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CONTENTS.

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A Royal Commission on the Civil Service.

AT the last meeting of the National Whitley Council for the Civil Service, the staff side, at the instance of the Institution of Professional Civil Servants, moved for the appointment of a joint committee of the Council in the following terms:

That a joint committee be appointed to inquire into the recruitment, organisation, duties, and pay of the professional, scientific, and technical Civil Servants employed in the scientific, research, and experimental branches of the Public Service, and to make recommendations.

In reply, the official side of the Council, speaking on behalf of the Government, stated that while the motion for such a committee could not be accepted, the Government had decided to set up an inquiry into the organisation and lay-out of the research departments, upon which persons outside the Civil Service familiar with the problems involved would be invited to serve. The Institution, while not satisfied that the views of the staffs it represented would be adequately considered by such an inquiry, decided to await further information before settling the policy it should adopt, and to call an early meeting of the standing joint committee of the Institution and the Association of Scientific Workers.

Two days after the meeting of the National Whitley Council, the Prime Minister unexpectedly announced to a women's deputation, not primarily concerned with Civil Service questions, that if returned to power the Government had decided to set up a Royal Commission on the Civil Service, with, it appears, wide terms of reference which would permit of a radical re-examination of the structure and organisation of the Service. This announcement was received with surprise in official circles, and it was thought in some quarters that the Royal Commission would, in view of the character of its proposed reference, take within its scope the inquiry concerning the research departments. The Institution has made inquiries through the staff side of the National Whitley Council, and learns that two separate inquiries are in fact intended.

It is all to the good that the special problem of the organisation of research under the auspices of the State should receive expert and impartial consideration. The recent Report of the Research Co-ordination Sub-Committee of the Committee of Civil Research indicated that there was scope for closer co-ordination in certain directions, and better organisation and concentration of control

should lead to a higher status for the research departments, and so to better conditions for the scientific staffs, which lag far behind those of non-scientific civil servants. But it is to be hoped that the Royal Commission will be so constituted as to ensure that, in the consideration of the structure of the Civil Service, due regard will be paid to the views of those who hold that science is an integral part of the life of civilised communities, and that economical administration requires a full recognition of the contribution that the technical expert in the wide sense can make towards the promotion of social welfare. In the Civil Service the technical expert has little or no authority and is normally regarded as a mere consultant, with the result that his career and status are adjusted accordingly. The control of the Service by a close caste of administrators, few of whom have received an advanced scientific training, has inevitable reactions on the part that the man of science, whether pure or applied, is permitted to play in administration. Status in the Civil Service, as elsewhere, is reflected in remuneration, and Sir Richard Redmayne has recently pointed out in his presidential address to the Institution of Professional Civil Servants that the highest scientific posts in the Service carry half the salary of the highest administrative posts.

The modern State cannot afford to treat in this fashion those upon whom material progress depends. Efficiency of the administrative machine must depend upon a ready acceptance of the results of research and appreciation of the need for the scientific approach in the solution of administrative problems. A Royal Commission which does not include a number of scientific and professional men of acknowledged authority and experienced in the application of scientific method and discovery to administrative necessities will inevitably produce a report highly coloured by traditional 'establishment' notions in the Civil Service, which will rivet upon the Service for yet another generation a system of control now some two generations old and completely out of touch with modern necessities. Mr. Churchill, in reply to a parliamentary question, has stated that the object of the Royal Commission is to undertake "a dispassionate and informed examination of the Civil Service from the point of view of its efficiency as a national instrument and of its own well-being". These words are admirable, but we shall await with interest the actual terms of reference, and above all the actual personnel of the Commission.

Rays and Waves.

(1) *Handbuch der Experimentalphysik.* Herausgegeben von W. Wien und F. Harms. Unter Mitarbeit von H. Lenz. Band 15: *Radioaktivität.* Von Prof. K. W. F. Kohlrausch. Pp. xii + 985. 81 gold marks. (2) Band 18: *Wellenoptik und Polarisation.* Bearbeitet von K. F. Bottlinger, R. Ladenburg, M. v. Laue, Hans Schulz. *Photochemie*, von E. Warburg. Pp. xiv + 674. 63·50 gold marks. (3) Band 19: *Dispersion und Absorption.* Von Prof. George Jaffé. *Medien mit veränderlichem Brechungsindex und Lichtzerstreuung.* Von Prof. Richard Gans. Pp. viii + 430. 41 gold marks. (4) Band 23: *Phosphoreszenz und Fluoreszenz.* Teil 1. Von P. Lenard, Ferd. Schmidt und R. Tomaschek. Pp. xxiii + 741. 71 gold marks. (5) Band 23: *Phosphoreszenz und Fluoreszenz.* Teil 2. Von P. Lenard, Ferd. Schmidt und R. Tomaschek. *Lichtelektrische Wirkung.* Von P. Lenard und A. Becker. Pp. xi + 745-1544. 72 gold marks. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1928.)

TO the third book of Newton's "Opticks" are appended certain famous Queries, some of which are as applicable to-day as when they were first written. In Query 17 he asks: "When a ray of light falls upon the surface of any pellucid body, and is there refracted or reflected, may not waves of vibrations, or tremors, be thereby excited in the refracting or reflecting medium at the point of incidence, and continue to arise there, and to be propagated from thence as long as they continue to arise and be propagated . . . ? and are not these vibrations propagated from the point of incidence to great distances ? and do they not overtake the rays of light, and by overtaking them successively, do they not put them into the fits of easy reflexion and easy transmission described above ?"

In these days when waves of light pose as corpuscles or quanta, and material particles assume the characteristics of waves (albeit waves in space of many dimensions), the whole of modern physics might be included in the two terms 'rays' and 'waves'. But these volumes of the monumental "Handbuch der Experimentalphysik" are more particularly concerned with light waves and the rays from radioactive substances, and there is no danger of misunderstanding when they are summarised under these two headings. At the same time, the dilemma which confronts the physicist is reflected in the treatment meted out to the quantum theory by the different authors to whom

the work has been assigned. Some accept the theory whole-heartedly, others with evident hesitation.

(1) Prof. Kohlrausch of Graz has written a complete and impartial account of the science of radioactivity, and we have nothing but praise to give to this admirable volume. In some Continental textbooks we have noticed a tendency to belittle or to ignore the work of the Cavendish Laboratory and the Cambridge physicists. No such tendency is to be found in this volume, where we meet repeatedly the names of J. J. Thomson, C. T. R. Wilson, E. Rutherford, and their numerous fellow-workers. The longest chapters in the book are devoted to gamma rays—a subject to which Prof. Kohlrausch has made important contributions—beta rays, and alpha rays. Very remarkable are the results obtained by the use of Wilson's cloud chamber, by means of which the tracks of such rays are made visible. In particular, mention may be made of the stereoscopic pictures by Meitner and Freitag (Figs. 169 and 170), in which the path of a hydrogen particle set in motion by the impact of an alpha ray is clearly marked. Some of Blackett's photographs are also well reproduced. We have taken special interest in the account of the H rays, including the description of Stetter's experiment, using Aston's mass-spectroscope to show that the mass of such a particle is identical with the mass of the hydrogen atom.

(2) The greater part of vol. 18 is devoted to physical optics. Rudolf Ladenburg gives an interesting critical account of the measurements of the velocity of light, taking Michelson's latest value, $c = 299{,}796$ km./sec., as a standard. In an added note it is pointed out that this is in close agreement with the value deduced by the astronomical method (H. Spencer Jones).[1]

M. v. Laue is responsible for valuable articles on the optics of moving bodies, the reflection and refraction of light at the interface between isotropic bodies, and the interference and diffraction of electromagnetic waves (with the exception of X-rays). The first of these contains information as to recent researches not easily available to the student. The same remark applies to Bottlinger's short article on the relativistic displacement of spectral lines towards the red and the bending of light in the gravitational field of a star. The polarisation of light is well treated by Hans Schulz, who gives a careful account of historical and modern experiments and apparatus—we notice references are made to instruments by Hilger and by Bellingham and Stanley. Reproductions are given of the striking interference patterns of crystals due to H. Hauswald.

A short article of 40 pages by E. Warburg on photochemistry is included in this volume. The author seems to have imposed severe restrictions on himself in his treatment of this subject, and the result is somewhat disappointing. This arises in part from the complexity of the material, for although the quantum theory affords some explanation of the simpler photochemical processes, the reactions are in general complicated by secondary changes which cannot at present be traced in detail or subjected to critical analysis. When absorption of incident radiation takes place, an electron is raised to a higher quantum level, or in other words, energy of radiation is transformed into quantum energy. It is now assumed that, by interaction with another molecule, this quantum energy can be changed into another form of energy, in this case, chemical energy.

To set up and preserve the laws of statistical equilibrium a particular process can in general never be supposed to act alone, unaccompanied by a corresponding reverse process; only the two together form a possible single mechanism of interaction. Collisions between electrons and atomic systems may be divided into two types, those in which kinetic energy of electrons is changed into quantum energy of atomic systems, and those in which the inverse change of quantum energy into kinetic energy of electrons occurs. In thermodynamic equilibrium there must be just as many collisions of one type as of the other. According to Franck, this conclusion must also be drawn with regard to the collisions between excited and unexcited atomic systems.

(3) Vol. 19 of the 'Handbuch', though less bulky than some of its companions, deserves special attention, as it has to do with subjects of great theoretical importance. Prof. Jaffé, of Giessen, writes on the related topics of the dispersion and absorption of light. After a short historical introduction the classical theories are discussed briefly but adequately. The theory of dispersion was first suggested by Maxwell in a question in the Cambridge Mathematical Tripos of 1869, but important work was done by Sellmeier (1871), who independently advanced the view that the differences in the velocity of light in different materials must be attributed to the direct action of the vibrating particles of the medium set in oscillation by the ether vibrations. The electromagnetic theory of dispersion is then described, and the

[1] See NATURE, vol. 120, p. 602; 1927.

later developments consequent upon the adoption of the electron theory discussed. Next we have an account of the application of the quantum theory to the problem, leading up to the dispersion formula of Kramers, and finally to the new quantum mechanics—a truly notable record of scientific progress. The experimental aspects of the subject are next taken up, gases, liquids, and solids being considered in turn, and comparison between theory and experiment being kept in view throughout. Chapter vi. deals with several related questions of great interest, such as the number of dispersion electrons, and the probability of quantum transitions.

Part II. consists of three chapters dealing with absorption, commencing with an account of the theories, including the collision theory of Lorentz and also the theory of Planck, in which the damping is referred solely to radiation. Then follow descriptions of experimental methods and of the results obtained for gases and vapours, liquids and solids. The whole work is well done and deserves high praise.

Prof. Gans of Königsberg contributes a short chapter on media with variable refractive indices, and a further three chapters, which, in view of the growing importance of their subject, might well have been longer, on the molecular scattering of light.

(4) The difficulty of dealing with the vast amount of material accumulating as the result of modern scientific research is illustrated by the volumes on phosphorescence and fluorescence. The method, which consists in abstracting or reproducing in considerable detail a large number of original papers, is far from attractive. In the opinion of the reviewer, who sympathises with the authors in their task, more severe pruning and more critical selection would have increased greatly the value of the resulting work. We hold that the author of such a volume need not attempt to provide an exhaustive account of all available data, even were that humanly possible, but rather to supply a judicious and stimulating survey of the main facts and theories. In the subject of luminescence the difficulty is acute, arising in part from the fact that the development of the theory has not kept pace with the increase in the number of facts of observation and experiment.

The historical method is followed in the earlier part of the volume, which begins with an account of the observations of Canton, Stokes, and Becquerel, followed by a description of the work of Klatt (to whom the book is dedicated), of Lenard and his fellow-workers, notably Hausser and Saeland. We can do no more than mention the investigations of Gudden and Pohl on the electrical conductivity of phosphorescent materials when illuminated, and the work of the same investigators and of Schmidt on the dielectric constant of the material.

(5) The second part of Vol. 23 contains five chapters which conclude the discussion of phosphorescence and fluorescence, and five more covering some 500 pages which are concerned with photoelectric activity. In the chapter on fluorescence, it is pointed out that the time during which the emission continues after the cessation of the stimulus does not afford a sharp criterion to enable us to distinguish between fluorescence and phosphorescence. It is suggested that a better criterion may perhaps be found in the photoelectric effect, which postulates the complete separation of electrons from the active centres of the phosphore in all cases of phosphorescence of long duration.

Of outstanding interest are the researches of R. W. Wood and others on the fluorescence of gases and vapours. When sodium vapour is illuminated by sodium light, some of this light is re-emitted without change of wave-length as *resonance radiation*. But, in addition, other monochromatic radiations, forming *resonance spectra*, are given out when the vapour is illuminated by the light of metallic arcs. Recent investigations have done much to unravel the complicated line spectrum obtained in this way.

The section on photoelectricity is mainly due to A. Becker, and even if emphasis is laid on the work carried out by German investigators, it is useful to have the results summarised by one who has himself made important contributions to the subject. We may mention in particular his work on the relation between photoelectric and thermionic emission. The reviewer turned at once to the chapter on photoelectric fatigue, and was interested to find that this perplexing phenomenon is attributed by the author mainly to the influence of gas (ozone) or vapour (water vapour) on the emission of electrons. The final chapter is on the practical applications of photoelectricity, and refers to the increasing importance of photoelectric cells in photometry.

It was by studying the energy of photoelectric emission that Einstein in 1905 was led to the theory of light quanta, which seemed in direct antagonism to the wave theory of light. The energy of the light quantum of frequency ν was assumed to be $h\nu$ where h is Planck's constant.

We may conclude with a question put by Schrödinger at the end of his lectures on wave mechanics: Is it quite certain that the conception of energy, indispensable as it is in macroscopic phenomena, has *any* other meaning in micro-mechanical phenomena than the number of vibrations in h seconds? H. S. ALLEN.

The Evolution of Human Races.

L'Ologenèse humaine (*Ologénisme*). Par Dr. George Montandon. Pp. xi + 477 + 14 planches. (Paris: Félix Alcan, 1928.) 200 francs.

DR. GEORGE MONTANDON is known to anthropologists because of the contributions he has made to our knowledge of the Mongoloid peoples of Asia, of the inhabitants of Abyssinia, and of the primitive cultures of Africa. In the present imposing book he appears as the author of a work on systematic anthropology. He has here attempted to do two quite separate things: to give a systematic account of the living races of mankind—of which he distinguishes twenty—and at the same time to apply a new theory to explain the origin of human races. The theory of evolution which he applies is that formulated by Prof. Rosa of Modêna in 1918 and named by its originator 'ologenesi' (holos, entire). We think the author would have done much better to have written two books—one for the exposition of the theory he has adopted, and utilised the other for his valuable data and charts relating to the descriptive ethnology of mankind. In brief, the theory is the weakest part of Dr. Montandon's book, and many anthropologists may turn away before they reach the really valuable chapters. We also think that the earlier chapters, which attempt to trace the origin of the earth and of life, might well have been omitted.

After citing the various theories which have been formulated to explain the origin of new species—Lamarckism, Darwinism, neo-Lamarckism, neo-Darwinism, mutationism, etc.—the author rejects them all in favour of Rosa's 'ologénisme', and proceeds to apply this theory to explain the facts of human evolution. It is not necessary to enumerate all the postulates of his theory; they are numerous and arbitrary. We need only mention two or three which are essential to understand its application to a race of human beings. The theory presumes that every man, woman, and child of a race is 'wound-up', so that all, after passing through a certain number of generations, will arrive at a critical or maturation stage. On this stage being reached the whole species divides, half of the individuals being changed into one kind of race, the other moiety into another. Races 'unwind' and reach critical stages at different rates—some rapidly, others slowly—so that a backward race may be a true cousin of another which is highly advanced. The theory is determinist in nature, but environment, habit, and competition are operative and modify the result. Races have also arisen by hybridisation. Further, as mankind is and has been distributed over wide areas of the world for long geological epochs, each area being the scene of independent advance, it is foolish to speak of, or search for, a limited area of origin or cradle for mankind. Under this theory a new race appears at the same time over a wide area.

In a brief notice such as this, it is impossible to give a full exposition of Dr. Montandon's ideas, but enough has been stated to place the reader in possession of their trend. Their practical application, even in Dr. Montandon's hands, requires a considerable degree of constraint to make facts fit with expectation. On the other hand, the author never shirks facts; he has searched all the latest literature dealing with blood reactions, immunity, etc., and sought to fit them into his scheme. Indeed, the book is a valuable repository of fact, even if the theory of 'ologénisme' proves to have little or no permanent value.

Chemistry and Physics of Sea Water.

Biological Chemistry and Physics of Sea Water. By H. W. Harvey. (Cambridge Comparative Physiology Series.) Pp. x + 194. (Cambridge: At the University Press, 1928.) 10*s.* 6*d.* net.

THIS book deals with the particular chemical and physical conditions in the sea which appear to be most important in affecting the growth of plants and animals. The author reviews the results of researches subsequent to the publication of Krümmel's "Handbuch der Oceanographie" in 1911. Since H.M.S. *Challenger* led the way in 1872, there has been a steady increase in the number of vessels investigating the high seas, while at the same time marine biological stations established in increasing numbers in different countries have investigated the conditions in coastal waters. The combination of a laboratory on shore with a small sea-going vessel has proved particularly fruitful, and provides the author with much of the material for this book.

Chapter i. gives a brief summary of the general physiology of marine organisms, the factors controlling photosynthesis, and the relation of the

animals to changes in oxygen tension, temperature, and light. The part played by the so-called dissolved organic matter is still obscure, but it is probably important. Chapter ii. deals with the chemical composition of the water, the dissolved salts and gases, and the hydrogen ion concentration. Practical details for the estimation of the more important substances are given. There is an interesting table of the elements occurring only in minute traces in the sea, of which there is a large number. Many of these rare substances are extracted from the water by the organisms, and they may assist or even replace related substances in metabolic processes, as copper replaces iron in the respiratory pigments of the Crustacea.

Recent work on the supply of food materials for the phytoplankton has shown that the nitrates and phosphates are formed in the deeper layers and are brought to the surface by currents. This dependence of the phytoplankton (and of course ultimately all the plankton, great and small) on currents leads to considerable space being devoted to water movements. The understanding of these movements is facilitated by a number of clear diagrams. A short account is given of the recent work of Bjerknes and Sandström on the mathematical treatment of currents. Chapter iv. deals with the gain and loss of heat by the water and with the currents, which are largely responsible for the vagaries of temperature that are found in many places. The study of the distribution of temperature with depth shows that in summer a layer of warmer water from 10 to 50 metres in depth overlies a layer of colder water, there being a difference of temperature of several degrees between the two. This condition, which occurs regularly in the summer in lakes in temperate regions, has only recently been noticed in the sea, although many of the old temperature records show it quite clearly. The difference in density between the two layers prevents them mixing freely, and so prevents the phosphates and nitrates formed in the deeper water from reaching the surface where they can be utilised by the plants. A prolonged period of fine weather in summer may therefore cut off the food supply of the phytoplankton.

Chapter v. deals with the colour and the penetration of light into sea water. There is here a considerable field for experimental work, apart from that on photosynthesis, on the effects on marine organisms of light of different wave-lengths. Chapter vi. concludes with a brief review of factors influencing the fertility of the sea and its fluctuations. Here we are no nearer the solution than we are to solving the problem of the fertility of the soil, and one of the greatest difficulties in the way is that we know so little of bacterial activity.

The author has succeeded in presenting the reader with a clear review of the present position of the study of the physical environment in which marine organisms live. There is a list of references to recent literature at the end of each chapter, which adds to the value of the book. It can be recommended to all who are interested in the sea, and particularly to those who are studying the physiology of its inhabitants.

Our Bookshelf.

Lehrbuch der Experimentalzoologie : Experimentelle Entwicklungslehre der Tiere. Von Prof. Dr. Bernhard Dürken. Zweite Auflage. Teil 1. Pp. 320. Teil 2 (Schluss). Pp. xii + 321-782. (Berlin : Gebrüder Borntraeger, 1928.) 51 gold marks.

In his first few pages the author of this book defines very accurately the scope of the subject with which he deals. It is to include all branches of the analytical study of development in the animal organism considered as a whole, but not that of its parts considered separately. In the book he therefore discusses heredity, fertilisation, and the differentiation of specific form. He does not deal with the growth of the body in size. Having so defined his subject, he proceeds to name it " Experimental Zoology ". The use of this title is open to objection from many points of view. In the first place, it is not descriptive. The experimental method is now used, or is coming to be used, in all branches of the science, wherever its use is effective. Its use is certainly as characteristic of many other branches as it is of the subject of this book. But a more important objection is that a classification of a science by the methods used in its various branches must always be unsound. In zoology this type of classification has been widely used and owes its origin to the history of the science. To speak of experimental zoology to-day in the sense of the author of this book, or in any similar sense, is an anachronism. It would surely be better to allow the term to fall into disuse and to name all the subdivisions of the science according to the subject matter of each. It would not be difficult to choose such a title for the subject of this book.

