 36 hours after fertilisation, the 4-celled stage in 48 hours, the 8-celled in 72 hours and the 16-celled stage in 96 hours. They also succeeded in photographing the behaviour of the centrosphere during cleavage. At no stage were chromosomes visible. In the same number of this publication appears a paper by Prof. G. W. Bartelmez on the microscopic changes which occur in the mucous membrane of the human uterus during menstruation. Prof. Bartelmez finds that in the human uterus, as in that of the monkey, menstrual changes may not be preceded by the discharge of an ovum.

**The Grassholm Gannets.** The great increase which has taken place since 1914 in the numbers of gannets (*Sula bassana*) on the little island of Grassholm, off the south coast of Wales, gives special interest to the survey and census made by H. Morrey Salmon and R. M. Lockley (*British Birds*, Nov. 1933, p. 142). Possibly gannets were there in 1820, but the first recorded count, made in 1886, revealed 250 nests. From that date up to 1914, the numbers kept remarkably constant, at no time exceeding 300 pairs. The War intervened, and the next count recorded 800-1,000 nesting pairs, in 1922. That was a considerable increase (16 per cent per annum), but the next two years were remarkable, for the 1,000 pairs of 1922 had multiplied to 2,000 pairs in 1924—42 per cent increase a year. Since then the increase has been steady but slower, the census of 1933 revealing 4,750 breeding pairs, a rate of growth of 10 per cent a year. It has been suggested that the development is due to more than natural increase, and that the Grassholm colony may have been supplemented by waifs driven from the overpopulated Irish colony on the Little Skellig.

**Sagitta of the Madras Coast.** Under this title, Dr. C. C. John gives a description of five species of *Sagitta* occurring in the Madras plankton (*Bull. Madras Gov. Mus.* New Series. Natural History Section, Vol. 3, No. 4). The collection studied contained *Sagitta* labelled *Sagitta bipunctata*, but Dr. John does not find this species at all, and has identified *S. enflata*, *gardineri*, *neglecta*, *tenuis* and *robusta*. In distinguishing the species, he finds that the characters generally used have not all good systematic value, especially the number of prehensile spines, and anterior and posterior teeth, for these are found to increase with age and are not really constant. The best dependable characters are the general appearance of the body, form of anterior and posterior fins, interval between them, position of the seminal vesicles and the percentage distance between the seminal vesicles and the opening of the oviduct. This last, as he shows, is important because sperm transference, which is reciprocal in the Chaetognatha, is not possible between individuals of different lengths, but as the increase in length is accompanied by a corresponding increase in the distance between the genital openings, the percentage distance between the genital openings, calculated in relation to the total length of the animal, is always constant. The percentage distance between the genital openings has been determined in eight species and in a number of specimens. In none of the examples has the percentage been found to vary more than 0.9 and in each species the distance is different, from 8 per cent in *S. gardineri* to 20 per cent in *S. tenuis*, the corresponding lengths being 10-13 mm. and 5.5-5 mm.

**New Intermediate Host for *Fasciola hepatica*.** W. H. Krull (*J. Wash. Acad. Sci.*, 23, No. 8, 1933) states that *Pseudosuccinea columella*, which is widely distributed from Nova Scotia to Minnesota and from Quebec and Manitoba to Texas and Florida in ponds and streams, is a very suitable intermediate host for the liver fluke of the sheep. This and another new intermediate host, *Fossaria modicella*, recently reported by the same author, provide a favourable factor for a wide range of distribution of the fluke,



unless control measures are undertaken. *P. columella* may become especially important in some places because of its ability to tolerate acid water (pH 6.1-6.8). The American snails previously incriminated as intermediate hosts have been species which prefer alkaline water. *P. columella* has been raised in the laboratory and is prolific, producing a new generation about every two months. Effective destruction by the application of copper sulphate might necessitate repeated applications, whereas in other snails, for example, *Helisoma*, in which egg-laying occurs only once, such repeated applications might not be necessary. Infected examples of *P. columella* in laboratory cultures began to shed cercariæ 47 days after the entry of the miracidia. The largest number of cercariæ shed by a snail in a day was 161. One snail which had been shedding cercariæ for two days was dissected and the liver found to contain 241 rediæ and 356 mature cercariæ.

**Blue Egg Colour in Fowls.** A breed of fowls from Chile lays blue eggs, and Prof. R. C. Punnett (*J. Genetics*, 27, No. 3) has investigated the inheritance of this character from crosses with a Gold-Pencilled Hamburg cock. Two  $F_1$  pullets were produced, one of which laid blue and the other white eggs. Further breeding showed that the blue egg character is a simple dominant to non-blue in inheritance. The blue pigment when present permeates the whole shell, but its chemical nature is not yet settled. The Chilean hens were also crossed to a Welsummer cock—a breed in which the eggs are deep brown. The resulting pullets laid eggs which were either brown, tinted, green or olive, the last two types containing the blue factor. Further studies show the presence of a main factor and several minor factors for shades of brown, as well as an inhibitor for brown. Punnett shows that pheasants produce a similar series of egg colour types, the genetic relations of which probably follow similar lines. The blue egg colour in Chilean fowls probably arose there as a dominant mutation, as it is not known elsewhere. A semi-wild breed of fowls in Costa Rica has, however, recently been shown to lay green eggs, probably due to the presence of factors for both blue and brown (see also p. 892 of this issue of NATURE).

**A Gene affecting Linkage and Non-Disjunction in *Drosophila*.** A gene has been known for some time in *Drosophila melanogaster* which affects the meiotic processes of oogenesis. Dr. John W. Gowen (*J. Expt. Zool.*, vol. 65, No. 1) has made a genetical study of its action. It is called *cIII*G, is present in the third chromosome, and practically eliminates crossing-over in all the chromosomes. For example, where the standard rate of crossing-over is 56.3 per cent it is reduced to 0.1 per cent in females homozygous for the gene. It is completely recessive to its normal allelomorph, since flies heterozygous for it show the normal rate of crossing-over. The effect is, moreover, confined to oogenesis, but it is well known that crossing-over never takes place in the males of *Drosophila*. The presence of this gene also results in chromosome irregularities, producing eggs which are trisomic or monosomic in one or more chromosomes, or are diploid. This factor thus affects the mechanism for both linkage and non-disjunction in the female. Several genes affecting meiosis in plants are now known. A recessive gene prevents chromosome pairing in *Datura*, and several such factors producing pollen sterility are known in maize and other plants, as well as genes which affect the shape

of the meiotic chromosomes. It is thus clear that the mitotic and meiotic mechanisms of the cell are subject to control through mutations, just as are the phenotypic characters of the organism.

**A Jurassic Pycnogonid.** Interest in these curious sea-creatures, sometimes called Pantopoda, and dubiously placed between Crustacea and Arachnida, was recently revived by Sir Douglas Mawson's discovery of a twelve-legged form, described by Drs. W. T. Calman and Isabella Gordon. Among the forty or so genera of Pycnogonida previously known, three had five pairs of limbs, but all the others had only four pairs. From the Lower Devonian slates of the Rhineland, Broili lately described a couple of genera which he regarded as Pycnogonida, but their reception was somewhat doubtful. Now Oberstleutnant Robert Léon, when turning the ultra-violet rays on a surface of Solnhofen lithographic stone that showed no apparent fossil, has observed and photographed the luminescent image of what undoubtedly appears to be a Pycnogonid, though other interpretations are not altogether excluded. This, which he names *Palaeonymphon*, would help to bridge the gulf between the Devonian and Recent genera, and is of further interest as showing five pairs of delicate limbs as well as two pairs of what are thought to be well-developed palps. The description and figures are published in *Natur und Museum* of November 1933.