Probably the chapters which deal with the experimental study of differentiation will be of most use to biologists outside Germany. This is a subject which German biologists have made particularly their own, and a good summary of their recent work upon it was needed. This need the book seems to supply. The other parts of the subject have been more frequently summarised, and the account given here is often short and sometimes incomplete. In particular, only some of the aspects of fertilisation are discussed, and a theory is put forward in regard to it with which by no means all workers upon the subject will agree.

It is perhaps not surprising that the examples

quoted are largely results obtained by German workers. Numerous examples could be given in which work of apparently equal or greater importance by other biologists is not discussed. In other respects the second edition of the book appears to have been brought up-to-date. It should be useful to biologists in Great Britain.

A Laboratory Manual of Elementary Physical Chemistry. By Prof. Edward Mack, Jr., and Prof. Wesley G. France. Pp. xi+195. (New York: D. Van Nostrand Co.; London: Macmillan and Co., Ltd., 1928.) 8*s.* 6*d.* net.

THE laboratory manual of Profs. Mack and France begins with three theoretical "Exercises", dealing with units and dimensions, significant figures, and errors of experiment, respectively. These are followed by a series of thirty-five experiments, of which two are concerned with determinations of molecular weights in solution, two more with conductivities and transport numbers, two with the preparation of a standard cell and the study of a concentration cell, whilst the hydrogen electrode and indicators form the subject of two more experiments in the electrical section of the book. These experiments provide adequate samples of measurements of those properties of dilute solutions of electrolytes which have occupied such a prominent position in physico-chemical literature during the past forty years, but they leave room for an exceptionally large proportion of experiments with gases and liquids other than dilute solutions.

The course is therefore exceptionally well-balanced, and can be recommended on account of its progressive outlook. The text dealing with the individual experiments is well written, and is presented in an attractive form. The manual is a competent and trustworthy guide for a laboratory course of thirty-six periods, and would serve as a good preparation for more advanced work in physical chemistry.

The Year-Book of the Scientific and Learned Societies of Great Britain and Ireland: a Record of Work done in Science, Literature, and Art during the Session 1927–1928 by numerous Societies and Government Institutions. Compiled from Official Sources. Forty-fifth Annual Issue. Pp. vii+420. (London: Charles Griffin and Co., Ltd., 1929.) 18*s.* net.

A NOTE of warning is sounded in the preface to the new issue of this valuable annual. The publishers state that for some years past "the heavy cost of production has been altogether out of proportion to the sales", and that although they are anxious to continue their part, they cannot do so without more support.

As usual, the societies included are grouped in fourteen sections according to the subject of their activities. Societies with London headquarters come first, followed by provincial, Scottish, and Irish societies. In each case the address, officers, and particulars of meetings, membership, and publications are given, followed by a list of papers read during the session 1927–28. Incidentally, it is remarked that in future, only papers which are published are to be included, so that the Year-Book will be an index of published work, and as such alone the volume must be of considerable service. Government departments such as the National Physical Laboratory are included in their appropriate sections.

The thanks of scientific workers generally are due to the officials of the societies who have co-operated with the publishers in making the Year-Book not only available but also authoritative. We hope with the publishers that sufficient sales will be forthcoming to make possible the continuance of this useful reference book.

Preparation of Scientific and Technical Papers. By Prof. Sam F. Trelease and Emma Sarepta Yule. Pp. 117. (London: Baillière, Tindall and Cox, 1927.) 7*s.* net.

IF every beginner, and some experienced transgressors, were to digest the contents of this little book before again attempting to place on printed record the method and results of a scientific investigation, critics of the quality of such contributions to literature would in large measure be deprived of illustrative material, of which there is at present no lack. Indeed, had the advice which the authors offer been less well founded, and their specific directions less generally acceptable than is in fact the case, they would still have rendered notable service in emphasising the importance in such matters of clear and logical presentation, of attention to detail, and of a reasonable measure of uniformity. Thus, whilst there may be two opinions concerning some of the individual instructions, there can be one only concerning the value of the book as a whole. The subject matter deals concisely with the arrangement of a paper and its preparation for the press, and the attention which is afterwards required of the author; it includes a description of methods of citation, abbreviation, tabulation, and illustration. Editors and readers of scientific literature will agree that there was room—on many a shelf—for such a book. A. A. E.

A Classbook of Practical Chemistry. First Year. By J. Morris. Pp. viii+103. (London: Methuen and Co., Ltd., 1928.) 2*s.*

THIS book is intended for pupils commencing the study of chemistry. A new feature is that the directions for carrying out experiments are given on the left-hand pages, while the results are described on the right-hand pages, and the author suggests that "by the adoption of some simple method of covering, the right-hand page is completely hidden during practical work". The success of such a scheme must depend largely upon the teacher and upon the age of the pupils. The instructions for carrying out experiments are simple and clear, but the scope of the book might with advantage have been slightly extended to include such experiments as the preparation of hydrogen and nitrous oxide. The melting and boiling points of sulphur are given as 115° C. and 448° C. instead of 112·8° C. and 444° C. respectively. The equation for the reaction of magnesium with carbon dioxide (p. 39) is incorrect.

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.*]

Ozone Absorption during Long Arctic Night.

IN NATURE of April 27, p. 644, Prof. R. W. Wood again raises the hopes of astronomers that it may be possible to obtain an extension of the ultra-violet spectra of the sun or stars by going to a station near the pole at the end of the winter. He assumes—as most people have done—that the ozone in the atmosphere is formed by ultra-violet radiation from the sun, and since it is the absorption by ozone which causes the abrupt extinction of stellar spectra at about 3000 A., he naturally concludes that this absorption would be least where the upper atmosphere has had least sunlight.

I fear that it is necessary to dash any such hopes of astronomers, and possibly this note may save someone from the discomforts involved in a fruitless expedition to high latitudes in the winter. We have now, by the kindness of a number of helpers, a series of observations extending over many months at twelve stations, ranging in latitude from 70° N. to 45° S. These observations are quite regular and consistent, and show that the lowest ozone values are found in tropical regions at any time of the year, while the highest ozone values are found in high latitudes in spring. In the tropics there is practically no annual variation, but in high latitudes the annual variation is very large (the maximum amount of ozone is about twice the minimum amount), the maximum being in spring and the minimum being in autumn. The autumn values in high latitudes are nearly as low as those in the tropics, so that while in the spring hemisphere the amount of ozone increases rapidly from the tropics to the pole, in the autumn hemisphere the amount of ozone is nearly constant at all latitudes.

These results are, of course, quite inconsistent with the suggestion that the ozone is formed by ultra-violet radiation from the sun. The shortest wave-lengths from the sun will undoubtedly form ozone, but the longer waves which are strongly absorbed by ozone will decompose it. As there is so much more energy in the band of longer wave-length, it is not surprising that the equilibrium amount of ozone, when the atmosphere is subjected to both wave-lengths, should be very small. What forms the ozone is not, at present, certain, but the connexion found between the amount of ozone and magnetic disturbance might suggest some action associated with the aurora, though occurring lower down (the ozone appears to be at a height of about 40 to 50 km., while the minimum height of the visible aurora is about 90 km.). Whatever the action forming ozone, it is clear that the equilibrium amount due to sunlight is always smaller than the amount actually present, so that the sunlight tends to reduce this amount.

If astronomers wish to get spectra extending as far as possible into the ultra-violet, they should go to the tropics, or should choose days in temperate regions during the autumn with anticyclonic conditions and a tropical air current above, as under these conditions the amount of ozone is as low in temperate regions as in the tropics.

G. M. B. DOBSON.

Boars' Hill, Oxford, April 27.

Thyroid and Temperature in Cold-blooded Vertebrates.

THE thyroid is well known to be concerned with temperature regulation in homothermic animals. It seems, however, also to have a somewhat analogous function in cold-blooded forms. In an experiment undertaken to investigate the temperature coefficient of metamorphosis, a number of sets of half-grown *Rana temporaria* tadpoles, after all being exposed to the same concentration of filtered thyroid suspension in water for the same length of time, were placed at various temperatures from 3° to 30° C. The thyroid dosage was moderate, sufficient to produce metamorphosis in about a week at room temperature.

As expected, temperature exerted a marked effect on metamorphic rate. Those exposed to temperatures below 5° C., however, provided a surprise. After showing a certain degree of change, they proceeded no further in metamorphosis. Even when removed to room temperature, they continued indefinitely in this half-and-half condition, as shown in the photograph (Fig. 1), taken several weeks after removal.

That permanent intermediate conditions between larva and adult could be obtained in urodeles was already known from the work of Jensen and others on axolotls. This is, I believe, the first case in Anura. It confirms the view that metamorphosis is not an all-or-nothing reaction. The relation to temperature, however, is what especially concerns us here. The half-and-half state can only be interpreted as follows: (1) the treatment with thyroid *ab extra* causes a marked compensatory reduction in the animal's own thyroid (a fact well known in amphibian experiments); (2) some of the effect of the thyroid dose, which causes rapid metamorphosis at higher temperatures, is here used up in counteracting the effect of low temperature instead of in producing metamorphosis.

FIG. 1.

Something of the same sort can be deduced from other work, such as that of Adler, who found that in untreated tadpoles high temperature caused regression of the thyroid, low temperature hypertrophy, both in growth and functional activity.

The conclusion appears to be justified that in tadpoles the thyroid is acting as a primitive temperature-regulator, or rather as a *temperature-buffer*. The metabolism of tadpoles is lower in the cold than in the hot; but thanks to the thyroid's hypertrophy in the cold and regression in the hot, and to the fact that thyroid secretion increases metabolism, the difference is not so great as it would be without a thyroid. On this view, the temperature coefficient of oxygen consumption and other metabolic activities should be greater in thyroidless than in normal tadpoles. It would be of great interest for anyone who has command of the technique of thyroidectomy in frog embryos to put this deduction to the test.

JULIAN S. HUXLEY.

King's College, London, W.C.2.

Mimicry.

IN NATURE of April 27 there appears an article on mimicry by Dr. Hale Carpenter, of Uganda, in which he pays me the compliment of quoting extensively from an essay of mine on evolution which appeared in the volume "Evolution in the Light of Modern Knowledge". In Dr. Carpenter's article he asserts

that 'natural selection' affords the only satisfactory explanation of mimicry, and he criticises the tentative explanation which I put forward.

I quite freely admit that I am unable to give an explanation of the numerous facts adduced by Dr. Carpenter. To do so would require years of original work in each locality; the environment, both physical and biological, would have to be thoroughly analysed in each case, which notoriously has not been done. We should have to account for the fact that in some cases the supposed model is rare and the mimic far more numerous, and we should have to deal with the distressing circumstance that evidence for serious attack by birds on butterflies in the adult condition is sadly lacking. Bergh in his "Nomogenesis" states that only one example of this was known to him, and that was in Ceylon, where the bee-eaters (Meropidæ) devour large numbers of the supposedly distasteful Danaidæ!

Of one thing, however, I am certain, and that is that 'natural selection' affords no explanation of mimicry or of any other form of evolution. It means nothing more than 'the survivors survive'. Why do certain individuals survive? Because they are the fittest. How do we know that they are the fittest? Because they survive. Is not this a mere form of words, just as deserving of condemnation as the phrase 'the Will of God' used by Darwin's theological opponents?

That more young are born than can survive was known to Lamarck, and is explicitly set forth in his "Zoological Philosophy", but he did not make the mistake of supposing that the killing of James can affect the qualities of Tom. Put in other words, natural selection can only 'select' what is already there, and the real problem for science is how 'what is there' came into existence. Towards the solution of this problem, so far as it affects the wing colours of butterflies, very little has as yet been done; nevertheless, a beginning has been made. Sir Frederick Gowland Hopkins has shown that uric acid forms the white background in the wings of Pieridæ, and my friend, Dr. D. L. Thomson, now lecturer on bio-chemistry in McGill University, Montreal, has shown that in another family the colour of the background is due to a substance in the plant on which the larva feeds. Only along such lines as these will the problem of animal coloration be solved.

When the school to which Dr. Carpenter apparently belongs are asked how the variations which are 'selected' originate, their only answer is 'chance', and 'chance' as an explanation of a regularly recurring biological phenomenon does not commend itself to me.

E. W. MACBRIDE.
Imperial College of Science,
South Kensington, S.W.7.

DR. HALE CARPENTER in his article on mimicry (NATURE, April 27) mentions that it is held by many as an objection to the theory of the evolution of mimetic forms by natural selection that the mimic must be mistaken by the predatory animal for its model, if the resemblance is to be of any use to it, and that therefore slight resemblances will be useless, and the evolution of the perfected resemblance unintelligible. This difficulty, he suggests, may be removed by the consideration that the mimic need only *remind* the enemy of its model to set up a repulsion in its mind and so escape. He instances our repulsion to a worm, which he attributes to its resemblance in form to a snake, for which we have an ancestral repulsion.

Is this necessary? Does not the objection in any case rest upon far too anthropomorphic a conception of the animal mind? Psychologists tell us that the animal may be regarded for practical purposes as unreasoning in everyday life. If this is so, the mental processes of an animal such as a bird in searching for its prey will be very different from ours in looking for an object. We, as we examine the bark of a tree for an insect, are continually comparing the form of each piece of bark with that of the insect, and considering whether it is bark or insect. The bird will not consider; its glance will pass over the bark, often slowly and with *apparent* care, until some object, by its resemblance to the remembered picture of the insect, starts the feeding reaction. There is no conscious comparison; the stimulus is received and the reaction follows instinctively. To protect the insect, its resemblance to the bark need only be sufficient to keep the stimulus, when the bird's glance lights upon it, below the threshold value for the reaction.

Protective resemblance and mimicry are here entirely parallel. The probability of stirring up the feeding reaction will be less the more perfect is the resemblance either to an inedible animal or to an inanimate object, but it seems that a very slight resemblance may often be effective. We know how readily we may mistake objects at a first glance, especially when our minds are inactive, for others to which they have only a slight resemblance. A man, waking from sleep, may mistake clothes thrown over a chair for a person in his bedroom. A second glance, always accompanied by thought and comparison, shows him his mistake, but for the animal there is no such thought and comparison. Hudson ("Birds and Man", Dent, 1923, pp. 46-8) has an account of an incident in which he was mobbed at dusk by a flock of goldcrests, and later by another of swallows and house-martins in full daylight. The behaviour of birds was due, as he afterwards showed, to the resemblance of the colour of his cap to that of the fur of a cat. The acuteness of the vision of the predatory animal only enters indirectly into the problem. The bird's vision may be easily acute enough to distinguish the differences between the mimic and its model, just as the swallows could certainly have appreciated the difference in form between the cap and the cat. Yet the differences may be unperceived and the resemblance effective, even when it is slight. These considerations seem to remove the difficulty, felt by many, in the evolution of mimicry and protective resemblance from beginnings which must have been very imperfect.

G. S. CARTER.
Zoological Department,
University of Glasgow.

Anomalous After-Effect with Quartz.

THE true and the apparent resistivities of some dielectrics have been found by S. W. Richardson (*Proc. Roy. Soc.*, A, **92**; 1916; **107**; 1925), one of the writers (the paper is now in the press at the Tôhoku Imperial University), and others. The apparent resistivity of quartz under a certain constant applied potential increases rapidly with time and then gradually tends to a saturation value after about 30 minutes for quartz plate cut perpendicular to its optical axis. (The resistivity is measured by conducting charge through dielectrics under various applied potentials, and the time means the duration of the application of a constant potential.)

It may be expected from the paper of one of the writers (*Sci. Rep. Tôhoku Imper. Univer.*, **10**, 101; 1921) that the apparent resistivity will show some anomaly for applied potential which increases beyond the 'limit potential'. Thus, we found an anomalous after-

effect on the apparent resistivity of quartz plate cut perpendicular to its optical axis. First, we put a known potential on the quartz during a constant time interval (always 10 minutes); in this time interval the quartz is made to conduct the electric charge freely, and it is connected to earth during a known time interval; then putting on a known potential, the accumulated charge due to conduction is measured during a known time interval; in this case the ap-

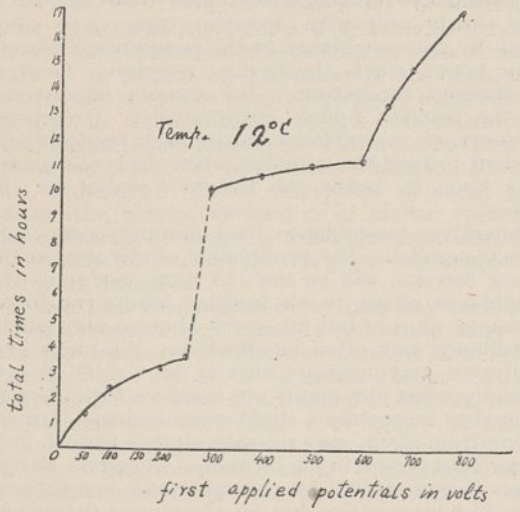

FIG. 1.

parent resistivity is much smaller than that of the quartz in neutral state. Next, it is earthed until the residual charge and the time effect due to the latter potential have completely disappeared, and then the measurement of the apparent resistivity is made under the same external conditions as the above during a known time interval, and then it is earthed; in this case the apparent resistivity is a little larger than that of the first, but yet smaller than that of neutral state.

The measurement and earthing as above are

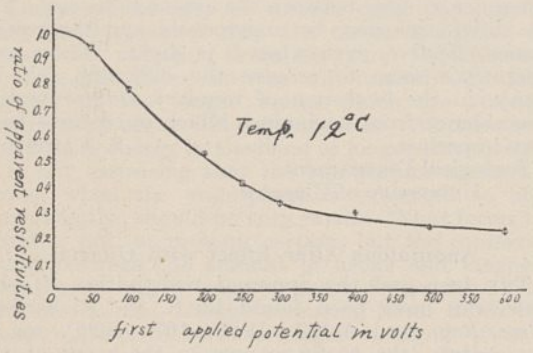

FIG. 2.

repeated until the effect of the first applied potential disappears. The variation of this total time interval for the first applied potential which affects the apparent resistivity as an after-effect is given in Fig. 1. The potential for measuring the apparent resistivity is always 50 volts. The temperature of the quartz is always kept at 12° C. As shown in Fig. 1, the time interval during which the after-effect exists increases slightly with the potential and is discontinuously increased at the potential between 300-350 volts per mm. thickness (250-300 volts for actual thickness), and again slowly increases, and from about 700 volts per mm. thickness (600 volts for actual thickness) it increases rapidly, and it seems that it gradually tends to a saturated state. In the paper of one of the writers above referred to, the limit potential is most important for dielectrics, and for quartz is equal to 324 volts per mm. thickness as the mean value from the residual charge and time effect. Thus it can be concluded that the anomalous after-effect appears at the limit potential.

Fig. 2 shows the variation of the ratio of the apparent resistivities at 5 minutes after the first earthing and the neutral state, with respect to the first applied potentials; the rate of decrease of the apparent resistivity increases rapidly in the neighbourhood of the limit potential and then gradually tends to a saturation value.

The decrease of the apparent resistivity and the appearance of the anomaly are exactly the same in both cases; the first applied potentials are positive and negative, and the after-effect depends simply on the absolute value of the first applied potentials. Hence it seems to us that this anomalous after-effect is probably due to some property of the atomic lattice of quartz.

H. SAEGUSA.
S. SHIMIZU.

Institute of Physics,
Tôhoku Imperial University, Sendai,
Mar. 2.

Plasticity and Water Absorption of Clays.

IN spite of the cause of the plasticity of clays having been the subject of much speculation, no generally accepted theory appears to have been developed. The following measurements of water absorption and some other properties of clays throw further light on the problem and appear to me to be of general interest in the theory of the properties of colloids.

The 'water absorbed' was measured by determining the increase in concentration in chloride ions which occurred when the clay, dried at 100°, was added to a standard solution of the chloride of the base with

TABLE I.

CLAY FROM HEAVY COTTON SOIL NO. 38724.

Base in Clay.	Water absorbed from Chloride Solutions per 100 gm. of Clay.		Plasticity Number.	Relative Hardness.	Bulk Density.
	N	*N*/10			
Li	18·4	46·5	82	92	2·12
Na	12·8	34·4	60	85	2·07
Mg	10·4	17·4	56	82	2·01
Ca	8·3	16·8	42	57	1·80
NH_4	5·2	15·4	22	6	1·70
K	2·7	15·1	22	1	1·45
H	..	5·3	20	0	1·65

which the clay was saturated, it having been proved by various workers that clay does not absorb the chlorine ion. Five grams of clay were usually added to 10 c.c. of solution; after centrifuging, the weighed decanted liquid was titrated with silver nitrate solution. This method of 'negative absorption' seems to have been strangely neglected in the study of the water affinity of colloids in spite of its use by McBain in the study of soaps, and by Gaunt and Francis for silica, and ferric, and aluminium hydroxide gels (*Trans. Faraday Society*, **24**, 32; 1928). The other three properties tabulated were determined on the soil which contained 60 per cent of clay. The relative 'hardness' figures represent the percentage material which failed to be powdered after a standard shaking treatment of dried pellets of each material. The Atterberg

plasticity number represents the range of percentage water content over which the soil remains plastic.

This direct demonstration of the lyophilic series correlates nearly perfectly with the other properties tabulated. Preliminary counts in an ultra-microscope of the number of particles per gram of clay seem to indicate that the ultimate dispersion of these clays will also follow the order of hydration, but it should be emphasised that this is not the same as the order of the flocculating concentrations of the different clays by the chlorides of the respective bases.

These figures show clearly how the properties of one clay with different bases follow the water absorption of the clay; Table II. shows in a preliminary way how the plasticity of different clays with the same base (sodium) also follows the water absorption. The properties of some of these clays have been described by Joseph and Oakley (*Jour. Agr. Science*, **19**, 121; 1929).

TABLE II.

Clay from—	SiO_2/Al_2O_3.	Water absorbed from $N/10$ NaCl by 100 gm. Clay.	Plasticity Number of Soil.	Clay (per cent in Soil).
Bentonite	7	41·8	441	91
38724 . .	4·0	31·3	60	62
30100/1 .	3·7	28·5	56	74
29933/4 .	2·7	26·6	37	57
13107 . .	2·4	18·5	20	80
Amorphous silica .	..	15·1	about 1	..
Kaolin 10096 .	2·0	3·0	about 1	about 64

Although the clay contents of the soils are not comparable, the influence of the composition and hydration of the clays is still sufficient to determine the plasticity. This is particularly striking in the low plasticity of No. 13107. This soil contains 80 per cent of a clay which, as shown by the ultra-microscope, contains more than twice as many particles as No. 38724. It is evident that although the fineness of a clay may be a factor in its plasticity, the water affinity is more important.

Finally, the water absorbed by a clay is greatly influenced by the concentration of the reference salt used in the solution. This is presumably an osmotic effect. Below is shown the effect of different concentrations of sodium chloride on the water absorbed by sodium 'saturated' clay No. 38724.

Dilution of NaCl (litres) . .	0·2	1	10	25	50	125
Water absorbed per 100 gm. dry clay	6·7	12·8	34·4	49·0	80·0	102

In keeping with this change in absorbed water the plasticity number fell 13 units when normal sodium chloride solution was used instead of pure water. Experiments at higher dilutions are rendered difficult by the deflocculation of the clay. At present it is impossible to decide whether this phenomenon of water absorption is due to imbibition by hypothetical gels in the clay or to a kind of polar absorption round each clay particle as postulated by Hatschek for other colloids (*Jour. Phys. Chem.*, **31**, 383; 1927) and others (Weisner and Cunningham, *Jour. Phys. Chem.*, **33**, 312; 1929). In view of the increase of dispersion with hydration observed in the ultra-microscope and the impossibility of separating a clay into two fractions of markedly different properties, I incline to the latter view.

H. B. OAKLEY.

Wellcome Tropical Research Laboratories,
Khartoum, April 7.

Co-education.

IN NATURE of April 13, I note an article which seems to me to maintain the thesis that co-education in the medical schools of London is undesirable because its prevalence would interfere with the efficiency and success of the London School of Medicine for Women. I would suggest that your brief against co-education is carried considerably farther than the highest authorities at the London School of Medicine for Women really desire, if one may judge from a letter to the *Nation and Athenæum*, written by Sir Francis Acland, the chairman of that School, dated April 9. In that letter Sir Francis expresses a pained surprise at my suggestion that the London School of Medicine for Women objects to co-education. He declares: "All the evidence given by the School before the Committee" (that is, the recent University Committee) "was in favour of co-educational facilities, and we have always welcomed every extension of it." The 'quota' system, which is condemned in NATURE, was first suggested by the Professorial Board of University College in 1915, since which date University College Hospital has taken a quota of twelve female students annually, and the system has worked with complete success.

You ask why the recent University Committee, appointed on the motion of Mr. Walter Spencer and myself, should have declared that there was a "prepossession in favour of co-education in the University". The reason is probably to be found in the report of a previous University committee in 1915, which had investigated this very question of medical co-education at the men's schools of London. That report was overwhelmingly in favour of co-education as a principle. It is significant that the large majority of women's societies have taken the view that co-education should be practised in the medical schools of the University of London as it is practised in provincial universities.

E. GRAHAM LITTLE.

House of Commons, S.W.1, April 18.

DR. GRAHAM LITTLE is well known as a champion of medical co-education, and we print his letter on the subject with pleasure. The article in NATURE was not intended to indicate any general objection to co-education, but we suggested that the question of medical co-education in London constitutes a special problem since a well-organised system of unisexual medical schools is already in existence. Conditions in 1915 during the War were quite exceptional, and the view then taken on the question of medical co-education cannot be regarded as binding the University. We retain our dislike of the 'quota' system, notwithstanding Dr. Graham Little's interesting evidence as to its origin and working.

THE EDITOR.

Active Nitrogen.

THE recent analysis of the band spectrum of nitrogen in the Schumann region by Profs. R. T. Birge and J. J. Hopfield (*Astro. Jour.*, **68**, p. 274; 1928) throws a flood of light on the identity of active nitrogen. It has been shown that the bands in the Schumann region have nothing in common with the bands in the visible and the ultra-violet. The presence of a strong metastable level in the N_2-molecule has thus been established, and is in accord with the electronic level scheme of R. S. Mulliken (*Phys. Rev.*, **32**, p. 216; 1928).

That active nitrogen is a molecule of nitrogen in this metastable condition is further supported by some recent experiments which we have carried out on the life of active nitrogen. This can be varied within wide and indefinite limits simply by the regulation of pressure, everything else remaining constant. For a short life of the order of 0·1 sec. the experiment is best performed by drawing our nitrogen at about 7 to 8 mm. pressure from a region of condensed discharge. For very low pressures, say 0·03 mm. of mercury, the active nitrogen is formed with an electrodeless discharge, and its life may be abnormally extended to several minutes. It has been clearly observed by us that for any given specimen of nitrogen the life of active nitrogen increases continuously and regularly with the decrease of pressure. This is a strong evidence for the presence of metastable molecules.

In another series of experiments we have produced the infra-red lines of nitrogen belonging to the electronic configurations $2L_2M_1 \leftarrow 2L_2M_2$ by exciting first nitrogen and then active nitrogen with uncondensed discharge under exactly identical conditions. No change in the relative intensity of lines was observed, which points to the conclusion that there is no appreciable density of atoms present in active nitrogen.

P. K. KICHLU.
S. BASU.

Department of Physics,
Science College, Patna, Mar. 27.

DR. KICHLU and Mr. Basu seem to have overlooked an early investigation (*Proc. Roy. Soc.*, A, vol. 86, p. 264), in which it is shown that a given sample of active nitrogen, made active at a low density by the electrodeless discharge, can, after intervals up to several minutes, be made momentarily very bright by compression.

This experiment seems to cover what Dr. Kichlu and Mr. Basu have observed, with the additional point that compression causes the active gas to give up its energy rapidly *in the form of light* (α bands).

This seems clearly to prove that collisions of some kind are the occasion of the emission of α bands (1st positive nitrogen bands).

I am not sure if I understand the views of the authors rightly. But the level which Mulliken concludes is metastable is the lower level concerned in the emission of the α bands. It is not clear to me how the metastability of this level helps us to understand how the gas remains for a long time loaded with the energy necessary for the emission of α bands, which involve a level several volts higher.

RAYLEIGH.
Terling Place,
Chelmsford, Essex, April 24.

Properties of the Terms of the Helium Molecule.

IF in a diatomic molecule the influence of the internuclear axis on the valence electron is strong compared with the influence of the nuclear rotation (case I.), the component σ, along that axis of the vector l representing the moment of momentum of the electron, is, as was shown by Hund, a whole multiple of $h/2\pi$, and the rotational energy is, apart from a constant, proportional to $j(j+1)$ (j = total moment of momentum of the molecule). If, on the other hand, the influence of the rotation is predominant (case II.), l is quantised with respect to the axis of rotation, and if its component along this axis is ρ, the rotational energy is proportional to $(j-\rho)(j-\rho+1)$. The energy in the intermediate case is a complicated function of j, and has been calculated approximately for simple cases by Hill and van Vleck (*Phys. Rev.*, **32**, p. 250; 1928).

Case I. is realised in most molecules. The electronic spin usually complicates the problem. In the helium band spectrum we can observe, as already shown in a qualitative way by Weizel (*Zeit. f. Phys.*, **52**, p. 175; 1928), all the different stages of transition between the cases I. and II. The terms which are produced by the different orientations of orbits with $l=2$ (δ-complex) are of special interest. The bands which originate from a combination of this complex with the $2p$-level show a very anomalous behaviour both with respect to the position of the lines and to their intensities. All their properties can, however, be understood, if one follows the transition from case I. to case II. The connexion between the theoretical and empirical term symbols and the values of σ and ρ is given below.

Term		$\pi\Sigma_b$	$\pi\Pi_a$	$\pi\Pi_b$	$\delta\Sigma_a$	$\delta\Pi_b$	$\delta\Pi_a$	$\delta\Delta_b$	$\delta\Delta_a$
Case I.		π_1	π_0	π_{-1}	δ_2	δ_1	δ_0	δ_{-1}	δ_{-2}
Case II.		..	p_a	p_b	z	x	y	d_b	d_a
Empirical designation		0	1	1	0	1	1	2	2
σ		1	0	−1	2	1	0	−1	−2
ρ									

The connexion of the Greek letters used in designating the terms with the values of l and σ is evident (Mulliken uses S, P, D instead of Σ, Π, Δ). In the He_2-molecule only the terms which are antisymmetric in the nuclei are present. They can only have odd values of $j-\rho$. Therefore, also in case I., j is odd for even values of ρ (index a) and even for odd ρ (index b).

In the 3δ-complex, case I. is realised for small values of j. This means we must use the σ-classification and have the normal type of transitions studied especially by Mulliken. We have here $\Sigma \rightarrow \Pi$, P-, Q-, and R-branches, $\Pi \rightarrow \Pi$ only P- and R-branches, and $\Delta \rightarrow \Pi$, P-, Q-, and R-branches. That is in exact agreement with the observations. For larger values of j the coupling of l with the internuclear axis becomes looser, which is shown by a shift in the energy levels and the appearance of Q-branches in the $\Pi \rightarrow \Pi$ band. At the same time the P-branch of the $\Sigma \rightarrow \Pi$ band disappears and the Q-branch becomes much weaker. The behaviour of the separate energy levels is represented by formulæ obtained in the same way as those of Hill and van Vleck.

The $2p$-4δ complex, which is also completely known, shows that the 4δ-terms are also for small values of j in the transition stage between cases I. and II. Whereas the energy of the separate terms becomes a complicated function of j, the theory shows that the mean values of δ_1 and δ_{-1} and those of δ_2, δ_0, and δ_{-2} behave like the energy of a $\sigma\Sigma$-term which can always be represented by a simple quadratic expression in j. That is in excellent agreement with the observations, and the molecular constants can easily be calculated in this way.

For the 5δ and 6δ complexes the observational data are not yet entirely complete. But the existing data show that stage II. is reached already for very small values of j. The anomalous energy values have disappeared. The nuclear moment of momentum is again an integration constant and ought therefore only to change 0 and ± 1 in a transition. That means that for the combination of a δ_ρ-term with the $2p$ level which is in stage I., we get the following branches:

Initial term	δ_2	δ_1	δ_0	δ_{-1}	δ_{-2}
Branches	R	R, Q	R, Q, P	Q, P	P
Appearance	P	Q, P	R, Q, P	R, Q	R

So far as the data permit this to be tested, it was found to be in agreement with the facts.

The transition stage of the π-terms is analogous, though much simpler, owing to the fact that there are only three of them, and because the one with $\sigma=1$

and $\rho = 0$ ($\pi\Pi_a$, the term which gives the Q-branches in the $s \rightarrow p$ bands) behaves like a $\sigma\Sigma$-term.

The constants $B = \frac{h}{8\pi^2 I}$ and A, which expresses the degree of coupling of the vector l to the internuclear axis, for the most important terms are :

	2π	3π	4π	3δ	4δ	Par 3δ
A	8890	2971	1482	165	75·06	132
B	7·336	7·173	7·130	7·072	7·088	7·079

For the degree of accuracy, way of calculating, etc., I must refer to the full paper which will be published elsewhere and will contain all the details. The ideas expressed in the present note have also proved fruitful for the understanding of the spectrum of the hydrogen molecule.

G. H. DIEKE.

Natuurkundig Laboratorium der
Rijks-Universiteit, Groningen.

Elastic Collisions of Electrons with Helium.

IN view of the recent experiments of Dymond and Watson on the scattering of electrons in helium (*Proc. Roy. Soc.*, vol. 122, p. 571), it has been of interest to work out the scattering predicted by the wave mechanics. The method used is that of Born (*Göttinger Nachrichten*, p. 146, 1926), and involves two separate approximations. In the first place, we neglect the polarisation of the atom by the incident

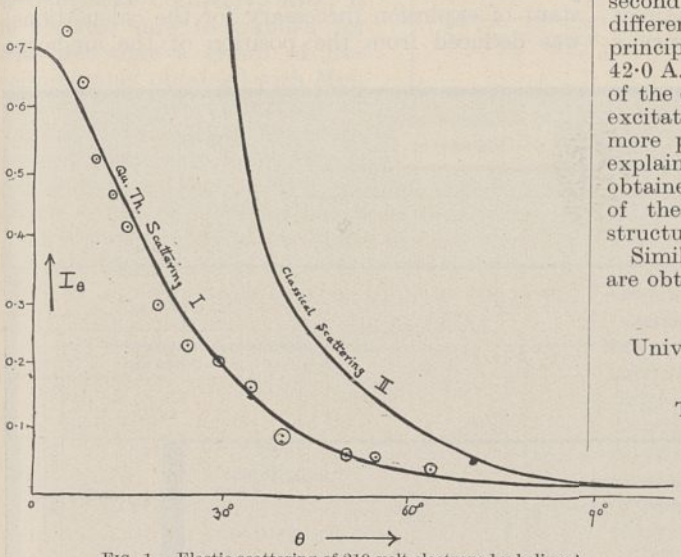

FIG. 1.—Elastic scattering of 210-volt electrons by helium. Experimental readings fitted at 30° are indicated by ⊙.

electron, the atom being treated as an electrostatic centre of force. We have used the field calculated for helium by Hartree (*Proc. Camb. Phil. Soc.*, vol. 24, p. 111). Secondly, we have calculated only the first approximation of Born, which is sufficient only if the de Broglie wave-length of the incident electrons is large compared to the classical distance of closest approach. Neither approximation will introduce a serious error if the energy of the incident electrons is large compared to the ionisation energy of the atom. For 200-volt electrons the error should not be greater than about 20 per cent.

Fig. 1 shows the variation of scattering with angle to be expected for elastic collisions with 210-volt electrons. I_ϑ is the scattering per unit solid angle. Curve I gives the quantum theory scattering, and curve II the classical scattering by the Hartree field of the atom. The two curves lie close together for large angles, where the scattering is mainly nuclear. For small angles there is a marked difference, the classical I_θ becoming infinite for θ equal to zero, as the following table suggests :

θ . . .	3·3°	5·7°	19°	30°	44°
I_θ (classical) .	190	54	2·1	0·81	0·26

It is not true, as is often stated, that the scattering integrated over all angles is the same both classically and on the quantum theory.

The results of Dymond give relative scattering only, and we have therefore fitted our curve and his readings at 30°. Considering the approximate nature of our calculations, the agreement is as good as can be expected. It is obvious that the experimental readings could not be fitted to the classical theory curve.

An account of these calculations will be published shortly, in which it is hoped to consider also inelastic collisions.

N. F. MOTT.

St. John's College, Cambridge.

Densitometric Measurements of the K-α Line of Carbon.

(BY CABLE.)

DENSITOMETRIC measurements of the K-α line of carbon in three orders obtained with a grating having twelve hundred lines per millimetre show distinct, clearly measurable separation of components in the second and third orders, wave-lengths checking in different orders and on different plates. There are four principal components in the main line at 44·2 A., 42·0 A., 45·4 A., and 46·15 A. The relative intensities of the components apparently depend on conditions of excitation, some of the longer components becoming more prominent at higher driving potentials, thus explaining the divergence of wave-length values obtained by other observers in the third order. Some of these components apparently have a doublet structure.

Similar but broad and more complex separations are obtained in boron K-α.

C. B. BAZZONI.
...FAUST.
...WEATHERBY.

University, Pennsylvania, April 24.

The Assembling of Male Moths due to the Sense of Smell.

DR. ERNEST WARREN, in his interesting letter published in NATURE of Feb. 23 (p. 278), suggests that the assembling of male moths around the female is evidence for the existence of "recondite influences". It is, however, clear that the flight of the males is stimulated and directed by air-borne odoriferous particles, which, however, have no effect upon the human olfactory sense. If a virgin female of certain moths, such as the Oak Egger, be carried in a closed box, males are not attracted, but they begin to assemble directly the cover is taken off. Furthermore, the box itself may continue to attract for some days after the female has been removed. Porous substances continue to be attractive longer than dense ones. Such 'assembling' males possess wide-spreading antennæ, adapted to comb the air during their rapid, characteristic flight, which is such as to test a large cross-section as they proceed. Some of the detailed evidence that the attraction is due to scent has been brought together in the *Proceedings of the Entomological Society of London*, vol. ii. 1927–28, pp. 75-82.

EDWARD B. POULTON.

Oxford, Mar. 29.

Physics in Relation to Oil Finding.[1]

By Prof. A. O. RANKINE.

IF a time-graph is plotted, with the intervals between the instant of explosion and that of *initial* disturbance of the seismograph as ordinates, and the distances between explosion and seismograph

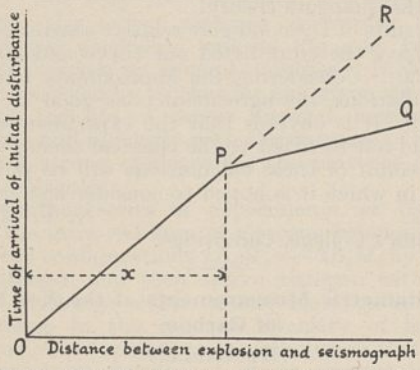

FIG. 2.—Time-distance graph corresponding to Fig. 1. x is the distance at which direct and indirect disturbances arrive synchronously.

as abscissæ as in Fig. 2, it will display a break (at P) where the times of arrival of direct and indirect disturbances are equal. Actually the distance x for time equality is related to the depth of the interface by the relation

$$\frac{h}{x} = \frac{1 - \sin\theta_c}{2\cos\theta_c}.$$

Moreover, the slope of OP, which corresponds to the direct disturbance, is proportional to $1/V_1$, while the slope PQ, which relates to the indirect disturbance, is proportional to $1/V_2$. Thus $\sin\theta_c = V_1/V_2 =$ (slope of PQ)/(slope of OP). Hence θ_c is determined, and its insertion in the above equation, together with the value of x read from the graph, enables the depth h of the interface to be calculated.

Owing to its relatively large magnitude, it is possible to recognise on the seismograms the arrival of the direct disturbance even when it reaches the seismograph *after* the indirect disturbance. This corresponds to the dotted portion PR of the curve, or OP produced.

This simple case is merely an illustration. Many others have been worked out, such as those corresponding to more than one stratum, sloping strata, or interfaces which abruptly change depth. To deal with these here would lead us too far. In all cases the procedure has to be the assumption of various possible underground structures until one is found which by calculation agrees with the time-graphs actually obtained. For this purpose it is frequently necessary to multiply observations by changing the position of the explosion point and the direction of the line of observation. The accumulation of field data over various structures also obviously facilitates the recognition of similar structures in subsequent surveys.