**A Fungal Parasite of Grasses.** Grasses are such common plants that one might suppose it would be very difficult for a fungal parasite to work much havoc upon them. This is true in general, but when improved strains of pasture or meadow grasses are being raised, they acquire an enhanced value, and any damage to them is worth combatting. The fungus *Epichloe typhina* causes considerable damage under these conditions, as has recently been shown by Miss K. Sampson (*Trans. Brit. Mycol. Soc.*, 18, pt. I, 30-47, Aug. 1933). The most obvious stage of this fungus is the fructification, which usually appears as a swelling all round the flowering stem. Some species of grass, such as *Festuca rubra*, however, rarely produce fructifications, whilst several other species harbour the fungus for years without making any fruit bodies. The fungus is an intercellular parasite, the small mycelium of which ramifies between the cells of almost all parts of the host. Vegetative propagation of grasses readily spreads the disease, and perennial parts of the host carry it from year to year. In experimental plots, control may be obtained by removing infected plants as soon as they produce fructifications, and plants imported from pastures and meadows require very close watching.

**Minor Barometric Oscillations and Rainfall.** In a paper entitled "A Note on the Rapid Fluctuations of Atmospheric Pressure and the Atmospheric Instability at Peshawar during 1928 and 1929" by S. Basu and S. K. Pramanik (*Sci. Notes India Meteor. Dept.*, 5, No. 53), an attempt is made to investigate the possibility of using the indications of the micro-barograph for forecasting rain. The grounds for supposing that the minor oscillations of atmospheric pressure may be an indication of the lapse-rate (the vertical gradient of temperature in the free atmosphere) can be found in an earlier paper by D. Brunt (*Quart. J. Roy. Meteor. Soc.*, 53, 30-32; 1927), in which the relation between the period of a simple vertical oscillation in the atmosphere and the lapse rate is



developed mathematically. It is sufficient here to note that, under isothermal conditions (lapse rate = 0), a particle displaced vertically will perform a rapid harmonic motion about its original position, and that as the lapse-rate increases towards the dry adiabatic rate, the period increases greatly, while with super-adiabatic conditions there is instability and therefore no restoring force. The practical investigation at Peshawar covers the two years 1928 and 1929, the indications of a Shaw-Dines microbarograph being examined in the light of the weather recorded at the time. It was found that 82 per cent of the occasions of measurable rainfall were associated with microbaric fluctuations, and that out of a total of 218 occasions on which there were fluctuations with a period greater than ten minutes, 140 were occasions of rain. The connexion would, of course, be of little use if it were one of simultaneous association only, but this was not the case, the average interval between the first commencement of the fluctuations and the subsequent rainfall being about six hours.

**Magnetic Test for Welds.** The extensive use that is now being made of welding for joining metal plates together has brought to the front the importance of methods of testing welded joints. A usual method is to mill out a portion of the joint under test and examine it, but this weakens the work examined. The X-ray method of investigation is better as the joint is not weakened and also the inner structure of the welded zone is shown. But it is necessary that the operator have considerable skill and experience. The method occupies much time and the expense precludes a continuous routine test. In *A.E.G. Progress*, No. 3, 1933, a magnetic test is described which seems to have many advantages. The welded seam is magnetised by two permanent magnets, magnetically linked by an iron core. If defective spots are present the field is distorted. The course of the magnetic field is explored by a probing device consisting of an amplifier and headphones. A search coil located in the head of the probing device is made to vibrate by means of a magnet energised from the supply voltage. When the device is glided slowly over the welded seam, any alteration in the loudness or tone of the sound produced shows that defects are present. The seam can be explored rapidly and after a little experience the kind of noise produced is sufficient to diagnose the nature of the fault. The great advantage of this continuous test is that it gives a positive assurance as to whether the welded seam is faultless or not. Tests like milling and X-ray exposures which are made at various places chosen at random cannot give such positive results. The outfit made by the A.E.G. for testing welds can also be used for testing iron and nickel for cracks, tempering faults and slag content.

**Strength of Concrete.** A paper issued by the Department of Scientific and Industrial Research (No. 14. H.M. Stationery Office. 2s. net) gives valuable data in connexion with the strength of concrete. It is only within the last few years that it has been realised that the expansion due to heat hydration of the cement followed by the contraction on cooling causes the detrimental cracks frequently observed in large concrete masses. In the United States, the specifications for the Hoover Dam enforced that only cements with a low evolution of heat be selected. In this report it is shown that the latest results of

laboratory tests are corroborated by full-scale tests on the evolution of heat in concrete during setting. These experiments are the most complete that have yet been made in any country. They show that in small masses of Portland cement concrete, it is desirable to conserve the heat evolved during the process of hydration in order to accelerate the strength development. In mass concrete work where high internal temperature may later result in contraction tending to the formation of cracks, the results confirm the desirability of only using Portland cements which have a slow rate of heat evolution. With high alumina cement, every effort must be made to dissipate the heat evolved as quickly as possible. The effects of cold weather on the material have also been investigated. If it be 'cured' within the yearly range of temperatures likely to occur in practice, there is no appreciable variation in its strength after 28 days. With high alumina cement, a very appreciable falling off in the strength was observed when it was matured at temperatures above 68° F. If suitable precautions are taken, its initial high strength can be maintained unimpaired. Special precautions have to be taken when it is used in marine work.

**Prevention of Coal Dust Explosions.** Explosions of coal dust underground are prevented by application of stone dust in the workings of collieries. It has been assumed that the nature of the incombustible dust was immaterial, and that all were equally effective under equal conditions of fineness. In the *Safety in Mines Research Board Technical Paper No. 79* (London: H.M. Stationery Office), by T. N. Mason and R. V. Wheeler, on the 'Inflammation of Coal Dust', it is shown that, as compared with the shale dust commonly used, limestone and gypsum are more effective in preventing the propagation of flame. It is important to have regard to the ease with which the dust can be dispersed as a cloud, especially after it has been exposed to the atmosphere of the mine. In this respect, gypsum is more liable to cake than either limestone or shale dust.

**Rotation Effect in Eclipsing Binaries.** The problem of determining the axial rotation of stars is somewhat simplified in the case of eclipsing binaries, since it is possible to approximate to an observation of a limb of the primary star when the other limb is obscured by the eclipsing companion. Radial velocities taken shortly before and after mid-eclipse should therefore deviate from the mean in opposite directions. A re-determination of the orbit of  $\alpha$  Coronæ has been made by D. B. McLaughlin (*Pub. Michigan Obs.*, 5, No. 7) with the object of detecting this effect. The radial velocity residuals show the effect very strongly, tending to positive values before mid-eclipse and negative values after. The semi-amplitude of the rotational effect is about 12 km./sec., from which an equatorial velocity of the order of 100 km./sec. is deduced. These results confirm the view that the diffuse character of the spectral lines is due to rapid rotation of the star. The orbit of  $\beta$  Lyrae has been similarly re-investigated by R. A. Rossiter (*ibid.*, No. 6). The rotation effect is strongly in evidence in this star also, and its elimination from the observational material has greatly aided the determination of the true orbit. The author finds that the observations are now satisfactorily represented by undisturbed elliptic motion after such elimination of the rotation effect, and that the results are conclusive in deciding that no third body exists.



## Anniversary Meeting of the Royal Society

THE report of the Council of the Royal Society, presented at the anniversary meeting on November 30, refers to a grant of £1,500 made from the accumulated and current income of the anonymous bequest fund to the Assam Medical Research Association, in support of a research by Col. J. Morison, of the Pasteur Institute, Shillong, on the preventive treatment of cholera by means of a special preparation of bacteriophage.