It is only possible to deal very briefly with field procedure. Where, as often happens, the salt-domes or limestone anticlines are deeply buried, large charges must be exploded because of the long ranges which must be covered to reach and pass beyond the point of time equality—an essential condition if the depth is to be determined. Consequently it is economical to multiply the number of seismographs used rather than the explosions. For celerity of survey the seismographs must be readily portable and easily set up in their new positions. In the early days of this work the instant of explosion (necessary for the calculations) was deduced from the position of the air-borne

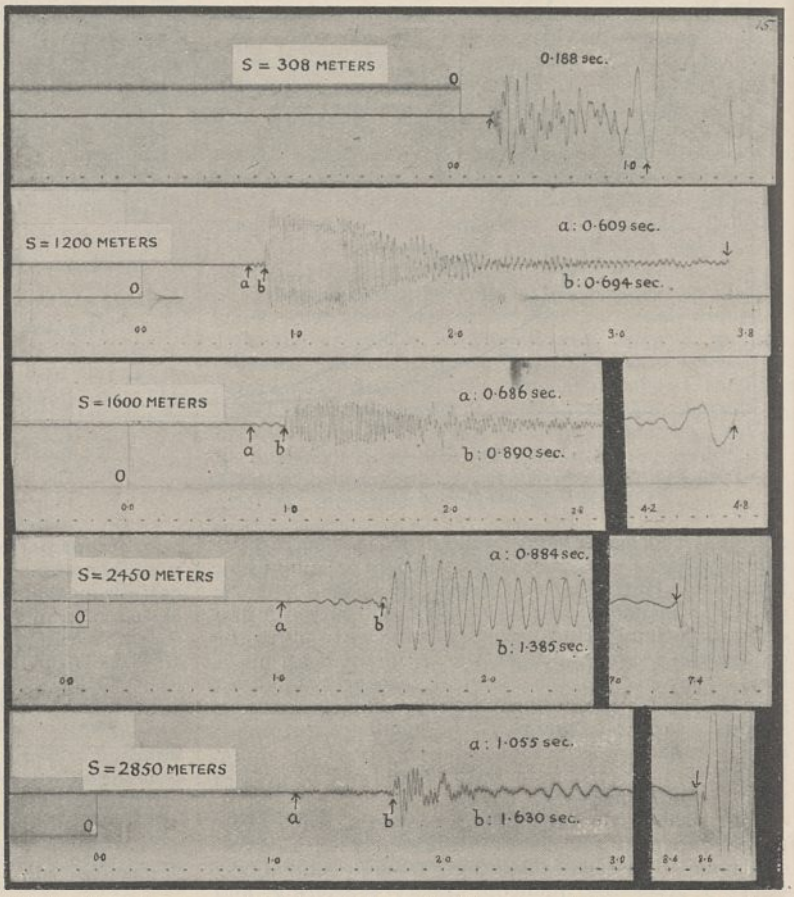

FIG. 3.—Five seismograms obtained on an observation line over a salt dome. Dots at bottom of each are made by time marker, interval being $\frac{1}{10}$ second.

[1] Continued from p. 686.

disturbance on the seismogram, assuming the value of the velocity of sound in air. This in practice is often the largest effect recorded, but it arrives much later than the earth-borne vibrations. This method, which is rather inaccurate on account of the wind and temperature corrections, has now been superseded by including with the recorder an oscillograph which places on the record a wireless signal actuated by the breaking of an electric circuit by the explosion itself. The recorder includes a time marker which enables the transmission times to be estimated with sufficient accuracy. Photographic recording is ordinarily used. I have seen a troop of observers of the Geophysical Company, Ltd., operating this system in the Anglo-Persian oil-fields, and have nothing but admiration for the celerity and efficiency with which the field work is carried out.

Through the courtesy of the Geophysical Company, Ltd., it is possible now to publish for the first time a group of five seismograms obtained with Mintrop seismographs (which record vertical movements of the earth's surface) over a salt-dome. These are shown in Fig. 3, and exhibit the various effects to which reference has been already made. Each shows (at the point *O*) the wireless signal of the explosion, and the final effect of the air-borne wave, in some cases so large as to make the detail

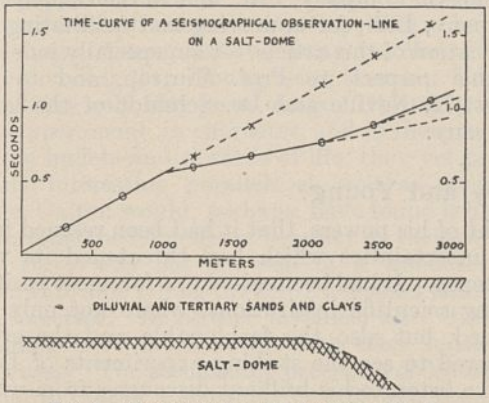

FIG. 4.—Time-distance graph corresponding to seismograms in Fig. 3.

of the trace invisible. In the last three records a piece has been cut out so as to bring this effect within the scope of the diagram. The earth-borne disturbance, which lies between the wireless signal and the air wave, changes in type as the distance is increased. The indirect disturbance, which is not visible in the first seismogram at 308 m., makes its first appearance in the second at 1200 m., as a small vibration preceding the much larger direct disturbance. In the next two, at 1600 m. and 2450 m., the time interval between the indirect and direct disturbance has increased progressively in magnitude, while in the last, at 2850 m., the time difference is approximately the same as in the one just previous.

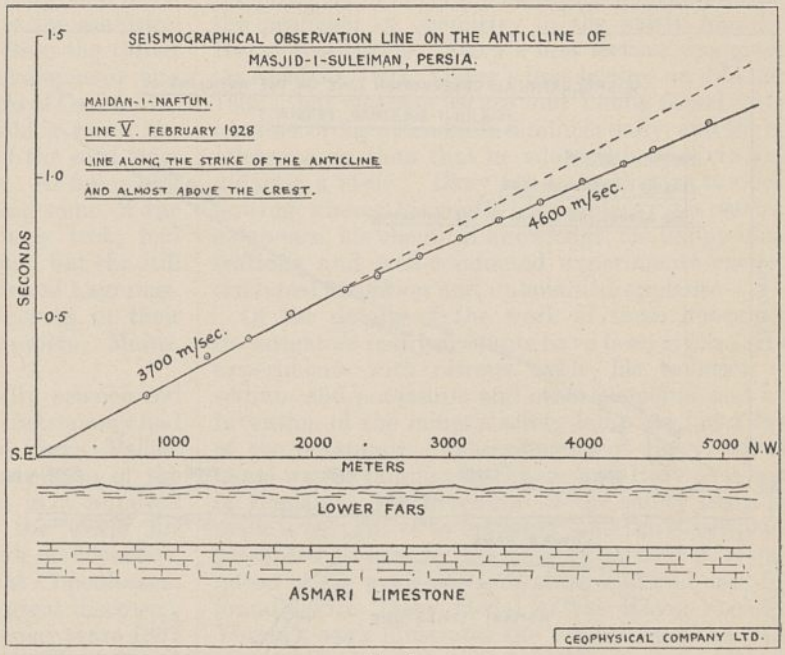

FIG. 5.

The time-graph in Fig. 4, which includes points from other seismograms besides those shown in Fig. 3, exhibits the results graphically. It shows unmistakably, at a range of about 1000 metres, a discontinuity of the kind mentioned in an earlier paragraph, and the two different slopes before and after this point. There is displayed besides the ultimate tendency of the curve to resume its initial slope—a feature known from theoretical considerations probably to signify a dipping of the interface. The depth, and roughly the shape and location of the edge of the salt-dome have thus been deducible, and are shown in the lower part of the diagram.

Time-graphs of the same general character relating to the great limestone anticline, from which most of the Anglo-Persian oil is at present drawn, are shown in Figs. 5 and 6. The survey in this region was carried out for the Anglo-Persian Oil Company, Ltd., by the Geophysical Company, Ltd., and really constituted a test of the efficacy of the seismic method over a region where the general features of the limestone structure were already known as a result of extensive drilling. Fig. 5 relates to a direction of observation parallel to the long axis of the anticline and Fig. 6 to a traverse across it. The conditions were much less favourable than over salt-domes, owing to the depth of the limestone and to the relatively small difference of velocity as between the limestone and the Lower Fars with which it is covered. This is indicated in the time-graphs by the smallness of the changes of

slope in the curves. Nevertheless, the method, which had previously been applied extensively and successfully to the location of salt-domes in Texas, proved of value in Persia also, the limestone depths being measured to an accuracy of 10 to 15 per cent. There are, therefore, good grounds for confidence that the surveys being carried out by the Geophysical Company, Ltd., on similar structures of unknown shape in other regions of Persia and in Iraq will provide the data required for successful drilling for oil.

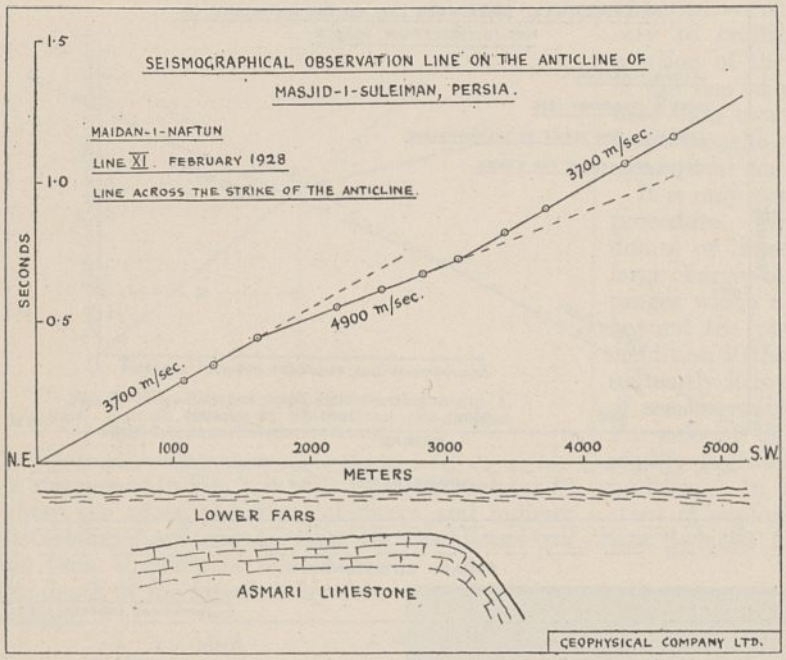

FIG. 6.

For descriptions of portable seismographs the reader must be referred elsewhere, for example to the recently published translation of Dr. Ambronn's book,[2] which contains the original references.

[2] "Elements of Geophysics." By Dr. Richard Ambronn, translated by Margaret C. Cobb. (London: McGraw-Hill Publishing Co., Ltd.)

Mintrop's seismograph, with which most of the seismic surveying has been done, is one in which the magnification of the earth's movement is secured partly mechanically and partly optically. There are others of the same type, notably Schweydar's, which records also horizontal movements. Another type employs electrical magnification, as in Dowling's and Ambronn's instruments. It is doubtful whether any of them imitates precisely the movements of the earth's surface, but so long as it is merely a question of determining the instant of first arrival of the disturbance, this is of no great importance. It is nevertheless worthy of note that the production of an exact recorder will open new lines of attack on the problem, such as the determination of the angles at which the disturbances arrive at the earth's surface.

Progress is being made in the gravimetric and seismic methods of survey, both as regards improvements of the instruments themselves and the technique of procedure in the field and in interpretation. In this matter Great Britain is much behind-hand; and it is hoped that this article may contribute to the stimulation of that interest which is essential to progress.

I desire to express my thanks to the Anglo-Persian Oil Company, Ltd., and to the Geophysical Company, Ltd., for approving and facilitating the publication of this article. I am specially indebted in this respect to Prof. Mintrop, and to Mr. Ernest H. Neville and Dr. Schmidt of the latter Company.

The Centenaries of Davy and Young.

IN the National Portrait Gallery hangs the well-known composite portrait group of eminent British men of science who were alive in 1807–8, the group being shown assembled in the Library of the Royal Institution. There are forty-eight portraits in all, including those of Banks, Watt, Rumford, Jenner, Herschel, Cavendish, Telford, Trevithick, Wollaston, Dalton, Davy, and Young. The oldest represented in the group was Matthew Boulton, the partner of Watt, who was born in 1728, while the youngest was Davy, born just fifty years later, in December 1778.

No more appropriate setting could have been found at that time for such a group, for though at its birth the Royal Institution had for its sponsors many notable men of the day, its infancy had been a somewhat precarious one, and it was mainly through the talents of Davy, then probably at the height of his powers, that it had been rescued from the uncertainties which had threatened its very existence. It had been raised to a foremost position among scientific institutions, where not only the learned, but also the fashionable and the great, gathered to see the striking experiments of Davy and to listen to his brilliant discourses from which we are told Coleridge increased his stock of metaphors.

Founded in 1799 through the exertions of Rumford, the Royal Institution had already counted among its first professors Garnett and Young, but it was the lectures of Davy which marked the beginning of the popularity it has since enjoyed and the reign of discovery with which its name is linked. After Davy came Brande, Faraday, Tyndall, Dewar, and others, and in "Britain's Heritage of Science" we are told "there is no

building in the world associated with so many classical and revolutionising researches as that in which the Royal Institution is housed".

If the setting for this remarkable group invites our approbation, no less does the date of its execution appeal to our sense of historic fitness. The early years of the still young century had been full of promise, and though owing to the ambition of Napoleon few nations were free from the threat of war, scientific and industrial development was proceeding apace, and the very names of Cavendish, of Herschel, of Watt and of Trevithick recall the pioneering work and the planting of the seed from which our later harvests have come. At home and abroad, science in 1807 was engaging some of the keenest minds. The guillotine, it is true, had robbed France of her greatest chemist, but she still counted among her veterans, Laplace and Lagrange, Legendre and Coulomb, while following in their footsteps came Fourier, Biot, Ampère, Malus, Arago, and Fresnel.

As in France, so in Europe generally, science and invention were bearing good fruit. Astronomy had been enriched by the discovery of Ceres, Pallas, Juno, and Vesta; Volta's great invention of the electric battery was being applied in a hundred experiments; Chladni had made the world his debtor by the publication of his work on acoustics, while Oersted had begun his work at Copenhagen, where he was destined to make his great discovery of electro-magnetism. To the particular years 1807 and 1808 belong the publication by Thomson of the atomic theory of Dalton, the publication of Young's "Lectures on Natural Philosophy", and the memorable experiments of Davy leading to the isolation of sodium and potassium.

However interesting a review of the science of that time may be, our immediate attention is naturally directed to the careers of Davy and Young, both of whom died in May 1829, a hundred years ago, Young passing away on May 10 and Davy on May 29; Young being then but fifty-five and Davy only fifty years of age. Strangely unlike in temperament, in character, and in their reaction to the buffets and rewards of life, they yet present many interesting parallels as well as contrasts. Even Galton would, perhaps, have found it hard to determine the influence of heredity on their careers; for Davy was but the son of a woodcarver of Cornwall, and Young the son of a Quaker landowner of Somerset. In neither instance, also, did early training have much to do with their subsequent successes. The astonishing precocity of Young was equal to that of a Macaulay or a Rowan Hamilton, and as a boy of fourteen years of age he was acquainted with Latin, Greek, French, Italian, Hebrew, Persian, and Arabic. Davy had a mind equally alert and a memory equally tenacious, but he enjoyed fewer advantages than Young, and it was to a Quaker saddler friend and a self-appointed guardian that he owed the encouragement and assistance without which, perhaps, his genius might have led him to less congenial pursuits. Young was the senior of Davy by five years, and while Davy was serving his apprenticeship to the Penzance apothecary and surgeon, Borlase, Young was leisurely following his academic course in medicine at Edinburgh, Göttingen, and Cambridge, where his learning led to his being known as "Phenomenon Young".

It was in 1801 that the paths of these two extraordinary men met, the older one becoming the professor of natural philosophy and the younger the professor of chemistry in the newly founded Royal Institution. Davy's first lecture was given on April 25, 1801, Young's first lecture on Jan. 20, 1802; but whereas we are told Young found "the number of his attendants diminish daily, and for no other reason than that he adopted too severe and didactic a style", Davy filled the theatre to overflowing, where "his youth, his simplicity, his natural eloquence, his chemical knowledge, his happy illustrations and well-conducted experiments excited universal attention and unbounded applause".

Of the details of the work of these illustrious investigators many accounts have been given. His experiments with nitrous oxide, his isolation of sodium and potassium and other elements, and his invention of the miner's safety lamp are but a few of the outstanding achievements of Davy, whose name was as familiar in France and Italy as it was in England. His invention of the safety lamp he made a free gift of to mankind, and the silver plate presented to him by the colliery owners in recognition of his work was long since sold and used for founding the Davy Medal of the Royal Society. Young's work illustrates the versatility of his rare mind. His most notable contributions to science were concerned with optics, the strength of materials, and elasticity. The first definitions of 'energy' as we understand it and of 'Young's modulus' are to be found in his "Lectures". His views and discoveries in light were fundamental, and he has been called "the founder of physiological optics". Of Young, Helmholtz said: "He was one of the most clear-sighted of men who ever lived, but he had the misfortune to be too greatly superior in sagacity to his contemporaries. They gazed at him in astonishment, but could not always follow the bold flights of his intellect."

Known widely for their writings, their lectures, their researches, and discoveries, Young and Davy are also remembered for the work they did in connexion with societies, committees, and institutions. Both were foreign associates of the Paris Academy of Sciences, both held secretaryships of the Royal Society, of which Davy was the twenty-fourth president, while Young was long physician to St. George's Hospital. The grave of Young is at Farnborough, Kent; that of Davy in a cemetery outside the city of Geneva. There is a statue of Davy at Penzance, a marble bust of Young in the Shire Hall, Taunton, while each is commemorated by a memorial tablet on the walls of St. Andrew's Chapel, Westminster Abbey. Such memorials, however, may crumble and perish, but the work of Young and Davy will endure for ever; for as Davy said when presenting the Copley Medal to Arago: "Science, like Nature, to which it belongs, is neither limited by time or space. It belongs to the world, and is of no country and no age."

Landscape at the Royal Academy.

By Dr. VAUGHAN CORNISH.

THE representation of the vibrant effect of sheer sunlight is a relatively modern achievement in painting, which has, however, passed through the experimental stage, and is well given in Mr. H. H. La Thangue's two pictures, Provençal Workers (34) and A Provençal Forecourt (488), and vibrance is well combined with the complementary colouring of sunlight and shadow on the white walls of the Farm near Sospel by Mr. St. Clair Marston (614). It is, however, from our own Cornish coast that Mr. Julius Olsson chooses his examples of moonlight on the waters, the acme of contrast in tone in an almost monochromatic scene which never fails to touch the chords of emotion. The subjects are St. Anthony Light (176) and Herring Fleet : St. Ives (500).

Sunlight and shadow on the waves are rendered in George F. Bradshaw's At Sea (1) and on the irregular surface of snow by Donald H. Floyd, Sunshine after Snow (131). Circumambient colour of sea and sky is effectively accentuated by its concentration and massing on hull and sails in Mr. Arthur J. W. Burgess's Gipsies of the Deep (357) and Pleasure Afloat (281). For the blue depths of atmospheric colour our painters have relied upon the mountain background, as in Lakeside (571) by Sydney V. North and in Mr. E. L. Lawrenson's picture of the remote Achill (153) where, as in Skye, some peculiarity of insular climate beside the western ocean dyes the distant hills in deepest purple.

For catching the moods of the mountains as determined by weather and season, a very mirror of the moods of man, the method of water-colour has advantages, and the enlarged space now given to the water-colours at Burlington House is therefore welcome to the student of Nature, as is also the allotment of a fine spacious gallery to the drawings, engravings, and etchings, among which are many interesting landscapes. Mr. Alfred Hartley's aquatints, A Storm on the Alps (1082) and Morning Haze on a Swiss Lake (1070), are the reward of those who watch and wait among the mountains. In Mr. Percival Gaskell's aquatint, On the Lake of Thun (1130), looking west across the water towards the Stockhorn range, the suffusion of afternoon light enables the artist to unite the boldness of the peaks and the repose of the lake, the combination which so greatly contributes to the delights of residence in Alpine lakeland. In Mr. B. Eyre Walker's aquatints, October Snow, Windermere (1126), and the tiny Autumn Snow on Coniston (1156), we are pleasantly reminded of the beautiful aspect of the English Lake District, when the peaks are emphasised by snow caps, while Sir D. Y. Cameron's wash drawing Cluanie (1034) indicates admirably the way in which the re-entrant line of the lake shore, stronger in tone than the skyline, imparts an appearance of ordered grouping to the surrounding mountains.

For landscapes which derive their motive in the cyclopæan masonry of rock structure, we must return to the oil paintings. In Pordenick, Land's End, by Charles W. S. Naper, the strongly jointed rock has a pattern of vertical and horizontal lines so easy for the eye to grasp that the strength of the cliff in no way impairs the sense of repose imparted by the calm sea from which it rises sheer. An effect not altogether dissimilar may be seen where church towers rise above the flat expanse of the Fen Country. Mr. John H. Willis's In the Nant Ffrancon Pass (403), one of the few large landscapes, is a fine study of a rhythm of rock structure more exciting to the eye, spiked, pyramidal. The colouring of this landscape, whether determined by preference or the chances of the season, is not that which best concords with the forms of this district, but we can find satisfaction in Miss Judith Ackland's Snowdon by the Pen y Gwryd Track (647), in which tone and colour convey the solemnity of Snowdonia. Other artists seek, I infer, to enhance the abstract quality of strength in mountains by stripping them of atmosphere so that the whole structure, including the serrated skyline in the distance, has a texture comparable to that of a rocky foreground. Such appears to be the intention in The Pillars of Heaven (284) and Mountains of Murcia (611) by Mr. Guy Kortright, and a somewhat similar treatment is found in The Alps from Sallanches by Mr. R. M. Hughes (160). These studies are in full daylight. If it be permitted to a fellow student of mountain beauty, though not a fellow artist, to offer a suggestion, I would venture to cite my experience that in certain types of weather the hours of dawn show the high mountains in a strength of tone rivalling lunar landscapes combined with such conditions of colour as would assist the abstract treatment of massive effect.

Among the studies of Arcadian England, there is one of special charm which is likely to escape notice on account of the fact that it is almost the smallest picture in the Exhibition, Miss Dorothy M. Snow's water-colour, A Sussex Farm (788). It shows that neatness of agricultural landscape which astonishes the visitor from the New World, causing him to exclaim, as I have myself heard, that " this country is a garden ". The smoothly rounded lines of the topography of the southern and midland counties of England, and the rounded forms of their spreading, broad-leaved trees, make difficult the task of harmonising architecture with the landscape, but in the barren and rocky lands of the Spanish *meseta*, architecture carries the forms of natural landscape to a culmination, as is shown in Mr. Oliver Hall's important picture, A Spanish Bridge (86), which gains in effect from its suitable frame of black and gold. Among the water-colours, Mr. Cecil A. Hunt's Gorge of the Tagus, Toledo (764), also deals with an architectural culmination of rocky form. At the present time, when controversy is so keen on the subject of styles of construction considered in relation to the amenities of the countryside, it is important that we should

(*Continued on p.* 731.)

Supplement to NATURE

No. 3106 MAY 11, 1929

The Maintenance of Life and Irritability in Isolated Animal Tissues.[1]

By Prof. A. V. HILL, F.R.S.

NOT infrequently one hears the view expressed that physiologists are too ready to work with isolated tissues, not willing enough to study the intact and living animal. The isolated organ is said to be 'abnormal', its behaviour too remote from that of its previous self, in its usual environment, to throw much light upon the normal processes of life. There is indeed a danger that those who work under artificially simplified conditions may, in their enthusiasm, extend their results too far: the greater danger—I speak with feeling—is that their friends, and the daily Press, may do so for them. If you describe how a nerve-fibre maintains the electrical potential difference at its boundary by an active process involving the consumption of oxygen, you may find your name in all the newspapers, and be invited to America to raise people from the dead: if you prove that chemical disintegration sets in, in a stimulated muscle deprived of oxygen, you may be charged with attempting to create a living cell (and indeed a living 'soul') in the laboratory.

Realising this danger, however, appreciating that only after hard and critical thinking may the results of laboratory work under simplified conditions be applied to the graver practical problems of life, we may—in fact, we must—go forward in the confident belief that only by investigating phenomena under such simplified conditions can we really hope to understand them.

Here, to the scientific mind, is in fact a definite and presumably soluble problem, that provided by 100 mgm. or so of isolated muscle or nerve, capable of responding in a regular and reproducible manner to certain treatment: academic—certainly: so was the study of the conduction of electricity through gases—until it led to X-rays and amplifying valves: abnormal—if you like: but still a fact, and one that presumably can be explained. The irritability, the responsiveness, of this little bit of surviving tissue can be maintained, under conditions which we are beginning slowly to understand, for considerable periods: and during all this time we can study the processes of life, in abnormal form if you wish, but still as phenomena, as facts, under conditions which allow us to apply the methods of physics and chemistry as we could never hope to do in the normal intact animal.

[1] From the Ludwig Mond Lecture delivered at the University of Manchester on Mar. 6.

Energy Exchanges in Nerve.

The isolated nerve of a frog, placed in an appropriate salt solution containing oxygen, will live, or at any rate continue to function, for days. We can detect its activity most readily by leaving it connected to a muscle, which will twitch when we stimulate the nerve. A better method, since it involves the properties of the nerve alone, is to record the 'action current', which passes for a few thousandths of a second between electrodes placed upon its surface. Another method, but more difficult to apply, is to measure the heat produced by the nerve when stimulated.

For long periods the surviving nerve will show all the outward and visible signs of a response to stimulation. During prolonged survival at rest it consumes oxygen and gives out carbon dioxide: at 20° C. about half a cubic millimetre per gram per minute, more at a high temperature, less at a low. During maximal activity, due to continual stimulation, its metabolism is doubled, its oxygen consumption at 20° C. is about one cubic millimetre per gram per minute. It gives out corresponding heat. Of this heat, only about one-tenth appears during the passage of the impulse—the rest comes off slowly, during the following fifteen minutes: clearly it is related to some recovery process, by which the nerve is 'recharged', by which its potential energy, so to speak, is restored.

The fact that extra oxygen is used as the result of activity is, in a sense, easy to understand. Breakdown has occurred, free energy has been liberated, and if the process is to be reversed, oxidation is necessary to supply the free energy required in the re-synthesis. The oxygen consumption at rest is much more difficult to comprehend. Why should

an isolated tissue, doing nothing at all except continuing to exist—that is, continuing *to be ready* to respond to a stimulus—require what is in fact a considerable amount of oxygen, three-quarters of its own volume per day at 20° C., three to four times its own volume at human body-temperature? Energy, we may say, is required to maintain the organisation. In what manner, however, is the energy being applied? What will happen if the supply of oxygen be stopped?

The last question is very readily answered by experiment. The air around the nerve is replaced by pure nitrogen, and from the known diffusion constant of oxygen and the known oxygen consumption of the nerve, we can calculate that in a very few minutes not a trace of molecular oxygen is left. A stimulus is applied at intervals, and the action current, or the heat, is used as a sign of activity. At first no particular change occurs: the nerve responds as before. Long after *all* the molecular oxygen is gone, action current and heat-production remain almost unaltered. Even the recovery heat, which surely is of oxidative origin, is unaffected. Presumably there is some source of intra-molecular oxygen, or some store of hydrogen-acceptor, which, for a time, can supply the energy required for recharge. Gradually, however, a change comes on: action current and heat diminish, and in two hours after the oxygen was removed they disappear together.

The nerve, however, is not dead: let oxygen in and it revives: its return is gradual, much slower than the inward diffusion of the gas—the oxygen clearly has some duty to perform, some debt to pay, before the situation is cleared up. The nerve asphyxiates much quicker a second time if its exposure to oxygen be cut short. Indeed, by the admission of oxygen alone, complete recovery from asphyxia is not possible: however long be the exposure to oxygen, subsequent asphyxia (as Gottschalk showed) is quicker than it was originally. Washing the asphyxiated nerve with *oxygen-free* salt solution restores it temporarily. Complete restoration, however, is attained only if washing be combined with oxygen. Then the nerve returns triumphantly to its full initial activity, apparently unaffected by the intervening period of asphyxia. It seems as though, in the absence of oxygen, two things have happened: (*a*) some metaphorical accumulators have run down and need recharging—a process which requires oxygen; and (*b*) certain abnormal substances have appeared, which cannot be removed by oxygen, but will diffuse away into surrounding salt solution.

Potential Differences in Nerve.

Many attempts have been made in recent years, before the latest and most successful ones, to measure the gaseous exchanges of isolated nerve. Actually in the refined methods employed by Meyerhof and by Warburg, modifications of those of Barcroft, a means has long been available of making these important measurements. When Downing and I succeeded at last in measuring the heat-production of nerve, it seemed to us, and to Gerard who had joined us, that corresponding determinations of oxygen consumption should be carried out. I wrote, therefore, to Meyerhof and asked him if Gerard could come to make these with him. Meyerhof waited a day to reply: his answer was, as I expected, "Of course, let Gerard come"; but also, as I had not expected: "es ist ausserordentlich leicht, I did it yesterday on the receipt of your letter". So Gerard went and made the experiments in Berlin. At the same time Fenn was doing the same thing in his laboratory at Rochester, New York. The oxygen consumed at rest, the oxygen needed for activity, and finally, the oxygen required for recovery from asphyxia, were all measured and are now tabulated for those who need to use them for their calculations.

I mention these measurements partly for their own sake—as the happy ending to a long series of persistent attempts—but more particularly for a curious by-product which, like many by-products, is likely to prove more important than the original object. An American worker, some years before, attempting to measure the carbon dioxide production of nerve, had employed a very convenient object, the limb nerve of the spider crab. Reading his paper I noticed that, whereas he had stimulated the nerve for long periods, he gave no evidence that the nerve had really responded at all to his stimuli. Knowing from experience of medical practical classes how often nerves do not respond to the best-intentioned stimuli, I thought I had better try for myself. So, being at Plymouth, where there are much bigger and better spider crabs than in America, I tried, and by good fortune a whole beautiful new field of work appeared.

The experiment was a simple one. *A* and *B* are two non-polarisable electrodes placed upon the nerve, which for the sake of the argument we take as a single nerve fibre. *A* is at an uninjured point, *B* at the cut and injured end. *A* and *B* are connected to a galvanometer. A difference of potential exists between *A* and *B*, the so-called injury potential, which produces what is called the 'demarca-

tion current' when it is allowed to flow through the galvanometer. A is positive to B in the external circuit. When we apply an induction shock to the nerve at a distant point C, the potential difference between A and B momentarily falls as the impulse passes A: the current through the galvanometer diminishes: we witness what is called the 'negative variation of the injury current'. If we apply a succession of induction shocks at C, each produces its effect at A as its corresponding impulse goes by, and if the galvanometer be a relatively slow one, these effects are summed up, and as we continue stimulating, the galvanometer returns

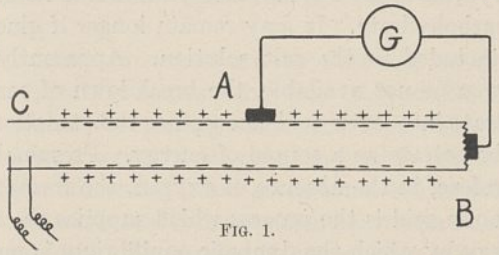

FIG. 1.

towards its zero, deflecting again when the series of stimuli ends. Such, at any rate, is what happens in a frog's nerve. The fact has been known for two generations: it is demonstrated to students: but curiously enough—so far as I am aware—nobody had ever tried to show it in a crab's nerve. In that tissue, if stimulation be continued long enough—for a minute or two—the galvanometer does indeed move backwards during the stimulus towards its zero, recording the usual 'negative variation', but it does not return outwards again when stimulation ends.

Let me pass for a moment to a fact recently established by Furusawa. If a crab's nerve be kept in air in a moist chamber, the difference of potential between A and B is maintained for long periods. If, however, the air be replaced by pure nitrogen, the difference of potential between A and B gradually diminishes. On introducing air again it rises to its original value, not immediately but in an hour or so. Clearly, oxygen is being used to maintain a potential difference somewhere within the nerve. Where can this potential difference be other than at the surface of the fibre itself? At the cut end the electrode is in contact with the naked protoplasm of the cell: at the uninjured point the electrode is in contact with the outside of the membrane surrounding the tissue. We must imagine that the injury potential is really the difference of potential across the membrane of the nerve fibre, the contents of the fibre between B and A simply acting as a continuation of electrode B. Apparently, then, Furusawa's observation shows that the potential difference existing across the membrane bounding the nerve is maintained by oxidation, and gradually 'runs down' if oxidation be prohibited.

Picture the passage of the impulse along the nerve as being momentarily accompanied by a breakdown, or maybe a short-circuit, of the membrane, perhaps by a change of permeability allowing local currents to run and so to propagate the impulse. Thinking of the membrane as similar to an accumulator of small capacity, a series of such momentary short-circuits might 'depolarise' it, so that by stimulation we might effect a decrease in the observed injury potential. Now Levin found, and Furusawa has confirmed the fact, that a prolonged stimulus applied at C causes a return of the galvanometer towards its zero, which is not followed by a deflection outwards again when the stimulus ends. Furusawa, moreover, has proved that if local fatigue at the point of stimulation be avoided by employing, in rapid succession, a series of such points, the nerve can be *completely depolarised by activity*. The 'accumulator' which lies along the bounding membrane of the nerve fibre can, it seems, be caused to run down completely by prolonged activity. Let us now withdraw the stimulus and wait. If the nerve be in air, the potential difference between A and B gradually rises again until finally it attains its original value. This is the recovery process to which I referred earlier. If, however, the nerve be in nitrogen, it remains depolarised and further activity is impossible. The potential difference existing across the boundary of the living cell is not only maintained but also restored by an active process of oxidation.

Osmotic Differences in the Egg.

In a recent paper from Holland by J. Straub, an investigation has been described of the difference of salt concentration, and of freezing-point, between the white and the yolk of an egg. It appears that, in the living fresh egg, there is an appreciably higher concentration of potassium, sodium, chlorine, and lactate ions in the yolk, and an excess lowering of freezing-point of about 0·15° C. In preserved eggs this difference is much less. The membrane surrounding the yolk is apparently freely permeable to water, even in its live condition, and the difference of freezing-point on the two sides is much too large to be accounted for by any such effect as that of the Donnan equilibrium. A difference of freezing-point of 0·15° would correspond to a difference of pressure of 1·8 atmospheres, and it is inconceivable

that a thin membrane so extensive as that surrounding the yolk could possibly stand a pressure such as this.

It is difficult to resist the conclusion that the existence side-by-side of white and yolk cannot be regarded as a thermodynamic equilibrium, and Straub suggests that the difference of concentration on the two sides of the membrane is maintained by an active process of oxidation. It is known that oxidation occurs in the living egg, and, according to a rough calculation, the amount of energy supplied thereby is ample to account for any osmotic work that would have to be performed to maintain, against diffusion, the observed concentration differences. It is suggested that the observed inequalities in concentration and in freezing-point must be due to some active life process, and the author discusses an electrical scheme for the employment of the energy obtained by oxidation in the egg. He supposes that the membrane acts as a galvanic oxidation element for glucose, and that the difference of potential so set up across the membrane results in the transfer, against diffusion, of the various positive ions in question. Such a galvanic battery existing across the membrane, together with differences in permeability, might be a sufficient explanation of the inequalities observed. A large number of physiological phenomena would be more intelligible were we able to suppose that oxidation at the surface of a cell is largely employed in maintaining the osmotic and other differences that exist between the outside and the interior.

Energy Exchanges in Muscle.

In isolated muscle it has long been known that oxygen is necessary for the preservation of the excitable state. A muscle left at rest in oxygenated salt solution maintains its condition for long periods if it be thin enough for the relatively slow process of diffusion to supply it adequately with that gas. A resting muscle uses oxygen continuously at a rate depending on the temperature: at 20° C. this is about 0·7 cubic millimetre per gram per minute: probably this process of oxidation at rest supplies the energy necessary in order to maintain the complex dynamic equilibrium of the living material in a steady state. The known diffusion constant of oxygen through muscle, as found by Krogh, and the rate of its consumption, allow us to calculate that a thin sartorius muscle of a frog can easily remain in a steady state in oxygen just so long as combustible material is available. The isolated muscle at 20° C. uses about its own volume of oxygen per day: and if it contains 1 per cent of glycogen this form of fuel alone should be sufficient, at that rate of oxidation, for some eight days. Dissected aseptically and suspended at rest in a suitable salt solution a frog's sartorius will, in fact, if supplied with oxygen, function for a week or more.

Deprived of oxygen, such a muscle produces lactic acid from its glycogen, the glycogen breaking down in this case about five times as fast as it did in oxygen. If the lactic acid be able to diffuse away, as is the case when the muscle is suspended in oxygen-free salt solution, the muscle lasts for a day or two, responding to a test stimulus at any time within that period: finally, however, its excitability vanishes with the disappearance of its store of carbohydrate. It may remain longer if glucose be included in the salt solution. Apparently, if oxygen be not available, the breakdown of carbohydrate into lactic acid can replace the oxidation of carbohydrate as a source of energy. Presumably, therefore, in the absence of oxygen, the formation of lactic acid is the process which supplies the free energy by which the dynamic equilibrium is maintained, by which, so to speak, the accumulators are kept charged.

The term 'free energy', used in this connexion, should be understood in its strict thermodynamic sense. It is interesting and important, as Burk has recently done, to calculate the free energy of the reaction by which, in living tissue, glycogen is broken down into sodium lactate. We consider the whole process, dissolved glycogen transformed in the buffered alkaline medium of the muscle into dissolved sodium lactate. Owing to the difference in chemical structure between the lactic acid and the glucose molecule, namely, in the ratio of the number of carbon atoms to the number of carbonyl oxygens, there is a considerable amount of free energy available in this breakdown, about 400 calories per gram of glycogen transformed. For this reason, presumably, Nature has selected this particular reaction as the means of providing, in the absence of oxygen, the free energy required, either for doing work, or for maintaining (against diffusion and similar irreversible processes) the osmotic and other differences existing during life at the boundaries and other interfaces of the cell. The free energy of the oxidation of glycogen is of course greater than that of its splitting to lactic acid: it is about 4000 calories per gram. If oxygen be absent a given process requires, let us say, 1 gram of glycogen to be broken down to lactic acid, yielding 400 calories of free energy: the same process, if oxygen be present, requires only one-fifth of a gram of glycogen to be oxidised, yielding 800 calories of free

energy: 400 of the latter are wasted, apparently, in the recovery process.

If, as I said, lactic acid is able to diffuse away, the muscle can continue to function until all its carbohydrate store is spent. If, however, it be suspended in nitrogen and not in salt solution, its lactic acid cannot escape and the end comes on much earlier. At 20° C. in nitrogen a muscle produces about four millionths of its weight of lactic acid every minute: about 0·3 per cent in 12 hours. At this stage the increase in hydrogen ion concentration due to the accumulating acid renders the muscle completely inexcitable: in less than 24 hours it attains the so-called lactic acid maximum and passes into *rigor mortis*.

The same processes can be observed to occur more rapidly when activity due to stimulation is substituted for resting survival. A muscle subjected to a series of maximal induction shocks in nitrogen fails when it has given some 400 twitches, when its lactic acid concentration has reached about 0·25 per cent. Suspended in oxygen-free salt solution and stimulated with a frequency low enough to allow its lactic acid to escape by diffusion, it can give several times as many twitches (as my friend Kupalov has recently shown), and will continue until practically all its carbohydrate has been broken down; suspended in oxygen, or in oxygenated salt solution, it can give several thousand twitches and maintain its activity until all its carbohydrate is oxidised. Moreover, as is now well known, if it be fatigued in nitrogen, and then allowed to recover in oxygen, its lactic acid vanishes and four-fifths of the corresponding amount of glycogen reappears. The free energy required for the reaction

Lactate → glycogen

is provided by the oxidation of a fraction (about one-fifth) of the lactic acid. How this synthesis occurs, and what the chemical nature of its mechanism is, are not known: but it undoubtedly does occur, and not only in muscle but also in practically every organ and tissue examined.

The work of Warburg on the metabolism of tumour and other tissue is a highly important product of these studies originally conducted on muscle and earlier, in another form, by Pasteur on yeast. It seems that nearly every kind of animal tissue employs the lactic acid breakdown, when deprived of oxygen, as the source of the free energy required for the maintenance—against irreversible processes—of its steady living state: and that certain types of tissue, particularly those found in malignant growths, actually prefer the lactic acid mechanism and may be relatively incapable of employing that of oxidation.