During the year the Society received a further sum of approximately £9,700 under the will of the late Dr. R. Messel; this has been added to the Messel Fund. A sum of £450 has been left to the Society under the will of Miss M. S. Greg; and a sum of £2,000, with part of the residue of the estate, under the will of the late Sir Dugald Clerk, F.R.S.

The Council reports that the policy of appointing Yarrow research professors has been eminently successful, but the financial position of the Yarrow Fund is such that the Council considers that no appointment of a successor to Prof. A. Fowler on his retirement should be made until the income of the Fund justifies the reconsideration of the appointment of a third Yarrow Professor; and that any surplus available should be added to the Yarrow Reserve Fund with the view of aiding any special research for which money is urgently required.

Sir Frederick Gowland Hopkins, in his presidential address, referred to the deaths during the past twelve months of two foreign members and fifteen fellows. He then indicated briefly the work and influence of the three Government research councils of Great Britain, the Medical Research Council, the Advisory Council of the Department of Scientific and Industrial Research and the recently formed Agricultural Research Council. Through the work of these bodies, men of science are now in control of the scientific policy of the country. A survey of progress in various branches of science followed, extracts from which appear elsewhere in this issue (p. 878), and Sir Frederick then proceeded to the presentation of medals. Extracts from his remarks on bestowing these honours are printed below.

## Presentation of Medals

## COPLEY MEDAL, awarded to PROF. T. SMITH

Prof. Theobald Smith was director of the Department of Animal Pathology of the Rockefeller Institute for Medical Research, Princeton, N.J., from 1914 until 1929. In 1886 with Prof. Salmon he showed a new method for producing immunity from contagious diseases by inoculating with a dead bacterial vaccine killed by heat, thus advocating a principle which was re-discovered fifteen years later and has been widely used, notably for making antityphoid vaccine. In 1889 he discovered the first known instance of a disease of vertebrates transmitted by an arthropod—Texas fever of cattle due to a protozoon transmitted by a tick. He introduced differential tests for bacteria based on their biochemical action. In 1896–98 he clearly, and for the first time, distinguished between the human and bovine types of *Bacillus tuberculosis* and the forms of disease which they produce, anticipating Koch's pronouncement in 1901.

In 1903, with Reagh, Prof. Smith described the non-motile variants of certain pathogenic motile

bacteria and their important serological differences. He discovered in 1904 the remarkable phenomenon known as anaphylactic shock in the guinea pig. In 1926 he discovered the very potent effect of the colostrum, the first milk of cows, in protecting calves from certain severe infections. He also made other notable original observations, such as those on the growth and toxin production of the diphtheria bacillus, and on the production of immunity by mixtures of toxin and antitoxin; he also described disease of the cow's udder communicable to man by the milk.

## ROYAL MEDAL, awarded to PROF. G. I. TAYLOR

Prof. Geoffrey Ingram Taylor is distinguished for theoretical and experimental researches covering an unusually large field. In meteorology Taylor's work on turbulence in the atmosphere has very greatly advanced our knowledge, and laid the foundation of all future work on the subject. He studied the effects of turbulence on the transfer of heat and water vapour through the atmosphere and on the variation of wind with height above the ground. He investigated the formation of fog, supplementing theoretical work by his observations on S.S. *Scotia*. He has also added to the knowledge of tides. In hydrodynamics he obtained the first (and only complete) solution of a case of hydrodynamic instability in a viscous liquid, namely, when the fluid is contained between two coaxial rotating cylinders; he has discovered many interesting phenomena associated with bodies moving through rotating liquids (in which surface effects are of minor importance); he has developed the theory of completely developed turbulence, in which statistical methods can be applied; and he has made very important advances in the theory of compressible fluids.

Taylor has rendered important services to metallurgy by his studies of the plastic deformation of metals, both in the form of single crystals and in the mass. In the Bakerian lecture of 1923, in collaboration with Miss C. F. Elam, he gave the first explanation of the mechanism of distortion of single crystals of aluminium, and determined the plane on which slip occurs. The plastic deformation of metals has now been studied by a number of investigators, but the foundations have been largely established on the basis of Taylor's work. Its essential feature has been the application of exact geometrical methods to the determination of the orientation of slip in metals, making use of X-ray and other measurements.

In a recent paper he has laid foundations for a rational theory of the strength of materials—hitherto a purely empirical science.

## ROYAL MEDAL, awarded to MR. P. P. LAIDLAW

During a period of twenty-five years Mr. Patrick Playfair Laidlaw has made an important series of contributions to knowledge over a wide field of medical science. Even in his first publication he showed originality when he demonstrated that the stability of iron in the haemoglobin molecule was dependent on the presence of oxygen, a fact of great significance in subsequent investigations on haemoglobin chemistry. Following this work, he published a number of papers on the action of various drugs, and especially the natural bases, from a pharmaco-



logical aspect. Thus with Dale he described the pharmacological action of histamine, demonstrating the physiological nature of histamine shock and the extension of the results to surgical shock. The work was revolutionary in demonstrating the part played by the capillaries in circulatory phenomena.

At a later stage Laidlaw turned his attention more particularly to the study of micro-organisms and related problems. He was the first to use spongy platinum and hydrogen in the anaerobic cultivation of bacteria. With Dobell he discovered a method for growing *Entamoeba histolytica* *in vitro* and also solved the problem as to how emetine acts in curing amoebic dysentery. With Dunkin he undertook an investigation into the cause, prevention and cure of distemper, one of the most successful investigations in medical science.

In a recent extension of this work, in co-operation with Wilson Smith and Andrewes, Laidlaw has shown that a virus can be transmitted to the ferret from cases of human infection diagnosed as influenza, and has thus discovered a technique for its further study.

DAVY MEDAL, awarded to DR. W. H. MILLS

Dr. William Hobson Mills is distinguished for his outstanding contributions to stereochemistry and to our knowledge of the cyanine dyes. He has made important observations in many branches of descriptive chemistry and has extended, especially, the theory of stereochemistry and strengthened its foundations by the devising and the performance of carefully planned experiments. In the most elegant manner he has demonstrated the occurrence of molecular dissymmetry in some of the most interesting cases predicted by theory, but, prior to his work, unconfirmed in the laboratory.

By his resolution of the oxime of ketohexahydrobenzoic acid, Mills not only justified in a new way a prediction of van't Hoff but also furnished convincing evidence of the validity of the Hantzsch-Werner theory of the configuration of the oximes. Later he explained the existence of stereoisomerism in certain diphenyl derivatives by an 'obstruction'

hypothesis and he brilliantly justified his views by predicting and demonstrating a similar phenomenon in the naphthalene series.

Mills has also developed the theory and practice of spirocyclic compounds of several very different kinds, and he has added a number of elements to the list of those which, acting as a central polyvalent atom, are known to give rise to enantiomorphism.

HUGHES MEDAL, awarded to PROF. E. V. APPLETON

The Heaviside layer, or reflector of electromagnetic waves in the upper atmosphere, was originally postulated to explain the bending of such waves round the earth's curvature. Appleton, in collaboration with M. A. F. Barnett, J. A. Ratcliff and others, has brought it within the range of detailed experimental examination. Working over a moderate distance of the order of 100 kilometres, he was able to examine the interference between the direct ray, and the ray reflected from the layer, by noting the successive intensity maxima as the wave-length of the sending station is varied continuously over a small range. In this way the height of the main reflecting layer is established to be about 100 kilometres, though at night it is found to be somewhat greater. Evidence was also found of a higher reflecting layer, situated at 180 kilometres, which has come to be known as the Appleton layer. In some of the experiments the horizontal distance was only 18 kilometres, so that the reflected ray came nearly straight down.