There is no reason to believe that when oxygen is present the processes at work are other than the sum, or the resultant, of these two. The free energy of the lactic acid breakdown is apparently the source of the mechanical energy liberated by muscle, alike in the presence and in the absence of oxygen. In the former case, however, a slow recovery process ensues, in which—perhaps under the action of a galvanic combustion element, as suggested by Straub for the case of the hen's egg—the lactic acid formed in the initial process is re-formed into its precursor glycogen. Moreover, the processes of resting survival and of activity are so similar that there appear to be strong grounds for supposing that, at rest also, the primary mechanism in which free energy is liberated (to counteract irreversible processes which lead finally to chaos and death) is that of lactic acid formation from carbohydrate.

It is not a wild extrapolation from this, and from the work of Warburg, to conclude that the same is true in all animal tissues. The living cell is a complex organised system of enzymes, interfaces, potential and osmotic differences, chemical substances: infinitely improbable in the thermodynamic sense, and yet existing in a steady state so long as free energy is available to maintain the organisation. The free energy of the carbohydrate–lactic acid breakdown is apparently the *sine qua non* of this maintenance, the common factor in the organisation of living animal cells. The primary function of oxidation is the reversal of this breakdown.

Reversible Inexcitability in Muscle.

All who have worked with isolated muscles have found—alas, too often—that these may 'die' without apparent cause and spoil their experiments. They do it more at some seasons than at others, often for weeks on end: some muscles are worse in this respect than others: and if we have not attributed it to the machinations of the devil (physiology leads many of us to a belief in that gentleman) we have been fain to call it 'fatigue', thereby expressing our ignorance of the whole matter. If we knew that a muscle survived better in oxygenated salt solution than in oxygen gas, we talked about the removal of 'fatigue products' in the former, even though the muscle—being supplied with oxygen and at rest—was never fatigued at all. It took two chemists, Dulière and Horton, to detect what physiologists should have recognised long ago, that a state of reversible inexcitability sets in spontaneously in isolated dissected muscles. It is true that some years ago, in the biochemical laboratory at Cambridge, it was shown that the legs of frogs, kept

at a low temperature in oxygen, gradually in the course of a week or so lose their irritability, which can be restored by soaking in salt solution. It is not certain, however, that this is the same phenomenon, and in any case Dulière and Horton have demonstrated it in much more striking and—one might almost say—provoking form.

A sartorius muscle is dissected with the utmost care from a frog and suspended in moist oxygen, or nitrogen, or air: silver or platinum electrodes are brought in contact with it and at intervals its response is tested. At first stimulation leads to an active contraction; as time goes on, however, the muscle apparently dies: it is not fatigued, it has been quite infrequently stimulated, and in oxygen or air there should not be, and in fact there is not, any accumulation of lactic acid. In an hour or two the muscle is apparently dead, it responds not at all to the strongest stimulus, though if it be taken out and tested chemically it is found to show all the chemical characteristics of resting muscle.

The phenomenon is not due to oxygen as such, or to the absence of oxygen: it cannot be attributed to surrounding the isolated muscle by a gas, since it happens also in liquid paraffin and mercury. I called it 'reversible'. Immerse the muscle, when it has become completely non-excitable, in salt solution, and its excitability returns, rapidly at first, more gradually later, following approximately a course we should expect were the return of excitability due to the outward diffusion of something present in the muscle. Any reasonable salt solution will cause a return of the excitability: Ringer's solution, sodium chloride,—anything, in fact, which does not itself lead directly to inexcitability in the muscle.

It would be easy, so far, to imagine that some product of activity in muscle, gradually accumulating, produces a toxic effect which leads to the inexcitable state. This simple suggestion, however, is not sufficient. If we soak a muscle, for three hours after removal from the animal, in salt solution, and then suspend it in a gas, it will remain excitable indefinitely. If we wash it for three hours after it has become inexcitable, its returned excitability will remain indefinitely, that is, until its carbohydrate reserves are used up or bacterial invasion sets in. If, however, we wash it for a shorter time, say for half an hour, after it has become inexcitable, its excitability indeed returns, but when we place it again in a gas, it becomes inexcitable once more. Not until the sum of the times of immersion has attained a certain value does the muscle become permanently excitable in the present sense. If any product of metabolism has a toxic effect, why should further metabolism after a 3-hour preliminary soaking in Ringer's solution now have no result? Are we dealing here with the same curious phenomenon as Furusawa found in the case of a crab's nerve? Moreover, why do the muscles of a frog's leg, allowed to remain *in situ* after the death of the animal and the removal of the skin, retain their excitability for hours, while a companion muscle dissected out and, to all intents and purposes, uninjured, becomes inexcitable in an hour? The muscle is not dead, for it shows a normal resting metabolism and can be revived by washing with salt solution: it may then live for days, which is a sign that any injury due to dissection is of negligible importance. Is the effect of a subtle physical nature, due to contact of the living tissue with a medium of unusual dielectric constant? Or is it to be attributed to the production of some substance, in or between the cells, which can be washed away by contact of the muscle with salt water? The phenomenon is an easy and dramatic one to witness, once one realises its existence, but a difficult one to explain. The realisation, however, that it occurs has greatly simplified experiments with isolated muscles, for we know now that by a preliminary period of washing we can prevent an occurrence which has spoilt so many experiments.

There is one possible explanation. If a Ringer's solution be prepared containing four times the usual concentration of potassium chloride, a muscle immersed in it slowly becomes inexcitable. One which has become spontaneously inexcitable by standing in oxygen shows no return of excitability when immersed in this solution. We might have expected a temporary return. A muscle consists of fibres and interspaces, mainly fibres. In the inside of the fibres there is a very high concentration of potassium, in the interspaces a low one. Excitability may depend—among other things—upon a normal concentration ratio of potassium across the boundary of the cell. Experiments have shown that when muscles are perfused, potassium tends to leak into the perfusing fluid. If it leaked into the interspaces between the fibres—not much would be required—it might gradually produce the same state of inexcitability as we can cause by the artificial application of a high potassium concentration. The chief difficulty in this explanation, which has much else to commend it, is that one cannot see why a few hours' immersion in salt solution should prevent any further egress of potassium. In any case it seems that the phenomenon is of a physical or of a physico-chemical nature, and has no connexion with the oxidative mechanism of the cell.

Anaerobic Disintegration in Muscle.

I come lastly to the most difficult problem of all: the cause of a phenomenon which I discovered in 1927 and about which I speculated last spring, perhaps rather rashly, in the *Proceedings of the Royal Society*. I say rashly, partly because my paper was the innocent cause of much excitement in the autumn, when the public Press discussed—in the 'silly season'—the 'mystery of life': partly because the explanation I originally gave may not be sufficient. The facts, however, seem certain, and are these. By improvements in technique, the rate of resting heat-production of a muscle can be measured, in oxygen or in nitrogen. The muscle lies in nitrogen upon the warm junctions of a thermopile, in a thermostat maintained at a constant temperature. The rate of the resting heat-production at 18° C. is (say) 60 gm. cm. per gram per minute: about 1½ thousandths of a calorie. The muscle has previously been washed for some time in salt solution, so that it does not now become spontaneously inexcitable in the manner described by Dulière and Horton. It is stimulated and gives a series of twitches: the heat due to activity is registered by the galvanometer attached to the thermopile: stimulation ends: the galvanometer returns: we should expect it to return, gradually, of course, to its original position, the muscle to revert to its original heat-rate. Nothing of the kind. I may illustrate what happens by a typical experiment.

Time: A.M. or P.M. . .	11.56	11.59	12.1	12.2	12.3½	12.5	12.6
Galvanometer deflection: mm.	22	23½	23½	22½	22½	24	23

The muscle was then stimulated by single shocks to fatigue: the galvanometer deflected, and, when the stimulation ended, returned to rest once more.

Time P.M. . . .	12.20	12.23	12.25
Galvanometer deflection: mm. .	130	130	130

The resting heat-rate in this case has been increased between five and six times.

The phenomenon has never failed to appear, and it occurs always in the same quantitative form. The quotient

$$\frac{\text{increment in heat-rate per minute}}{\text{total heat by stimulation}}$$

is always (in the frog's sartorius at 17° C.) of the order of 0·0075. The high heat-rate induced by stimulation is permanent so long as the muscle remains in nitrogen. It may attain 800 gm. cm. per gram per minute after severe fatigue—more than 1 calorie per gram per hour. It may remain at this level, so long as the muscle is kept in nitrogen, for 24 or even 48 hours, in which time the total heat liberated may be many times as great as can possibly be accounted for by the breakdown of *all* the available carbohydrate into lactic acid. Since, apart from carbohydrate, there is very little except the actual protein of the muscle which we can imagine to break down with such an evolution of heat, we are forced to conclude that the process of anaerobic activity (or its products) has somehow induced the degradation of the muscle protoplasm itself to bodies containing less total energy.

If, when the muscle has been fatigued in nitrogen, and its resting heat-rate is high, we admit oxygen, a recovery process sets in as usual, with a considerable evolution of heat. The lactic acid is removed and the muscle is restored to its previous resting condition. This occupies about an hour. If, now, we replace the oxygen by a stream of pure nitrogen, within half an hour diffusion on one hand, and the resting metabolism of the muscle on the other, have removed the last traces of oxygen from the interior of the muscle substance, and the resting heat-rate in nitrogen can again be measured. Instead of the high value found after stimulation, we now observe a low value of the same order of size as before it. The breakdown processes produced by anaerobic activity have been cut short and the muscle has regained its previous steady state. The same treatment can then be applied once more. If the muscle be stimulated to fatigue again its resting heat-rate rises: if oxygen be again admitted recovery ensues, and finally a low value of the resting heat-rate appears as before.

There seem to be two alternatives: either (1) the provision of energy by oxidation has restored to their normal state the membranes, interfaces, or agents, which in ordinary life hold apart the unstable reacting substances present in the living cell, which prevent—as I said in my paper—the organised system of the living cell from becoming a biochemical chaos; or (2) in the presence of oxygen some substances have been removed, perhaps by simple oxidation, perhaps by restoration to a precursor, which, if they be allowed to remain, assist as catalysts, or in some other capacity, in the anaerobic disintegration of the living material. One thing seems certain—the high heat-rate *is* a sign of some kind of irreversible breakdown or disintegration: if—as Kupalov has shown—it be allowed to continue for a few hours, no subsequent restoration of the muscle to its normal excitability is possible, either in oxygen or in oxygenated salt solution.

The phenomena in question are so curious, and the effects so relatively large and so easily demon-

strated, that they demand an explanation. They have been tested by every means available and have withstood the attack. Were they due to a change in the hydrogen ion concentration caused by the liberation of lactic acid? A resting muscle was immersed in pure carbon dioxide and its heat-rate remained practically unaltered: the carbon dioxide must have made it as acid as extreme fatigue. Were they due to a technical error of some kind? To a reaction of some fatigue product with the metals of the thermopile? The thermopile was insulated with baked 'Elo' (an artificial resin), shellac, and paraffin wax: on top of these a piece of tin-foil: and over this a further layer of wax. The phenomenon appeared quantitatively as before. It is inconceivable that breakdown products of muscular activity can penetrate wax, tin-foil, wax, shellac, and 'Elo', one on top of the other. Was it due to injury in dissection? It was found unaltered in a frog's gastrocnemius, which can be prepared with a minimum of injury. The temperature was lowered to 0° C. The high heat-rate existing in a fatigued muscle diminished to one-sixth, which is what we should expect were it due to a chemical process occurring continuously, not at all what we should look for were a technical physical error the basis of the phenomenon.

I was inclined, when I first described the phenomenon, to the first of the two alternatives just mentioned, to the belief that oxygen restores the normal interfaces, or conditions, which prevent the organised system from becoming a biochemical chaos. During the last few months, however, I have come across another effect which inclines me a little to the second alternative—perhaps both are correct. The experiment is a simple one and the result quite certain: it ought to have been made long ago: but one only thinks of these things slowly. If a muscle showing a very high resting heat-rate induced by anaerobic stimulation be immersed for an hour or two in *oxygen-free* salt solution, its heat-rate returns to its original low level: the muscle need not even be alive: it may have been 'electrocuted' by excessive stimulation, it may have been irreversibly damaged by too long a maintenance of its high heat-rate in nitrogen. Yet, under the influence of the washing, in a time which suggests diffusion outwards of some catalysing agent, the breakdown evidenced by the previous high heat-rate is completely—or almost completely—stopped. Clearly, oxygen as such is not necessary for a reversal of the effect. Perhaps if lactic acid be not already present in excessive amount, the lactic acid breakdown can take the place of oxidation in the maintenance of the normal internal architecture of the cell: perhaps, however, *something* is set free in the absence of oxygen, which induces—or helps to induce—the irreversible breakdown of the muscle protoplasm with a liberation of energy: a something which can be dialysed away by immersion of the muscle in salt water.

It is well known that, in man, too prolonged exposure to anoxæmia may produce harmful effects lasting for a long time or even permanently. As Haldane writes: "A short exposure even with loss of consciousness produces no serious after-symptoms: but occasionally a man's behaviour is very abnormal for a few minutes after recovery." "With severe and prolonged exposure to want of oxygen the nervous after-symptoms are of an extremely formidable nature and often end in death." "The symptoms are evidently due in the main to widespread injury to the nerve cells during the exposure." "The heart may also suffer in prolonged exposure to want of oxygen. The after-symptoms may be mainly cardiac; it may be a considerable time before the heart fully recovers." "Probably every other organ and tissue in the body feels the after-effects of severe exposure to want of oxygen. The patient often enough dies of pneumonia. Acute nephritis and gangrene of extremities have been noted." And so on. May we not be witnessing here in man the after-effects of the same partial disintegration of the living protoplasm as can so easily be demonstrated in anoxæmia in the isolated muscle?

In Warburg's work we find further evidence of a harmful effect of oxygen lack. An embryo of a chick is kept for some hours in salt solution saturated with nitrogen: oxygen is then introduced. In the normal embryo there is practically no lactic acid formation if sufficient oxygen be present: the free energy required for continued existence is supplied by oxidation. In the embryo which has been subjected to a period of anoxæmia, however, the capacity for oxidation is found to be diminished and a large part of the energy it requires must now be derived from the lactic acid breakdown. By anoxæmia, in fact, the normal embryo has been reduced to a state in which its metabolism is similar to that which Warburg has found to characterise tumour tissue. Can it be, as Warburg's work suggests, that oxygen-lack, working upon the normal architecture and machinery of the cell, leaves behind a type of mechanism analogous to that of tumour? Dare we see in the disintegrative process set up by anaerobic activity in the isolated muscle cell an exaggerated case of the harmful effect produced in man by prolonged and severe anoxæmia, or in the chicken embryo by oxygen want? It is dangerous to speculate too far, but it is foolish not to speculate at all.

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learn to look at architecture as it might appear to an observer from another planet, to whom its human origin was unknown, and on the whole this detachment is more nearly attained by the landscape painter than by the historian or even, perhaps, the architect himself.

The old towns of the Riviera crowning the foothills of the Alpes Maritimes, or capping promontories which project against the blue Mediterranean, provide as usual the subject for one kind of culmination of natural in architectural form. Of the purely natural landscape of this delightful coast there are as usual several studies, of which Mr. H. Van der Weyden's The Lone Pine of La Mortola (208) is the most considerable; but it is to be regretted that the landscape of the tropics should be almost unrepresented in the Exhibition. The gamut of the emotions evoked by the world's scenery remains incomplete so long as the tropics are passed over, and the traveller longs to see at least something which will recall the coast with fringe of waving palms and the gleam of green translucent water within the coral reef, with its line of foaming breakers and deep blue sea beyond.

Among the artists who are enterprising in their research for natural effects Mr. W. L. Wyllie is certainly to be reckoned, and in Fifty North and Forty West (207) he gives us the impression of an occurrence which is never seen without a thrill of excitement, the sudden breaking away of the whole summit of a great dome-shaped wave in the foaming cap which sailors call a 'cauliflower sea', which, launched bodily forward, is here seen rolling towards the observer.

Such were the aspects of Nature, or the emotions aroused by aspects of Nature, which I found observed and recorded by our fellow-students, the landscape painters in this year's Exhibition of the Royal Academy.

News and Views.

In his Ludwig Mond lecture, delivered recently at the University of Manchester, the main part of which appears as a supplement to this issue of NATURE, Prof. A. V. Hill refers to the value of experiments carried out on isolated animal tissues for the elucidation of the phenomena of life, and illustrates his thesis with descriptions of some recent work performed on the isolated nerve and muscle of cold-blooded animals. Both tissues consume oxygen not only as a result of activity but also whilst at rest: it appears that not only is the production of energy in the form of a nerve impulse or a muscular contraction accompanied, or followed by, the consumption of oxygen, but also oxygen is required for the process of remaining alive and irritable, of being ready to respond to a stimulus. The isolated muscle uses the absorbed oxygen to oxidise glycogen; in the absence of oxygen, lactic acid is formed from the glycogen, which breaks down much more rapidly than in the presence of oxygen, and the free energy of this breakdown suffices to maintain irritability in the muscle for a short time, provided that the lactic acid is removed by immersing the muscle in saline. In the presence of oxygen a portion of the acid is completely oxidised, but the remainder is resynthesised to glycogen, so that in the presence of oxygen the muscle lives much longer than in its absence.

The next step in the chain of evidence given by Prof. Hill is the result of studies of a muscle stimulated in nitrogen to fatigue. The heat production at rest after the stimulation is much greater than before, and may in time exceed the amount that can be obtained by the breakdown of all the carbohydrate into lactic acid, indicating that the muscle protein is also breaking down. The resting heat production can be reduced to its low pre-stimulation level by immersing the muscle in oxygen-free saline or by supplying it with oxygen. The exposure to nitrogen, then, appears to have initiated a degradation of the muscle protoplasm which can be stopped by again admitting oxygen, or by washing away some substance which may be supposed to aid the protoplasmic breakdown. In any event, the deleterious effects of asphyxiation appear to be due to disintegration of the cells of the tissue themselves, and, conversely, oxygen is necessary for the maintenance of cell structure. Put in other words, Prof. Hill argues that the living cell may be considered to be in a state of dynamic, as opposed to static, equilibrium, and therefore to require a supply of oxygen for the maintenance of its very structure.

On Monday next, May 13, Messrs. Sotheby and Co. will offer for sale a collection of letters (1743–1820) from and to Sir Joseph Banks, president of the Royal Society. They are being sold by a collateral descendant of Dorothea Lady Banks, wife of Sir Joseph Banks. The series includes botanical and horticultural letters and papers of Australian interest—communications to Banks from the early governors of New South Wales—also letters of Matthew Flinders, George Bass, and Bligh. It would seem improbable that any have been published; no indication, however, is supplied as to this. The correspondence is suitably secured in handsomely bound folio albums, each having a list of contents, though unfortunately no numbers are given to accord with the sequence of letters; thus reference is tedious.

Among miscellaneous matter (Lot 7) we notice a letter of Thomas Young, in a fine script, addressed to Count Rumford at the Royal Institution and dated July 9, 1801. It refers to his appointment to the professorship of natural philosophy. "As to the journals", he says, "I should not much object to engage that a sheet or more should be read for publication every week; but I conceive that it would give them additional importance if it were left to the discretion of the professor, with the approbation of the committee, and with proper notice, to publish a number at the end of a fortnight instead of a week, whenever there might appear to be a real deficiency of

matter to fill it. As I think I should want little or no assistance either in translating or transcribing, except what Mr. Davy might have the goodness to give me, I hope when you have reconsidered what I have stated you will not much differ from me in opinion."

AT Oxford, on May 4, under the auspices of the Society of Friends of the Old Ashmolean, a public lecture was delivered by Prof. D'Arcy Thompson on "The Hellenic Element in the Development of Science". It was shown that Aristotle's doctrine of excess and defect, applied by him in the region of biology as in that of ethics, was in accordance with conceptions of Greek mathematicians in regard to the theory of numbers, especially as developed in later times by Theon of Smyrna in the series known as the 'indeterminate' or 'boundless' dyad. The geometrical aspect of number was always kept in view by the Greeks; Euclid's treatment of the square of the hypotenuse exemplified this, and his whole system culminated in the dodecahedron with its pentagonal surfaces. Much of the fabric of modern science has its foundation in the mathematical conceptions amplified and illuminated by the genius of the Greeks, but shared with them by other peoples, as by those of Egypt and Chaldea. The lecture, which was largely attended, was followed by a meeting at which various donations to the Lewis Evans collection were announced, and means were considered for increasing the membership of the above-mentioned Society.