Appleton has shown that ionisation penetrates downwards, and the height of the reflecting layer becomes less as the sun rises. During the night the number of free electrons diminishes, and the reverse process can be traced.

In a further important series of experiments Appleton and his collaborators have shown that the downcoming electric waves from the Heaviside layer are elliptically polarised in a left-handed sense. This he connected with the modification in the motion of the ions (electrons) by the earth's magnetic field, and predicted a right-hand polarisation in the southern hemisphere, a prediction since confirmed.

### The Divine King in Africa

THE death of the Divine King, which may well be regarded as the central picture of Sir James Frazer's shield of Achilles, has been considered by Prof. Moret alone among the Frazer lecturers, and he had concerned himself especially with the Egyptian evidence. Prof. C. G. Seligman made it his object to repair this omission in his Frazer lecture entitled "Egypt and Negro Africa: a Study in Divine Kingship", delivered in the University of Liverpool on November 30. He reviewed the evidence which he and his colleagues have collected in Africa, with the view of shedding new light on the subject, confining himself to the position of the Divine King in living cultures.

In the Sudan in the winter of 1909-10, Prof. Seligman and his wife were able not only to obtain evidence concerning the existence and killing of the Divine King among two great Nilotic tribes—the Skilluk and Dinka—but also in the case of the former, they were given an account of the installation of the new king, part of the ceremony providing the actual mechanism whereby the divine spirit immanent in

the Skilluk king was passed on to his successor. Further evidence has been obtained from the Dinka and Skilluk, and also from the Nuer, by Prof. Evans-Pritchard, and our knowledge has been much increased by the work of Mr. C. K. Meek in West Africa.

On the basis of this material, it is possible on one hand to set forth an account of at least a portion of the recently acquired knowledge concerning Divine Kings in Africa, and then to estimate whether the existence of those rulers is to be regarded as due to the survival in different parts of Africa of the beliefs of a very old immigrant Caucasian stock, the Hamites, of whom the proto-Egyptians were themselves a branch, or whether the belief is to be considered as specifically Egyptian in origin and as having spread from Egypt by culture contact.

The evidence is derived from (1) the Nile Valley south of Khartum, here including the tribes from the neighbourhood of the great lakes; (2) Nigeria and the adjoining parts of West Africa; and (3) parts of East and South Africa inhabited by Bantu tribes.



The two great geographical areas of the Nile Valley and West Africa, inhabited, one by an eastern Nilotic and predominantly Negro-Hamitic population, the other by a great mass of predominantly forest Negroes, show a most striking community in ideas and customs. There can scarcely be any doubt that a number of the traits common to Ancient Egypt and the western area arose in Egypt and were passed on to the negroid tribes of the Nile Valley and the Negroes of the Congo. The evidence whether they were further transmitted from the Congo to Nigeria is much less clear, although it can scarcely be doubted that Egyptian influence sometimes did reach West Africa.

Summarising the facts, however, there are certain main conclusions to which they lead. At a remote period of more than 5,000 years ago, in that part of the Nile Valley now called Upper Egypt, the king or tribal leader among the pre-dynastic Egyptians was particularly associated with vegetation, the cultivation of the crops and the welfare of the land. This king, there is reason to believe, was slain ceremonially when he had reigned for a certain number of years or when he had grown old. Whether this be so or not, at any rate during historical times, a group of ceremonies known as the *sed* festival was performed, which had for their purpose the confirmation of the king in his kingship (re-investiture) and probably rejuvenation. These too can be traced back to pre-dynastic times.

There is abundant evidence for the direct extension of Egyptian ideas, beliefs, art-forms and technical devices southwards for some distance up the Nile Valley. To the south, among the Negroid tribes of the Nile basin, we find at the present day kings who are especially associated with the welfare of the crops, herds and people and these kings may either be killed ceremonially on showing signs of ill-health or senescence (Skilluk), or after a number of years at their own request (Dinka). Sometimes such kings, though concerned with the welfare of the crops, are not killed (Nuer, Latuka); sometimes a 'confirmation' or 'rejuvenation' ceremony is performed for their benefit (Baganda). Among a neighbouring tribe, the Bakitara, the most prominent feature of the *sed* festival, the shooting of arrows towards the cardinal points, constitutes a rite at the installation of the king, which is repeated annually at the beginning of the year.

In spite of these amazing resemblances, chronological factors forbid us to believe that the Divine Kings of the Sudan are directly due to Egyptian influence. Rather must they be regarded as examples of an old and widespread Hamitic belief, though there has become attached to them through Egyptian influence a number of specifically Egyptian rites such as the *sed* ceremony.

Turning to West Africa, we find Divine Kings in their typical form in a group of tribes (Jukun, etc.) with sun-worship and a ceremony corresponding to the *sed*. Here the quality of the Divine Kings conforms more closely to the Egyptian agricultural pattern than it does in the Nile Valley, where the concern of the tribesmen for their cattle may have diminished their interest in agriculture. But here again it must be recognised that we are dealing not with the transmission of a specifically Egyptian custom, but with an older Hamitic belief, which did, however, reach West Africa from the east, that is, from the neighbourhood of the Great Lakes, via the Congo.

Speculating on the deeper significance of the beliefs and ceremonies, more weight, Prof. Seligman held, should be given to the complicated installation ceremonial ritual of the Divine King than had been done in the past, for it is in the installation and rejuvenation ceremonies that there is especially the emotional projection upon the Divine King of his peoples' deepest desire for life, fertility and prosperity.

### University and Educational Intelligence

CAMBRIDGE.—Prof. H. A. Harris has been elected professor of anatomy as from October 1, 1934, in succession to Prof. J. T. Wilson, who will retire on that date. Prof. Harris is at present professor of clinical anatomy at University College, London.

Prof. W. Heisenberg, of the University of Leipzig, has been appointed Scott lecturer for the year 1934 and Prof. G. von Hevesy, of the University of Freiburg i. Br., for the year 1935.

A. E. Platt has been elected to the Gwyneth Pretty studentship.

The George Henry Lewes studentship in physiology has been awarded to Dr. John Burnaston Bateman.

LONDON.—The celebration of the one hundred and tenth anniversary of the foundation of Birkbeck College will be held on Wednesday, December 13. The foundation oration will be delivered by Col. John Buchan at 8.15 on "The Margins of Life". Admission is free.

OXFORD.—In convocation on November 28, the honorary degree of D.Sc. was conferred on Prof. Arthur Thompson, who is about to resign the chair of human anatomy, which he has held for nearly fifty years. The Public Orator in presenting him referred to his eminent services to the Medical School in Oxford, to his professorship of anatomy at the Royal Academy, to his achievements as an anthropologist, and to his skill as an artist.

Congregation has also approved the preamble of a statute providing for the addition of 'entomology' to the style of the Hope professorship of zoology.

THE annual conference of the Geographical Association will be held at the London School of Economics on January 3-6. The presidential address will be delivered on January 3 by Prof. P. M. Roxby, Rankin professor of geography in the University of Liverpool, on "China as an Entity—the Comparison with Europe". Lectures will be delivered by Prof. J. D. Greene, Dr. J. H. Hutton, Prof. G. C. Allen, Prof. J. Coatman, Commander L. C. Bernacchi, Dr. S. W. Wooldridge, Mr. D. L. Linton, and Prof. Julian Huxley. Two discussions have also been arranged: for teachers in primary schools, on "The Place and Problems of Local Geography", to be opened by Mr. J. C. E. Rogers; for secondary schools, on "Suggestions for a First School Certificate Geography Syllabus", to be opened by Mr. J. A. Mortlock. Further information concerning the conference can be obtained from the Clerk, Geographical Association, c/o Municipal High School of Commerce, Princess Street, Manchester, 1.

THE twenty-second Conference of Educational Associations will be held at University College, Gower Street, London, W.C.1, on January 1-8, under the presidency of Dr. George Dyson. On January 1,



Dr. Dyson will deliver his presidential address entitled "Education for Life". A joint conference on "The Failure of Modern Science Teaching to Develop an Adequate Cultural Background to Life" will be held on January 4, when the principal speakers will be Prof. Julian Huxley, Mr. St. John Ervine and Sir Arnold Wilson. Among the lectures to be given before the large number of societies and associations taking part in the Conference are "Experimental Work on Heredity", by Dame Helen Gwynne-Vaughan (School Nature Study Union), and "Biology and the School Curriculum", by G. W. Olive (British Social Hygiene Council—Educational Advisory Board). Further information can be obtained from the Conference Secretary, 29 Gordon Square, London, W.C.1.

The thirty-fourth annual meeting of the Science Masters' Association will be held in the Chemistry Department of the Imperial College of Science and Technology, South Kensington, London, on January 2-5; evening meetings will be held at King's College of Household and Social Science, Campden Hill Road, London. The following lectures have been provisionally arranged: H. T. Tizard, "Science and the Industrial Depression"; Prof. E. N. da C. Andrade, "New Experimental Work in Sound"; Prof. H. V. A. Briscoe, "Valency"; Dr. Allan Ferguson, "Some of London's Contributions to Science"; Mr. J. Ramsbottom, "Fungi"; Prof. A. Brammall, "Geochemistry applied to the Genetic Study of 'Hybrid' Rock Types"; Dr. H. Spencer Jones, "The Structure of the Universe"; Prof. R. A. Fisher, "Adaptations and Mutations"; Mr. H. Harle, "Polarisation of Light and its Applications to Photoelasticity". A discussion on School Certificate science will be held. It is also proposed to make a special feature of the exhibition of members' apparatus; in the event of a member not being able to attend the meeting, apparatus may be sent to the Secretary. Further information can be obtained from Mr. H. G. Lambert, Shirley Corner, Boden Road, Hall Green, Birmingham.

THE modern universities' shortcomings have been discussed in a series of articles in recent issues of the *Universities Review*. In the October issue there is an article entitled "Suggestions for a Reformed University Curriculum" based on the assumption that the aim of university education is to further human welfare by equipping the best minds for effective intervention in the philosophical and practical problems of to-day, that university studies ought to be fitted into schemes framed in accordance with this aim, and that inasmuch as they are turning out year by year large numbers of graduates who are quite uneducated, the universities are failing deplorably in their mission. On the science side, all undergraduates should receive, it is contended, a general scientific education, either a natural philosophy course, humanised by, for example, work in the history and philosophy of science and by such co-ordination as the linking up of mathematics with statistical science and economics, or a biological course treated with definite reference to fundamental modern problems. Specialised study should be permitted only after graduation and should in every case be "the activity of a mature mind stimulated by a real desire to know" instead of, as happens too often, "amassing a deal of useless information that will be promptly and rightly buried in the recesses of the university library".

## Calendar of Nature Topics

### December Frosts

December, the first month of winter, is often traditionally associated with frosts. Actually, in England, December is not so cold as either January or February, the average temperature at Greenwich over a period of 90 years having been just above 40° F., while the historic frosts of the seventeenth to nineteenth centuries did not usually begin until January. The most notable exception was the intensely cold month of December 1879 in western Europe. In the British Isles the chief characteristic of December is the frequency of rain, which, at most places, is greater than in any other month, though the actual amounts which fall may be less than in October or August. In the French Revolutionary Calendar of 1793, the period November 21–December 20 was the month *Frimaire*, but this refers rather to the formation of hoar-frost on the ground at night than to the occurrence of temperatures persistently below freezing point. In December, the air still contains a large amount of water vapour, while clear calm nights are cold enough for the ground to fall below 32° F., and under these conditions the deposits of hoar frost may be heavier than they are later in the winter when the temperature is lower.

### Halcyon Days

In Virgil's "Georgics", Book 1, appears a reference to the fourteen halcyon days, which he describes as beginning on December 11. The legend relates to the myth that the lovers Ceyx and Alcyone were changed into kingfishers or halcyons by the gods for their presumption. Kingfishers were formerly supposed to construct nests floating on the sea, and their breeding time is near the winter solstice. Hence from about seven days before to seven days after the solstice, through the influence of Aeolus the wind god, father of Alcyone, all gales were hushed and the sea calmed so that the lovers' floating nest might not be injured by the waves or carried out to sea. The wind data for examining this belief are not readily available, but while periods of fine weather sometimes occur in the Mediterranean in winter, it is unlikely that they are especially frequent during the legendary period. 'Halcyon days' was later extended to include any period of fine calm weather.

### Seasonal Variations in Tropical Animals

In a general way, it appears to be true that sexual rhythms associated with the seasons, such as are familiar in temperate regions, do not occur amongst tropical animals. Nevertheless, the seemingly uniform tropical breeding season has, at any rate in cases which have been carefully investigated, an indication of minor cycles not definitely associated with temperature. The case of the common toad of southern Asia (*Bufo melanostictus*) has been investigated by Gordon Alexander by morphological methods (*Univ. Colorado Bull.*, 33, 195; 1933). It has been suggested that in certain areas November marks an increase in sexual activity, while Boulenger and Flower state that in the Malay Peninsula the breeding season is in March and April. Alexander dissected the gonads of sixty-eight specimens from Bangkok, and examined externally several hundreds of individuals from China; he found that the ovary weight was greatest in November; that although the breeding season extended through all the months



of the year with the possible exception of October, a larger number of breeding females occurred from November to January, and that a secondary period of heightened breeding activity occurred during March and April.

#### Late Stay of British Migrant Birds

The Phenological Committee of the Royal Meteorological Society, which has just presented its forty-third annual report, the annual phenological reports of the *Irish Naturalists' Journal*, and local reports, such as those of the Yorkshire Naturalists' Union, have added to knowledge of the dates of arrival and departure of British migrant birds. Every year a number of abnormally late migrants, especially cuckoos and swallows, are reported, while the chiff-chaff and other warblers have been recorded wintering in England. The 12 years' average Royal Meteorological Society record for the last call of the cuckoo is June 28, but the dates of departure of young cuckoos seem more difficult to collect. A specimen of the year in the Natural History Museum was shot in Cheshire on December 26, 1928; another was recorded in Devonshire on December 23, 1913; in Wiltshire, specimens on December 3, 1916 and 1921; and in 1925, one from Kent on January 5. November cuckoos and swallows occur frequently, though the 35-years' average date for the last swallow in the Royal Meteorological Society records is October 5. *British Birds* recorded a swallow from Hartford, Cheshire, on December 4 and 5, 1929. Out of 341 observers' dates for the last swallow in Britain in 1932, 11 were November records (Phenological Report, 1932); out of 361 records for 1931, 7 were November dates, and of 282 records for 1930, 18 were November dates.