ON Saturday, May 11, Lord Birkenhead is to unveil stained-glass armorial windows given for the embellishment of the staircase of the Old Ashmolean Building, Oxford. Two armorial windows are being added to those already in the Museum to commemorate the foundation gift of historic scientific instruments by Dr. Lewis Evans, and in gratitude to four of the great City Companies which by timely benefactions made it possible for the University to install the Evans collection in the Old Ashmolean, and thus to fulfil the condition on which it was offered to Oxford. The Evans window is presented by certain members of the Society of Friends of the Old Ashmolean, chief among whom was the late Lady Osler. It is inscribed: LUDOVICUS EVANS, D.SC., QUI MUSEUM ASHMOLEANUM DENUO LOCUPLETAVIT INSTRUMENTIS NATURALIS SCIENTIAE COLLATIS HIC COMMEMORATUR MCMXXV. The second window, given by Sir Dugald Clerk, bears the arms of the Companies of the Goldsmiths, Ironmongers, Clothworkers, and Fishmongers. It is a delightful composition, and a reminder of their many services on behalf of education. The inscription runs: MUSEI ARMARIA INSTRUXIT ET ARCAM DITAVIT GILDARUM LONDINIENSIUM LIBERALITAS QUARUM INSIGNIA DEPINGENDA CURAVIT DUGALDUS CLERK MCMXXIX. The earlier windows commemorate Elias Ashmole, the first founder of the Museum in the seventeenth century, and his friends, John Tradescant the younger, Dr. Plot, and Sir Christopher Wren. The new windows which Lord Birkenhead is to unveil relate to the re-founding of the old Museum in the twentieth century after a lapse of thirty-five years, during which it had been allowed to fall into a neglected state.

AMONG the portraits in the exhibition now open at the Royal Academy, that of Sir Ray Lankester by Sir William Orpen is acknowledged to be the outstanding picture of the year. The fundamental note of the picture is that of declining years, yet the harmonies give it wonderful tone. There is still an inquiring look in the face, with its fine forehead and the clear, steady eyes which always seem to mirror thought and observation, while the beautifully formed hands are given their full value in an easy attitude which seems to signify rest after labour. Another very successful portrait is that of Prof. J. Millar Thomson, emeritus professor of chemistry, King's College, London, by Mr. P. A. Hay. Mr. Richard Jack exhibits a fine picture of Lord Moynihan, president of the Royal College of Surgeons; and other portraits of people well known in scientific circles are those of Mr. E. F. C. Trench, past president of the Institution of Civil Engineers, by Mr. George Harcourt; Mr. W. Tapper, president of the Royal Institute of British Architects, by Sir William Orpen; Mr. J. L. S. Hatton, principal of the East London College, by Mr. Augustus E. John; Prof. Priestley Smith, emeritus professor of ophthalmology, University of Birmingham, by Mr. Harold Speed; Sir Hugo Hirst, chairman and managing director of the General Electric Co., Ltd., by Mr. Richard Jack; and Mr. A. S. Ramsey, president of Magdalene College, Cambridge, by Mr. Francis Dodd. There is also a bust in bronze of Col. R. E. Crompton, by Mr. George H. Paulin, and a miniature of Prof. J. P. Hill, by Elizabeth A. Steele.

THE fourth Huxley Memorial Lecture of the Royal College of Science was delivered by Prof. F. O. Bower, at the Imperial College of Science and Technology, on Friday, May 3, the title being "The Origin of a Land Flora, 1908–1929". Prof. Bower began by referring to his book "The Origin of a Land Flora", published in 1908. He summarised the theory of 'interpolation' there put forward to account for the origin and progression of the spore-bearing plants, the dominance of which is so striking in all land plants from the ferns upwards. He then indicated the more important modifications in the view expressed twenty-one years ago which have resulted from advances in botanical knowledge. The chief of these concern, first, the expansion of our knowledge of alternation of generations in the brown and green algæ and the significance of the cytological distinctions between the two generations in these plants. Secondly, the outlook has been changed by the increase in the knowledge of the very simply organised plants now known to have existed in early Devonian times; thirdly, a study of the embryology of the Psilotaceæ has shown that this group now stands nearest to these ancient fossils.

GIVING these new facts and others their full value, Prof. Bower holds that his position as stated in 1908 needs "neither reversal nor obliteration but only modification". He suggested that the remote ancestors of the Archegoniatæ were of the same general type as the Green Algæ, but in these ancestors the act of meiosis was deferred, and a diploid phase

interpolated which was structurally suited to sub-aerial conditions and bore numerous spores. These plants would thus at one stroke achieve three biological advantages of prime importance: (1) a multiplication of possible combinations of hereditary characters (as suggested by Svedelius); (2) an opportunity of securing a wide spread on dry land by the dissemination of spores; and (3) relief from dependence on repeated syngamy by numerical increase on land, where the necessary medium of external liquid water is not always available. In conclusion, Prof. Bower pointed out that while the gap between the Algæ and the Archegoniatæ is still open, and indeed remains as in 1908, yet the evolution of the constituent parts of the land-living sporophyte can now be traced with the aid of the early Devonian plants.

ACCORDING to a recent *Daily Science News Bulletin* issued by Science Service, Washington, D.C., a notable invention was announced to the National Academy of Sciences on April 19 by General G. O. Squier, the inventor of 'wired wireless'. The principle of wired wireless is the same as that used in sending telegraph or telephone messages over lines carrying signals of different frequency or over power lines. The new method, which is called the 'monophone', is the perfection of a form of radio transmitted partly by telephone wires. In America the ether is inconveniently crowded with messages of all kinds. It is now proposed to make the ordinary telephone wires carry some of these so as to relieve the congestion. In particular, without interfering with the present point-to-point service of the broadcasting and without change of equipment, the telephone wires can be made to work sixteen hours a day, bringing the broadcasting programmes to the householder. It is suggested that this 'line radio' could be made to provide a method of financial support to the broadcasting companies, thus eliminating the necessity of broadcasting advertisements both directly and indirectly. The small power used in this system is also claimed as a further advantage. The power taken by a small incandescent lamp would be sufficient to supply five thousand telephones. When operating the telephone-connected set, no tuning would be necessary. To get a new programme all that is necessary is to turn a switch. Fading and the various kinds of interference which prevent good broadcast reception would be eliminated. There would be no difficulty in receiving sound-motion pictures and television by this method. It could be usefully employed for educational purposes.

ANOTHER development in broadcasting was described by Prof. A. L. Foley, of Indiana University, in a paper read on April 23 to the National Academy of Sciences, on a new type of microphone for use by broadcasters and public speakers. It is still in the experimental stage, but as the principle is novel it is considered to be very promising. It contains no moving diaphragm. A usual type of microphone (or 'mike' as it is frequently called in America) is the condenser microphone. A thin diaphragm of metal is hung in front of a metal plate with an air space between them. Both have electrical charges, and as the diaphragm is pushed or pulled by the sound waves the electrical charges fluctuate in value and electrical currents flow. Some of the energy is radiated into space and picked up by the receiver's set. The difficulty with any type of diaphragm is that it has free vibration periods of its own which it tends to assume, thus distorting the forced vibrations due to the sound waves. In Prof. Foley's microphone there are only two solid metal plates with an air space between them. The sound waves of the speaker's voice directed between the plates cause alternate condensations and rarefactions of the air. As the air is acting as the dielectric of the condenser formed by the plates, the rapid changes in its density cause alternating currents in the plates, which are used to radiate energy into the ether. Prof. Foley says that the new device is in process of development and will not be on the market for some time.

THERE is always interesting matter in the Annual Report of the Zoological Society of London, the centenary celebrations of which were referred to in our issue of May 4. The outstanding feature of this year's report is the remarkable record diagrammatically presented in its "Century Chart of Progress". On the whole, the chart shows a steady record of progress, apart from a slack period which began in 1839 and continued for about thirty years. But the extraordinary rise in the numbers of members and of visitors to the Zoological Gardens in Regent's Park, and in income, which commenced in 1910 and has carried the Society from height to height in almost unbroken leaps, is witness to the success of the policy of Dr. Chalmers Mitchell and the Council, and perhaps also to an increasing love of entertainment which has seized the people of Great Britain. There has been a certain increase in the numbers of deaths, especially amongst mammals and birds, but this is attributed to the increased size of the collection, and the installation of electric heating and lighting into more of the houses in the Gardens shows that every effort is being made to ameliorate the living conditions. No indication is given of the effect upon general health and mortality of the electric systems already installed. Such information, based upon the definite records of the pathologist, would afford an invaluable guide to other zoological gardens at home and abroad which, on account of the great cost, hesitate to install electric fittings until their value has been clearly proved.

THE second number of the *Realist* continues some of the subjects begun in the first and gives a clearer idea of the general idea which the promoters have in mind. It is to be a journal of scientific humanism, and this must mean treating of matters of living human interest in the light of scientific research. It does not at present offer any review of scientific works or attempt to summarise the recent additions to our knowledge, but matters of current moment and discussion are taken up and suggestions made as to the lines of future development. The emphasis, in fact, is rather strongly laid in these opening numbers on the present and, still more, the future. The first article in the May issue, by G. E. G. Catlin, deals in this spirit with the 'Next Step for Democracy'.

The outstanding point in the recent American presidential election is well taken. Both candidates were in the true sense realists and represented a great advance in the political sense of the democracy which adopted them as its champions. It is clear that in the modern conditions of extreme complexity and world-wide extent of industrial and social relations, real expertness is needed in those actually in power. It is also apparent that control of the industrial conditions and relations of one State and another has already become more important than the merely political relations of the old governments and diplomacy. This involves more scientific expertness on the part of the governors and a better appreciation of such expertness on the part of the governed.

MOST of the other articles in the *Realist* for May strike a similar keynote to that sounded by Prof. Catlin. That on the "Crisis in Psychical Research", by Mr. E. J. Dingwall, will interest a good many people by its suggestion for a new thoroughly sound and independent investigation of recent phenomena of a spiritualistic kind. The point is made that the Society for Psychical Research, which was founded to do this very thing, has lost its standing as a scientific body just at the time when the phenomena to be investigated have become more numerous. Dr. Charles S. Myers gives an account of the work and the results of the Institute of Industrial Psychology. Cases are quoted in which not only greater industrial efficiency has been secured and sickness among employés has been reduced, but also the earnings of the workers have been increased. Mr. H. Martin Leake has a somewhat similar plea for the rationalisation of British agriculture. Dr. Norman Haire concludes his account of the recent experiments in rejuvenation, mainly of Voronoff and Steinach. He sounds a fairly hopeful note while admitting that it is at present impossible to decide whether any of these procedures actually prolong life in a human being. Dr. A. P. Laurie has a short but very interesting and convincing defence of the scientific analysis of the materials and methods of the old masters. Much of this has appeared in letters to the *Times* and it is useful to have it collected. The editor, Major A. G. Church, has an equally persuasive article on the need of applying scientific methods to the development of our imperial possessions. This is imposed upon us, both by our monopoly of so much of the world's richest soil and the 'sacred trust' which we have professed to the world for the well-being and development of the backward races.

THE curators of the University of Edinburgh unanimously agreed to offer the principalship—which will become vacant on Sept. 30 by the resignation of Sir Alfred Ewing—to Sir Thomas Holland, Rector of the Imperial College of Science, London, who has accepted the appointment. Sir Thomas is at present in South America, and the negotiations have been completed by cable. He is to be president of the British Association during the forthcoming meeting in South Africa, and it is understood he will not arrive in Edinburgh until about the middle of October. He will take to his new office a wide experience—academic and administrative—and extensive first-hand knowledge of conditions in the Dominions and in India, a matter of great importance to the University of Edinburgh, which has more students from overseas than any other university in Great Britain.

AT the meeting on May 2 of the Linnean Society of London the following honorary members were elected: Dr. Theodor Mortensen, superintendent, Zoological Museum, University of Copenhagen, distinguished for his researches on Echinodermata and other marine organisms; Prof. Carl Hansen Ostenfeld, professor of botany and director of gardens and museum, Copenhagen, distinguished for his researches on the taxonomy and distribution of arctic plants, and also on cytology, heredity, and phytoplankton; Prof. Bohumil Němec, professor of plant anatomy and physiology, Charles University, Prague, distinguished for his researches in cytology, physiology and anatomy of higher plants, and in mycology and bacteriology. The presidential address of the Society will be delivered at the anniversary meeting on May 24, when the Gold Medal will be presented to Prof. Hugo de Vries, who, unfortunately, on account of ill-health, will not be able to be present.

THE fortieth anniversary of the completion of the Eiffel Tower in Paris was celebrated on May 2 by the unveiling of a bust of Gustave Eiffel at the base of the tower. The ceremony was performed by M. G. Martin, Secretary for Posts and Telegraphs, who paid a tribute to the great engineer. Eiffel was born at Dijon on Dec. 15, 1832, and died in Paris on Dec. 28, 1923. He was a student of the École Centrale des Arts et Métiers; he obtained a wide experience of engineering construction, and by 1887, when he began the Tower, had built iron and steel bridges, etc., of more than 100,000 tons total weight. The Tower, which is 984 feet high, is still the highest structure in the world. It is a resort of sightseers, but it is also used as a wireless and meteorological station. Nearly 14,000,000 persons have ascended the Tower since its construction. Eiffel served as president of the French Society of Civil Engineers and was also an honorary life member of the British Institution of Mechanical Engineers.

THE Ministry of Health has issued a statement respecting the present situation in regard to smallpox. Smallpox of a mild type has been prevalent in England and Wales during the last few years, and in 1928 there were 12,420 cases with 53 deaths. The distribution of the disease has been relatively wide, but it has been kept under control or stamped out in all of the 35 or 40 counties in which it has appeared, except in some five to ten districts where it has obtained a greater hold, owing in particular to neglect of vaccination. In the Administrative County of London, with a population of 4½ millions, only 167 cases have occurred this year. Some uneasiness has been occasioned by cases derived from the s.s. *Tuscania*. This vessel arrived from Bombay at Marseilles on Mar. 27 with passengers and crew numbering 1589, afterwards proceeding to Liverpool and Glasgow. In all, 45 persons from the *Tuscania* have been notified as suffering from smallpox, of whom 7 have died,

but there is reason to think that this epidemic is now at an end, and as a result of the rigorous measures taken, English ports have been kept free.

THE Yorkshire Naturalists' Union, founded in the sixties of last century, is one of the oldest, as it is one of the most flourishing of the amalgamations of natural history societies in Great Britain. The Annual Report for 1928 states that the affiliation includes thirty-eight local societies, and the summaries of work accomplished by the various sections of the Union show how active is the interest taken in the fauna, flora, and geology of the county. The official organ of the Union is *The Naturalist*, a magazine the usefulness of which as a medium for the publication of natural history in all its branches is emphasised by the absence of an all-England magazine of the same kind. It is a remarkable fact that, since *The Zoologist* died, a Nature-loving country like England should possess no periodical dealing with general natural history on the lines followed by that much-lamented journal.

THE Government Museum at Madras, under the superintendence of Dr. F. H. Gravely, and, during his absence in Europe in 1927, of Prof. E. Barnes, continues to make good progress. Like other progressive museums, it finds that detailed specialist collections are unsuitable for exhibition, and accordingly the Bruce Foote collection of prehistoric implements has been stored for reference, and the valuable exhibition space which it occupied has been given over to a much-needed expansion of the ethnological collection. The Buddhist sculptures have been rearranged, and a description of part of this exhibit is in the press, and various improvements have been made in the zoological and the coin collections. Appendices to the Administration Report for 1927–28 show that the Museum receives a very small proportion of its material as gifts from the public, and that a surprising number of coins and of copper statues of saints and kings turned up as treasure-trove in the villages of the Presidency.

A SOMEWHAT alarmist article on "Fundamentalism in England", by Maynard Shipley, appears in the March number of *Evolution*. Among other statements, it alleges that "much anti-scientific propaganda is being 'put over' in the smaller provincial towns and vast districts of Wales, Ireland, and Scotland, where people still believe in witchcraft, as firmly as our 'Pennsylvania Dutch' towns where no hint of modern scientific thought has so far penetrated." So far as our experience goes, Mr. Shipley's statement, as it refers to Scotland, at any rate, is as shaky as his composition. We have never denied that there is a strong undercurrent of dislike to the theory of human evolution in the British Isles, but it is the 'die-hard' resistance of conservatives who do no more than wish their old-fashioned beliefs to be left alone. It certainly does not express itself in active and fussy propaganda, and much of it will die with its generation. As for witchcraft in Scotland, the most we can say is that a canny Scot may occasionally believe in luck, but even evolutionists of the highest standing have been known to risk their chances at the casinos of Europe.

SOME four or five years ago Dr. Percy R. Lowe, of the British Museum (Natural History), discussed with the eminent French ornithologist, M. Jean Delacour, plans for a joint Franco-British Expedition to Madagascar to collect specimens of both living and extinct animals which might possibly supply further clues to the origin of the fauna of this, one of the most interesting islands in the world. What was most desired was the discovery of more remains of the extinct ostrich-like fossil known as *Mullerornis*, which may throw light on the past history of all struthions, or ostrich-like birds, and incidentally perhaps of the island itself. Another most welcome discovery would be a complete skeleton of the giant flightless bird *Æpyornis maximus*, which stood at least ten feet high. Funds for such an expedition have now been provided by Mr. Arthur Vernay, and the Trustees of the British Museum have loaned the services of a palæontologist, Dr. Errol I. White, who is due to arrive at Madagascar towards the end of May. At the last moment the Expedition has been joined by a party of American scientific workers. It is now, therefore, representative of France, Great Britain, and the United States of America.

THE Royal Horticultural Society is issuing invitations to the International Congress which the Society is arranging to be held in London on August 7–15, 1930; that is, immediately before the International Botanical Congress meets at Cambridge. A representative executive committee has been appointed by the Society, with Lieut.-Col. Durham, the secretary of the Society, as secretary, to whom the subscription for membership, one pound, should be paid. The programme will include lectures and excursions, and a flower show on the last two days. The main subject for discussion will be "Propagation: vegetative and seminal", for which communications are invited and in which eminent British and Overseas authorities have already signified their intention of taking part. There will also be other sections, and suggestions for papers for consideration are invited. The six committees appointed at the Vienna Congress in 1927 will present their reports. These include a Committee on Nomenclature, the report of which will be awaited with special interest in view of the lack of uniformity in the use of plant-names, especially of varieties and hybrids, which exists at present among horticulturists. Communications by means of papers, or participation in the general discussion, will be permissible in English, French, and German. All correspondence should be addressed to the secretary of the Royal Horticultural Society, London, S.W.1.

THE first conversazione this year of the Royal Society will be held at the Society's rooms at Burlington House, W.1, on Wednesday next, May 15.

UNDER the Order in Council dated Feb. 6, 1928, the Lord President of the Council has appointed Sir James Alfred Ewing to be a member of the Advisory Council to the Committee of the Privy Council for

Scientific and Industrial Research, to fill a vacancy occasioned by the death of Mr. Robert Whyte Reid.

SIR JAMES IRVINE, Principal of the University of St. Andrews, has been awarded the Elliott Cresson Gold Medal of the Franklin Institute of the State of Pennsylvania "for his brilliant research on Carbohydrate Chemistry." The Medal will be presented on May 25, and will be accepted on behalf of Sir James Irvine by Sir Esmé Howard, British Ambassador to the United States.

AT the annual general meeting of the Society of Glass Technology, held in Sheffield on April 17, Mr. Herbert Webb, of Stourbridge, was elected president in succession to Mr. Walter Butterworth, Sen. The following other officers were elected:—*Vice-Presidents:* Mr. E. A. Coad-Pryor, Dr. C. J. Peddle; *General Treasurer:* Mr. Joseph Connolly; *American Treasurer:* Mr. F. C. Flint; *Hon. Secretary:* Prof. W. E. S. Turner.

THE council of the Institution of Civil Engineers has recently made the following awards in respect of papers read and discussed at the ordinary meetings during the session 1928–29: A Telford Gold Medal and a Telford Premium to Mr. Conrad Gribble (London); a George Stephenson Gold Medal to Mr. Harry Hall (London). Telford Premiums to Messrs. H. N. Colam (London); F. W. A. Handman (London); T. P. M. Somers (Glasgow); H. V. C. Johnstone (Sudan); and jointly to J. H. Hyde (Twickenham) and H. R. Lintern (Teddington).

THE disastrous earthquake which occurred in Khorasan, Persia, on May 1, was recorded as a well-marked disturbance at Kew Observatory. The preliminary tremors reached the Observatory at 15 h. 45 m. 28 s. G.M.T., and the records indicate that the epicentre was near lat. 35° N., long. 54° E. The disturbance lasted about three hours, and the maximum displacement of the earth at Kew was nearly half a millimetre. It is reported that a large area has been devastated and that great loss of life has occurred.