#### The European Wolf

One of the features of the winter in villages in eastern France, Russia and other parts of Europe is the appearance of wolves from their forest habitats during severe weather. In Europe, the wolf has disappeared from the British Isles and central and northern Germany within comparatively recent historical times. Wolves were abundant in Yorkshire in the reign of Richard II, and in Ireland during Cromwell's time. Harting ("Extinct British Mammals") gives evidence to show that wolves were not exterminated in England until close on the fifteenth century, and in Scotland about 1743, while Sir J. E. Tennant gives the last Irish record so late as 1766, in Co. Kerry, and Richardson, 1770. There were sufficient wolves in Cheshire in 1302 to trouble the deer forests and necessitate the construction of special traps (*Proc. Hist. Soc. Lancs and Cheshire*, 43-44). An ancient tax made the subdued Welshmen deliver annually, instead of money, 300 wolves' heads to the king, and in four years the country was said to have become comparatively free from wolves.

With the exception of the antarctic wolf of the Falkland Islands (*Canis antarcticus*), true wolves are restricted to the northern hemisphere, and in Europe there is, as in American wolves, a marked variation in colour: those of the northern regions being lighter than those of the southern, blackish wolves being not uncommon in Spain. In the winter invasions of European villages, human lives are sometimes taken; in 1875, 161 persons were killed by wolves in Russia (Lydekker). Merriam has described a small pack sometimes killing hundreds of deer in the Adirondack region.

#### Societies and Academies

##### EDINBURGH

Royal Society, Nov. 6, 1933. A. GRAHAM: Cruciform muscle of lamellibranchs. In bivalves belonging to the families Tellinidae, Semelidae, Asaphidae, Donacidae and some Solenidae, there occurs a special cross-shaped muscle linking the two pallial edges at the base of the inhalent siphon, regarded by its discoverer, von Ihering, as an accessory adductor. It is now shown that in association with each half of the cross is a ciliated pit, beneath which lies a small ganglion. Contraction of the muscle draws water into the pits and the whole acts as a water-testing apparatus. On the basis of their possession of this organ, the Solecurtinæ are removed from the Solenidae and made a new family. A. G. NICHOLLS: Developmental stages of *Euchaeta norvegica*, Boeck. This includes a description of all the stages in the development of this large marine copepod, which is found in the deep waters of the Firth of Clyde. The young stages were reared in the laboratory and later stages were taken from the plankton. A. P. ORR: Weight and chemical composition of *Euchaeta norvegica*, Boeck. This animal has a high proportion of fat and is potentially a rich food for fish. The adult females are very much heavier than the males, which are about the same weight as males and females in the pre-adult stage. IVAN M. LAMB: Morphology and cytology of *Puccinia Prostii*, Moug. This is a micro-form occurring on *Tulipa* sp. The dikaryophase is initiated at the base of the bases of the teleutospore fundaments by cell fusions and nuclear migrations. The diploid hyphæ thus formed are 5-6 cells long and their terminal cells form the teleutospores; nuclear fusion takes place in the latter. During nuclear division a spindle is formed but no individual chromosomes were distinguished. Teleutospores kept under favourable conditions failed to germinate in the spring and it is suggested that in Great Britain the rust spreads solely by a systemic mycelium. T. NICOL: Reproductive system in the guinea pig: *post partum* repair of the uterus and the associated appearances in the ovaries. Variation in the rate of repair of the endometrium after parturition is analysed. It is shown that repair in a normal animal not re-impregnated was completed in 4½-6½ days *post partum*; if impregnation had occurred, repair was accelerated, the acceleration not being due apparently to ovarian conditions, but probably to the presence of the fertilised ovum. In animals in which normal ovulation had not occurred, *post partum* repair was delayed. The examination of the associated ovaries led to the conclusion that the delay was due to the absence of young corpora lutea, the possibility of failure of action of the pituitary hormones not being ignored. A. C. AITKEN: (1) Fitting polynomials to weighted data by least squares. (2) Fitting polynomials to data with weighted and correlated errors. These papers conclude the author's work on passing polynomial curves as near as possible to given points by least squares. The first paper follows the lead of Tchebycheff up to the point of obtaining a set of equations involving moments of data and moments of weights. For solving these equations the author suggests a new scheme by which the desired polynomials and residual errors are produced by a uniform repetitive process, well suited to practical work. The final paper undertakes the more difficult question of correlated errors. Here the principle of least squares must be extended.



The author solves the problem by introducing polynomials orthogonal in an extended sense, in which a quadratic expression replaces the usual sum of squares. The desired solution is then obtained with comparative theoretical ease. The practical application, though straightforward, is naturally rather tedious. R. GRANT: Physiology of reproduction in the ewe. (1) Observations on Scottish lowland sheep; together with an analysis of the influences of internal and external factors upon the oestrous cycle. The hormonal conditions governing the cycle are discussed. Inter-oestrus is regarded as a period of luteal activity. (2) Changes in the vagina and cervix: a description of the macroscopic and microscopic changes in these organs during the complete reproductive cycle, and a discussion of their hormonal basis and significance.

## PARIS

Academy of Sciences, October 23 (*C.R.*, 197, 877-952). A. DEMOULIN: The  $R$  and  $T'$  transformations. LÉON POMEY: An application of the theory of uniaxial involutions to cubics and to quartics. FINIKOFF: The pairs of surfaces the asymptotes of which correspond and which, at corresponding points, have the same Wilczynski directrices. CLAUDE CHEVALLEY and RENÉ DE POSSSEL: A theorem on completely additive functions of ensembles. J. KARAMATA: Theorems of Tauberian nature. RAPHAËL SALEM: Fourier's series. G. CERF: Partial differential equations with two variables of the form  $F[G(z)] = 0$ . D. MICHNEVITCH: The structure of partial differential equations of the first order with one unknown function. S. NIKITINE: A principle of diminution of the resistance to the advance of a body in a fluid. L. SACKMANN: The evolution of the regimes of flow between parallel glass walls as a function of the distance between them. D. RIABOUCHINSKY: The phenomena of striation of the limiting layer. V. VOLKOVISKY: Aerodynamic spectra at supersonic velocities. CH. BERTAUD: Researches on the movement of the  $A$  stars. ALBERT NODON: The terrestrial repercussions of the variations of solar activity. The active foci, detected by electrical and magnetic observations and barely visible, must be regarded as causing the greater part of the electrical, magnetic and atmospheric disturbances. NICOLAS KRYLOFF and NICOLAS BOGOLIUBOFF: Some general properties of resonances in non-linear mechanics. ANDRÉ EGAL: A new method of measuring the flow of fluids by the application of thermoelectric phenomena. The cold junctions of a series of thermocouples are in thermal contact with the tube containing the fluid in motion, whilst the hot junctions are heated to a controlled temperature. The variation of the thermoelectric potential is a function of the rate of flow of the fluid. H. R. CRANE, C. C. LAURITSEN and A. SOLTAN: A new artificial source of electrons. Lithium chloride and beryllium were bombarded with a mixture of light and heavy hydrogen ions containing 5 per cent of the latter, and also with hydrogen ions from ordinary water: curves are given showing the disintegration of the lithium and of the beryllium by the hydrogen ions as a function of the accelerating voltage. JEAN THIBAUD: Study of the physical properties of the positron. W. SCHUMACHER: The mechanical effects observed in the sudden superheating of lead azide in a vacuum. Mercury fulminate and lead azide behave differently when suddenly heated in a vacuum: the former disintegrates without

explosion, the latter explodes. JACQUES LEFOL: The hydrated calcium aluminates. Curves are given showing the loss of water as a function of the temperature of calcium aluminates prepared in different ways. D. LIBERMANN: The preparation of the salts of trioxotriarylsulphonium. D. IVANOFF and I. PAONOFF: A new complex organomagnesium derivative,  $\beta$ -magnesiyl-phenylacetoneitrile. In the study of the reaction between benzyl cyanide and the magnesium compound  $\text{RMgX}$ , the formation of the compound  $\text{PhCH}(\text{CN})\text{MgX}$  was proved indirectly by treating with carbon dioxide and separating the acid  $\text{PhCH}(\text{CN})\text{CO}_2\text{H}$ . ED. SAURIN: The marine Lias and Trias of north-eastern Cambodia and of Darlac. P. FALLOT and L. DONCIEUX: The Flysch of the Spanish Rif. J. JUNG and A. JEANNET: The geology of the Kafan-Kouh (Persia) chain. J. CUVILLIER: The presence of *Orbitolites complanatus* in the layers of passage from the middle Eocene to the upper Eocene in Egypt. J. RAYMOND: The kinesis of the ascus of *Pyronema confluens*. PHILIPPE HAGENE: The production of heat by the contact of dry earth with water. MAURICE QUENDIAC: The localisation of the tannic substances in the ligneous tissue of the chestnut tree. J. BRANAS and J. DULAC: The mode of action of cupric mixtures at the moment of their use. FERNAND MERCIER and L. J. MERCIER: The combinations of sparteine and the cyclic substituted barbituric acids. Description of the preparation and properties of sparteine ethylphenylbarbiturate and methylphenylbarbiturate. Only the neutral compounds are well defined, the neutral ethylphenylbarbiturate of sparteine being the most stable. G. ROUSSEL and MME. Z. GRUZEWSKA: The iron in the liver of the foetus of the calf. The existence of reserve iron and the variations in foetal livers in the course of foetal life are confirmed. LÉON BINET and JEAN PAUTRAT: The plasmatic phosphatase in cases of pulmonary tuberculosis. Phosphatase, the ferment concerned in processes of calcification, is clearly shown to be present in increased proportions in patients affected with fibrous pulmonary tuberculosis. ERWIN CHARGAFF: The carotinoids of bacteria. CH. DHÉRÉ: The fluorescence spectra of hypericine and of mycoporphyrine. These two pigments give identical fluorescent spectra: it has been shown previously (H. Fischer and R. Hess) that their absorption spectra are also identical. V. CHORINE and R. GILLIER: The mechanism of Henry's reaction in malarial infection.

## MELBOURNE

Royal Society of Victoria, September 14. WALTER HANKS: The Tertiary sands and older basalt of Coburg, Pascoe Vale and Campbellfield: The older basalts of the area are described and the Tertiary sands are separated into pre-older basaltic leaf-beds and Lower Pliocene beds. Localities from which fossils have been secured are recorded. The alterations in drainage from older basaltic times through newer basaltic times are discussed. HELEN T. PATERSON: Notes on some Tertiary leaves from Pascoe Vale: Leaf-bearing clays in the Moonee Ponds Creek containing plant remains of the 'brush' type of vegetation, together with forms resembling eucalypts and Banksias. The determinations include the genera *Nothofagus*, *Ficonium*, *Magnolia*, *Lomatia*, *Nephelites*, *Pomaderris*, *Bombax*, *Eucalyptus*, *Angophora* and *Cordia*. These impressions resemble types of leaves recorded from Narracan and Berwick in a similar pre-older basaltic series.



## Forthcoming Events

[Meetings marked with an asterisk are open to the public.]

## Monday, December 11

ROYAL GEOGRAPHICAL SOCIETY, at 5.—Lieut. J. S. A. Salt: "Plotting the Vertical Photographs from the Mount Everest Flight".

ROYAL COLLEGE OF SCIENCE, at 5.30.—Dr. R. M. Craig: "Geology in the Service of Man" (Swiney Lectures. Succeeding lectures on December 13, 15, 18, 20, 22, January 3, 5, 8, 10, 12 and 15.)\*

## Tuesday, December 12

BRITISH INSTITUTE, at 8.15—(at University College, Gower Street, W.C.1).—Prof. W. D. Ross: "Plato and Aristotle in Relation to Modern Thought" (cards of admission from the Director of Studies, University Hall, 14 Gordon Square, W.C.1).\*

PHARMACEUTICAL SOCIETY, at 8.30—Bernard F. Howard: "Cinchona and Civilisation" (Harrison Memorial Lecture).

## Wednesday, December 13

BIRKBECK COLLEGE, at 8.15.—Col. John Buchan: "The Margins of Life" (Foundation Oration).

## Thursday, December 14

ROYAL SOCIETY, at 4.30.—Discussion on "Heavy Hydrogen" to be opened by Lord Rutherford.

## Friday, December 15

ROYAL INSTITUTION, at 9.—Dr. Kenneth Lee: "Industrial Research: a Business Man's View".

## Official Publications Received

## GREAT BRITAIN AND IRELAND

The British Mycological Society Transactions. Edited by J. Ramsbottom, B. F. Barnes and H. Wormald. Vol. 18, Part 2, November 8. Pp. 93-118. (London: Cambridge University Press.) 7s. 6d.

Institute for Research in Agricultural Engineering: University of Oxford. Abstracts of Current Literature and Notes. No. 9, October. Pp. 11. (Oxford.)

County Council of the West Riding of Yorkshire. Twenty-ninth Annual Report of the Education Committee for the Year ended 31st March, 1933. Pp. 45. Handbook of the Education Committee. Part 2: High Education. Section 10: Regulations relating to Scholarships and Exhibitions and the Training of Teachers, 1934. Pp. iii+44. Report on the Examination for County Minor Scholarships, 1933. Pp. 31. (Wakefield.)

League of Nations. Conference for facilitating the International Circulation of Films of an Educational Character (Geneva, October 5th-11th, 1933). Convention for facilitating the International Circulation of Films of an Educational Character. (C. 588. M. 274. 1933. XII.) Pp. 16. 6d. Final Act. (C. 589. M. 275. 1933. XII.) Pp. 16. 6d. (London: George Allen and Unwin, Ltd.)

Proceedings of the Royal Society of Edinburgh, Session 1932-1933. Vol. 53, Part 4, No. 22: Studies on the Gametogenesis of *Stenophylax stellatus*, Curt. (Trichoptera).—Oogenesis. By Dr. R. A. R. Gresson. Pp. 322-346+2 plates. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.) 2s. 6d.

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 73, No. 443, November. Pp. 457-544+xviii. (London: E. and F. N. Spon, Ltd.) 10s. 6d.

The Physical Society. List of Officers and Members, corrected to October 1, 1933. Pp. 29. (London.)

The Institution of Electrical Engineers. List of Corporate Members, and of Non-Corporate Members, including a List of Names arranged Geographically; corrected to 1st September 1933. Pp. 499. (London.)

Imperial Agricultural Bureaux. Index Veterinarius, 1933. Vol. 1, No. 1. Pp. 304. (Weybridge: Imperial Bureau of Animal Health.)

University of Cambridge: Solar Physics Observatory. Twenty-first Annual Report of the Director of the Solar Physics Observatory to the Solar Physics Committee, 1932 August 1-1933 July 31. Pp. 3. (Cambridge.)

Imperial Bureaux of Animal Genetics. The Technique of Artificial Insemination. With an Introductory Chapter by Dr. Arthur Walton. Pp. 56. (Edinburgh and London: Oliver and Boyd.) 2s. 6d.

The Marine Biological Station at Port Erin: being the Forty-sixth Annual Report of the former Liverpool Marine Biology Committee, now the Oceanography Department of the University of Liverpool. Drawn up by Dr. R. J. Daniel. Pp. 39. (Liverpool: University Press of Liverpool.) 1s. 6d. net.

British Cast Iron Research Association. Twelfth Annual Report for the Year ended June 30th, 1933. Pp. 32. (Birmingham.)

Books and the Farmer: an Address delivered at the Tenth Annual Conference of the Association of Special Libraries and Information Bureaux at Wills Hall, Bristol. By Sir E. John Russell. Pp. 16. (London: Association of Special Libraries and Information Bureaux.)

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Thirty-seventh Session adopted at the Annual Meeting of Governors held on the 17th October, 1933. Pp. 84. (Glasgow.)

Development Commission. Twenty-third Report of the Development Commissioners, being for the Year ended 31st March, 1933. Pp. 107. (London: H.M. Stationery Office.) 2s. net.

Department of Scientific and Industrial Research. Report of the Fuel Research Board for the Year ended 31st March, 1933; with Report of the Director of Fuel Research. Pp. viii+140+6 plates. (London: H.M. Stationery Office.) 2s. 6d. net.

## OTHER COUNTRIES

Bulletin of the American Museum of Natural History. Vol. 67, Art. 2: On the Dinosaurian Fauna of the Iren Dabasu Formation. By Charles W. Gilmore. Pp. 23-78+8 plates. (New York City.)

Seismometrical Report of the Earthquake Research Institute, Tokyo Imperial University. 1933, Part 1 (January 1-March 31, 1933). Pp. 6+7 plates. (Tokyo.)

Bulletin of the Earthquake Research Institute, Tokyo Imperial University. Vol. 11, Part 3, September. Pp. 403-594+plates 24-39. (Tokyo: Iwanami Shoten.) 3.00 yen.

Abhandlungen aus dem Seminar für Vektor- und Tensoranalysis samt Anwendungen auf Geometrie, Mechanik und Physik. Herausgegeben von Prof. B. Kagan. (Wissenschaftliches Forschungsinstitut für Mathematik und Mechanik an der Staatsuniversität Moskau. Lieferung 1. Pp. 303. (Moskau und Leningrad: Staatlicher Technisch-Theoretischer Verlag.)

Koninklijk Magnetische en Meteorologisch Observatorium te Batavia. Verhandelingen No. 25: Sea-Surface Temperatures on some Steamer Routes in Netherlands India (Second Series 1928-1932). By Dr. H. P. Berlage, Jr. Pp. 35. (Batavia: Landsdrukkerij.)

Indian Central Cotton Committee. Technological Laboratory. Technological Bulletin, Series B, No. 17: The Foundations of Yarn Strength and Yarn-Extension. Part 5: The Prediction of the Spinning Value of a Cotton from its Fibre-Properties. By Dr. A. J. Turner and V. Venkataraman. Pp. ii+48. (Bombay.) 1 rupee.

Carnegie Institution of Washington. Publication No. 416: Contributions to Paleontology—Fossil Floras of Yellowstone National Park and Southeastern Oregon. Pp. iii+68+22 plates. Publication No. 444: Atitlan; an Archaeological Study of Ancient Remains on the Borders of Lake Atitlan, Guatemala. By Samuel Kirkland Lothrop. Pp. vii+122. (Washington, D.C.: Carnegie Institution.)

Annual Report of the Board of Regents of the Smithsonian Institution, showing the Operations, Expenditures and Condition of the Institution for the Year ending June 30, 1932. (Publication 3185.) Pp. xiii+497+55 plates. (Washington, D.C.: Government Printing Office.) 70 cents.

Indian Central Cotton Committee. Technological Laboratory. Technological Bulletin, Series A, No. 25: Testing of Indian Cottons for Quality at the Technological Laboratory. By Dr. Nazir Ahmad. Pp. ii+20. (Bombay.) 8 annas.

U.S. Department of the Interior: Office of Education. Pamphlet No. 37: Religious Education Bibliography, January-December 1932. Pp. vi+36. (Washington, D.C.: Government Printing Office.) 5 cents.

Classified List of Smithsonian Publications available for Distribution, November 1, 1933. Compiled by Helen Munroe. (Publication 3220.) Pp. v+33. (Washington, D.C.: Smithsonian Institution.)

Journal of Science of the Hiroshima University. Series A (Mathematics, Physics, Chemistry). Vol. 3, No. 3, October. Pp. 243-366. (Tokyo: Maruzen Co., Ltd.) 98 sen.

Reports of the Institute for Science of Labour. No. 15: A Study of the Physical Development of Female Workers, especially with regard to their Fitness for Maternity. By Dr. Korehiko Ogawa. Pp. 19. 50 sen. No. 16: An Experimental Study on School Feeding. By Dr. Syüzô Matsushima and Syô Sasaki. Pp. 12. 40 sen. No. 17: Studies on the Output Curve. Part 1: The Daily Output Curve; Part 2: The Monthly Output Curve; Part 3: The Hourly Output Curve (First Report). By Dr. Takatugu Yagi. Pp. 46. 1.00 yen. No. 18: On the Change of Position of the Center of Gravity with the Progress of Pregnancy; Studies on the Center of Gravity of the Human Body. By Dr. Misao Okuyama. Pp. 11. 40 sen. (Kuraski.)

Collection des travaux chimiques de Tchecoslovaquie. Rédigée et publiée par E. Votoček et J. Heyrovský. Année 5, No. 9-10, Septembre-Octobre. Pp. 367-456. (Prague: Regia Societas Scientiarum Bohemica.)

Report of the Danish Biological Station to the Ministry of Shipping and Fisheries. 38, 1933. By Dr. H. Blegvad. Pp. 32. (Copenhagen: C. A. Reitzel.)

Jamaica. History of the Hope Farm and Part 1 of the Jamaica Herd Book of Pure Bred Cattle. By H. H. Cousins. Pp. vi+308+59+54 plates. (Jamaica: Government Printing Office.)

Ministerio da Educação e Saúde Pública: Observatorio Nacional do Rio de Janeiro. Taboas das Marés para o Ano de 1933 nos Portos do Rio de Janeiro, Belém, S. Luiz, Amarração, Camocim, Fortaleza, Natal, Cabedelo, Tambau, Recife, Aracaju, Baía, Ilhéos, Vitória, Santos, Paranaguá e Itajaí. Pp. 209. (Rio de Janeiro.)

Ministerio da Educação e Saúde Pública. Anuário publicado pelo Observatorio Nacional do Rio de Janeiro para o Ano de 1933. Ano 49. Pp. xv+416. (Rio de Janeiro.)

Det Kongelige Departement for Handel, Sjøfart, Industri, Håndverk og Fiskeri: Norges Svalbard- og Ishavsundersøkelser. No. 59: On Dufourea and Dactylina, Three Arctic Lichens. By B. Lynge. Pp. 62+2 plates. 5.00 kr. Meddelelse Nr. 24: Norges Svalbard- og Ishavsundersøkelser. Ekspedisjon til Sydøst-Grønland med Vestemari sommeren 1932. Av Gunnar Horn. Pp. 409-427. (Oslo.)

Proceedings of the American Academy of Arts and Sciences. Vol. 68, No. 7: Gyromagnetic Experiments on the Process of Magnetization in Weak Fields. By S. J. Barnett. Pp. 229-249. (Boston.) 65 cents.

Ceylon Journal of Science. Section C: Fisheries. Edited by Dr. Joseph Pearson. Vol. 5. Pp. 111. (Colombo: Colombo Museum; London: Dulau and Co., Ltd.) 3 rupees.