IT is announced in *Science* that the committee of the Academy of Natural Sciences of Philadelphia appointed to select a recipient for the Hayden Memorial Geological Award for 1929 has nominated Dr. Charles Schuchert, professor emeritus of palæontology in Yale University, for the award, in recognition of his distinguished work in invertebrate palæontology, palæogeography, historical geology, and the migration of faunas. The Hayden Award was founded in 1888 by Mrs. Emma W. Hayden as a memorial to her husband, Dr. Ferdinand V. Hayden, director of the U.S. Geological and Geographical Survey in the early days of that organisation. It consisted at first of a bronze medal with an honorarium in cash, but it now consists simply of a gold medal, and is given for pre-eminent research in geology, palæontology, or in related sciences.

HIS Majesty the King has approved the award of the Royal Medals of the Royal Geographical Society as follows: Founder's Medal to Mr. Francis Rennell Rodd for his journeys in Aïr and his studies of the Tuareg people; Patron's Medal to Mr. C. H. Karius, assistant resident magistrate, Papua, for his crossing from the Fly River to the Sepik. The Council has made the following awards: Murchison Grant to Mr. C. S. Elton for his three seasons' study of the distribution of life in Spitsbergen; Back Grant to Mr. C. P. Visser for his exploration of the Hunza-Karakoram glaciers; Cuthbert Peek Grant to Lieut. Donald Cameron for his journey across the Sahara from Nigeria to Algiers; and Gill Memorial to Mr. George Dyott for his recent expedition in search of Colonel Fawcett.

WITH reference to the note in NATURE of April 27, p. 655, on the Huygens' object glasses presented to the Royal Society, it has been pointed out to us that Dr. R. T. Gunther photographed the signatures "Constantine H", scratched on all three object glasses with their focal lengths, and published them in "Early Science in Oxford", vol. 2, p. 300, in 1923. The photographs show the bubbles in the glass of the lenses very clearly.

THE palæontological collections at Upsala have increased so enormously of recent years, thanks mainly to the receipt of the vertebrate material from China so thoroughly described by Prof. C. Wiman and his pupils, that it was necessary to store them in about half a dozen different buildings. It is good news that the Swedish Riksdag has voted the sum of 791,000 kroner (about £44,000) for a new palæontological institute, in which research and teaching will be more conveniently carried on. Building is to begin in the autumn.

WE have received the Annual Report of the Calcutta School of Tropical Medicine, Institute of Hygiene, and the Carmichael Hospital for Tropical Diseases, 1928. Administrative matters are very briefly dealt with, and the bulk of the publication consists of reports of the various departments with summaries of the research work carried out, much of which is of considerable value and importance.

THE Report of the Director-General of Public Health, New South Wales, for the year 1927 has been recently issued. In addition to statistical details, reports of scientific investigations are included. As in former years, a large number of rats were examined for plague infection, but none was found. In all, 220 samples of milk were examined for tubercule bacilli, and in no instance was evidence of tuberculosis found—an excellent record. The year was notable for the very low incidence of typhoid fever, but diphtheria has continued to be prevalent. The death-rate from cancer increased, and has been increasing steadily for a number of years.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the York Technical Institute—The Secretary for Education, Education Offices, York (May 18). A junior technical officer in the Admiralty Technical Pool for duty in the experimental section of an Ad-

miralty Establishment at Portsmouth—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (May 18). A head of the mathematics department of the Dundee Technical College and School of Art—The Secretary, Technical College, Dundee (May 20). A part-time demonstrator in biology at King's College of Household and Social Science—The Secretary, King's College of Household and Social Science, Campden Hill Road, W.8 (May 22). A woman lecturer in geography at the Hull Municipal Training College—The Principal, Municipal Training College, Hull (May 22). Physicists and electrical engineers on the staff of the Radio Research Board of the Australian Commonwealth Council for Scientific Research—F. L. McDougall, Australia House, Strand, W.C.2 (May 26). A horticulturist and an agricultural lecturer and warden at the Kent County Farm Institute at Borden—The Agricultural Organiser, Springfield, Maidstone (May 27). A principal of the Technical College and Junior Technical School, Horwich—J. McLean, Railway Mechanics' Institute, Horwich, Lancashire (May 28). A lecturer in physiology at the Chelsea Polytechnic—The Principal, Chelsea Polytechnic, Manresa Road, S.W.3 (May 31). A Government analyst for Cyprus—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1 (May 31). A teacher in engineering at the Technical College, Wolverton—The Principal, Technical College, Wolverton, Bucks (June 1). A professor of commerce in the University of Birmingham—The Registrar, The University, Edgbaston, Birmingham (June 7). A professor of physiology in the University of Sydney—The Agent-General for New South Wales, Australia House, Strand, W.C.2 (June 8). A temporary junior assistant in botany in the University of Aberdeen—The Secretary, The University, Aberdeen. A chief mathematical master at Whitgift Grammar School, Croydon—The Headmaster, Whitgift Grammar School, Croydon. A woman lecturer in mathematics and geography at St. Hild's Training College, Durham—The Principal, St. Hild's Training College, Durham. A tutor in psychology at Loughborough College—The Registrar, Loughborough College, Leicestershire. An assistant in the public health laboratories and bacteriological department of the University of Durham College of Medicine—The Registrar, University of Durham College of Medicine, Newcastle-upon-Tyne.

Our Astronomical Column.

THE PLANET MERCURY.—This planet will be very favourably placed for observation at the middle of May as an evening star, being at its greatest elongation east of the sun on May 15, when it is placed twenty-two degrees east of that luminary. The planet will set on several nights more than two hours after the sun, and its position near the new moon on the night of May 10 will afford a very interesting spectacle in the west-north-west sky if the weather is clear. On the date mentioned, Mercury will set at 9.46 P.M. G.M.T., and the moon goes down at 9.45 P.M. The sun sets at 7.33 P.M., so that the phenomenon will be best seen at about 8.30 P.M. and may be watched until the two objects set. Mercury will be situated to the north-west of the moon about two degrees, and ought to be readily visible for about an hour to an observer who commands a good open view of the west-north-west sky in the region of the horizon. The moon will appear as a very narrow crescent, but should be distinctly observable to the unassisted eye with Mercury in close attendance sparkling with a rosy light and looking more like a star than a planet.

THE CENTRE OF THE GALAXY.—There are two papers on this subject in the March issue of *Proc. U.S. Nat. Acad. Sci.* Dr. O. Struve makes use of the conclusion that the strength of the calcium lines in early-type stars ascribed to interstellar matter is a measure of their distance; the lines becoming stronger as this increases. He has grouped the results for stars within 10° of the galaxy, taking means for every 30° of galactic longitude. The results when plotted show a good approximation to a sine-curve the maximum of which is in galactic longitude 337·6°, with a probable error of 18°. The longitude is only 10½° greater than the value adopted by Shapley for the galactic centre. Hence it strengthens the conclusion that the intensity of the spectral lines is a measure of distance, since the average distance is clearly a maximum towards the centre of the system of stars. It should be noted that the galactic longitude is reckoned from the intersection (in Aquila) of the galaxy with the equator of 1900. Very few astronomers pay any attention to the resolution adopted at the meeting of the International Astronomical Union in 1925 that it should be reckoned from Alpha Cygni, with the view of getting rid of the correction for precession.

Prof. H. Shapley's paper contains photographs and diagrams of the central region of the galaxy. There are very brilliant star-clouds to the south of the central line, but much dark matter along this line and to the north of it. It is shown, however, that the dark clouds do not spread very far, and that there are transparent regions outside them where some spiral nebulæ have been photographed, which are evidently extra-galactic. The dark clouds may, however, conceal rich star-clouds in the central region, also the mass of the obscuring matter itself is presumably large, so that it seems possible to imagine a sufficient amount of matter in the central region to account for the high velocities of revolution of the stars about this region which Oort, Plaskett, and others have found.

THE DISTANCES OF DARK NEBULÆ.—Series 2, No. 52 of *Lund Meddelande* contains an investigation by W. Gyllenberg of the distances of two regions where obscuration by dark matter is indicated by paucity of stars. The method used is to make star counts in the obscured region and in a neighbouring unobscured one. It is assumed that the dark nebulosity blots out entirely the light of stars behind it; assumptions are made as to the absolute magnitudes of the stars visible in the dark nebula based on general stellar statistics.

Mr. Gyllenberg applies his method to two regions. The distance of the dark matter in the America nebula near ξ-Cygni is given as between 440 and 510 light-years (Lundmark had previously found 610). The distance of the dark nebula near S. Monocerotis is given as 250 light-years: in this case Lundmark had found a value 13 times as great. Mr. Gyllenberg confesses himself puzzled by this large difference. He considers that if the colours or spectral types of the stars were considered, a much higher degree of accuracy could be attained.

Research Items.

HEAD-HUNTING.—In Vol. 58, Pt. 2 of the *Journal of the Royal Anthropological Institute*, Mr. J. H. Hutton analyses the head-hunting customs of the Nagas of Assam with the view of elucidating their significance both in that area and generally. Head-hunting has been explained as due either to a desire to obtain human hair for use as ornament or the desire for human beings to send to the next world as slaves of the dead. The latter belief, though present among the Nagas, is not found among the tribes where the practice of head-hunting was most flourishing. The religion of the Naga hill-tribes centres on fertility cults, with which are connected phallic observances and the erection of menhirs. But though these observances secure fertility they are not its source. This seems to lie in the souls of the dead. A wooden figure which contained the soul of the dead used to be placed on a grave by the Angami. This was thrown away before the sowing of the millet crop. Among the Ao the smoke-dried body of a dead relative was kept in the house until the first fruits were eaten, after which it was disposed of in the usual way. Other customs of a similar character point to the association of the dead body with fertility through its preservation either until the sowing of the seed or until the first-fruit ceremonies, when it was torn to pieces or otherwise treated. But among the peoples of Assam the head is more especially regarded as the seat of the soul. This is specifically stated among the Ao and may be inferred from the special sanctity of the head. A soul, for example, among the Konyaks may be transferred to a wooden figure by placing a skull upon it. If, therefore, the soul is a fertiliser and it resides especially in the head, when soul matter is required it may be obtained by cutting off a head and taking it home. Then not only enemies' heads are taken, but also the heads of comrades who fall in battle are cut off and brought back so that the enemy may not benefit by them. Women who hesitate to marry a man who has not taken a head may do so from the fear that he may be the less likely to be fertile. This form of belief seems also to underlie the head-hunting customs of Indonesia and the Pacific and may be traced westward and possibly as far as Britain and to neolithic or even palæolithic times.

ASYMMETRY AND CROSS-BREEDING.—In an address to the Eugenics Society, delivered on April 24, Dr. C. J. Bond dealt with hemilateral asymmetry in animals and man and its relation to cross-breeding, and made a stimulating addition to biological thought. He concluded that hemilateral—and sometimes serial—asymmetry is closely associated with previous cross-breeding. He contrasted the ancient breeds of cattle, for example, *Bos primigenus* and *Bos longifrons* and others, the horns of which curved either upwards or downwards, with such modern cross-bred animals as the shorthorns, the horns of which frequently curve upwards on one side and downwards on the other. Similarly, heterodactyly in fowls is a frequent occurrence in the F^2 product of a cross: while in man there are cases of parents with different sized ear lobes producing children whose right ears resemble those of one parent and left ears those of the other. Other examples were derived from asymmetrical eye-colour in man and animals. He argued that just as Mendelian segregation occurs in the formation of gametes, so in the cell differentiation of embryonic development, when the bilateral plan of growth is laid down, there is an analogous segregation of maternal and paternal genes. The degree of asymmetry appears to depend upon the closeness of kinship of the parents, whose physiological compatibility determines the stage at which segregation occurs. He hoped that the further study of this dissimilarity *in* the individual, like the study of dissimilarity *among* individuals, would assist genetic research.

BRITISH HERONRIES.—Although it is commonly believed that British heronries have declined during the past few centuries, there is no evidence of such decline in the statistics collected by E. M. Nicholson and his collaborators (*British Birds* for April). The number of heron's nests in England and Wales and part of Ireland in 1928 was between 3900 and 4000, but the English total was by far the greatest (3480 to 3566) not only in absolute numbers, but also in the average number of nests in a heronry, 14 there contrasting with about 7 in Wales and about 8 in Ireland. The highest averages occur in the south, Sussex leading with 54-55, followed by Dorset 38, and Essex 36, while at the other end of the scale lies Cumberland with an average of 6, and Northumberland with 6-7. Four English colonies had a total of a hundred or more nests. While in some places there have been marked declines, as at Aldershaw in Sussex, where there are said to have been 400 nests in 1840 and are now only about 80, taking the country as a whole the heron is holding its own or gaining slightly. The Scottish statistics have not yet been thoroughly collected and do not appear here, but will ultimately be published in the *Scottish Naturalist*.

CRUSTACEAN FEEDING MECHANISMS.—In continuation of their work on the feeding mechanisms of Crustacea, Prof. H. G. Cannon and Dr. S. M. Manton (*Trans. R. Soc. Edin.*, vol. 56, pt. 1, No. 9, 1929) have examined the three living genera of the Syncarida, *Anaspides*, *Paranaspides*, and *Koonunga*. They conclude that the first two genera exhibit two types of feeding, raptatory (*i.e.* grasping large food particles) and filtratory, essentially homologous with those previously described by these authors in *Hemimysis*. The third genus, *Koonunga*, and probably also *Bathynella*, have given up the filtratory method and feed only on large food masses. The Syncarida can thus be grouped in two series, *Anaspides* and *Paranaspides-Koonunga* and *Bathynella*, comparable with the Peracaridan series, Mysidacea-Isopoda or Amphipoda. Both series commence with forms exhibiting a filtratory mechanism, and through the development of the distal portions of the mouth parts and the suppression of the proximal filtering parts, end in a purely raptatory type. The raptatory mechanisms of *Anaspides* and *Paranaspides* have become modified for scraping up algal slime and similar bottom food by the enlargement of the basal portions of the first trunk limbs. The deviation of the feeding mechanism of *Koonunga* from the dual filtratory and raptatory type seems to have followed the same lines as the evolution of the typical amphipod or isopod type from that of the mysids. The maxilla has become an attenuated biting limb and lost all trace of endopodite and exopodite. The first trunk limbs have not formed a maxillipedal plate as in the higher Peracarida, but their heavy clawed armature and their marked flexure between the merus and carpus suggest that they are used for holding large food masses over the biting mouth parts. The most important characteristic of the *Koonunga* mechanism is the concentration of biting limbs, not around the mandibles at the mouth entrance, but around the distal endites of the maxillule.

GERMINATION OF *CYATHODIUM* SPORES.—The liverwort *Cyathodium*, one of the Marchantiaceæ, for a time wrongly regarded as having a British representative (*Riccia spuria* Dicks.), has recently been investigated by Mr. N. K. Tiwary at Benares, secretary of Benares Hindoo University, who has sent to NATURE a communication on the subject. Mr. Tiwary has succeeded in finding an abundance of germinating spores, though it has not been possible to bring about germination artificially. The spores are unusual in having from two to four germ-pores; they appear to have a distinct polarity, for the germ-tube and rhizoids arise from opposite ends, not from a single pore as is customary. There is variation in the manner of germination; the cell-contents on emerging from the germ pore form either an ovoid mass or a germ-tube. We have thus an addition to those species which have protonemata varying between the two main types.

EARTHQUAKE IN THE ALEUTIAN DEEP.—A great earthquake was registered at the Hawaiian Volcano Observatory (*Volcano Letter* for Mar. 14) at 3 h. 11 m. 22 s. P.M. on Mar. 6 (1 h. 41 m. 22 s. A.M. on Mar. 7, G.M.T.), the long waves being so prominent that the pens of the seismographs swept off the smoked paper. From the duration of the preliminary tremors it was clear that the origin was about 3650 km. from Kilauea. This is the distance of the well-known earthquake region that lies to the south of the Aleutian Islands, and later reports, received from Japanese vessels and elsewhere, show that the epicentre was on the north edge of the Aleutian Deep, a trough more than 4½ miles in depth, and about 100 miles south of Amukta Island. About 7.45 P.M., that is, in little more than 4½ hours later, the first sea-waves reached Hawaii, the largest occurring between 8 and 9 P.M. The range of motion in Hilo Bay was, however, only 16 inches. With the equally strong Alaskan earthquake of Feb. 3, 1923, the sea-waves at Hilo rose about 15 feet above the normal level.

ECHO AND SCATTERING WITH SHORT WAVE RADIO TRANSMISSION.—Radio engineers have been greatly puzzled by the anomalous results obtained when working with radio waves less than 100 metres in length. Partial explanations of some of these results are given in a paper on short wave transmission read by T. L. Eckersley to the Institution of Electrical Engineers on April 10. The main interest in short wave transmission, both from the practical and theoretical points of view, lies in echo and scattering effects. The author classes both these results together, as ultimately the two effects merge into one. He regards the conducting 'layer' as a complex structure of scattering clouds, the scattering being more intense in the lower levels of the layer. Experiments carried out near Chelmsford showed that local signals from Ongar could be balanced almost perfectly by means of a special receiver. On the other hand, signals from Bodmin, Grimsby, the Dutch stations, and a Berlin station at night time (during the period of weak signals) could not be balanced by any adjustment of the circuits. All these stations are within the 'skip' distance. Long distance stations such as Canada, Australia, India, South Africa, Rio, Java, and many other distant beam stations give results which are intermediate between those obtained from near stations and more distant stations lying within the skip distance. The author considers that the direct rays from the beam stations are so weak that their effects can be neglected. The rays received at Chelmsford are those scattered back from the regions where the main transmitting beam penetrates into the scattering region of the conducting layer. He now estimates the effective height of the daylight conducting layer as about 48 miles in summer and 60 miles in winter. The scattering of short waves bears some resemblance to that of a searchlight playing upon the clouds. If the searchlight itself is hidden from view, the point of intersection of the searchlight beam and the scattering clouds appears to be the source.

A NEW THERAPEUTIC LAMP.—Mr. Albert Eidinow describes in the *British Medical Journal* of April 13 a new therapeutic lamp, the novelty of which lies in a closer imitation of the sun's spectrum. Heliotherapy consists in the exposure of the patient's body to the sun's radiations, and to those from the sky, for carefully graded periods, which are increased up to several hours as the patient becomes accustomed to the treatment and as his body pigments: he thus receives long combined doses of short infra-red, intense visible light, and moderately intense 'long' ultra-violet radiations between 3000 and 3200 A.—the latter producing by slow degrees a deep, intense pigmentation. Mercury vapour lamps and arc lamps all produce intense radiations in the ultra-violet at wave-lengths below 3000 A., to which patients can be exposed only for short periods without the production of intense erythemas. The new lamp (Fig. 1) is intended to give radiations more like those of the sun, and to this end a number of small metal-filament glow lamps are used in series to supply visible light and heat in the yellow-red part of the spectrum, while the necessary ultra-violet component and the blue light are supplied by a long vacuum mercury vapour lamp tube, from which intense source all the short radiations are filtered out. To effect this, the tube of the lamp is composed of frosted silica instead of fused quartz, and in addition, a screen of 'sanalux' glass, which cuts off most of the rays below 2900 A., can be interposed between the lamp and the patient. To such a lamp patients may be exposed for several hours, either sitting up or recumbent, in the same way that they may be exposed to the sun in suitable climates, and so may obtain mild applications of long wave-length ultra-violet radiations together with the warming and stimulating heat and light from the glow-lamps. The lamp may be used for photographic purposes and for artificial daylight illumination, as for colour-matching its light is almost indistinguishable from daylight.

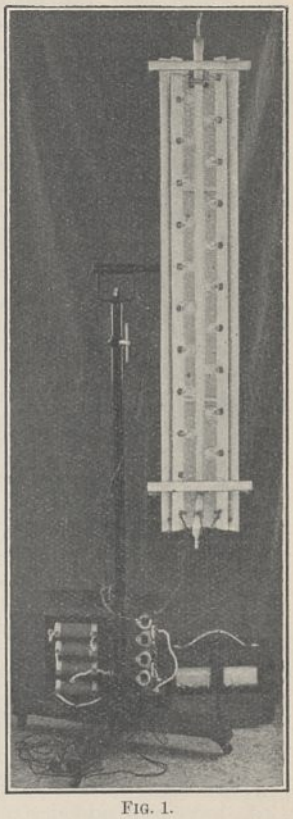

FIG. 1.

PHOTOGRAPHING ARTIFICIAL DISINTEGRATIONS.—The practical difficulties which arise in the study of artificial disintegration by the Wilson cloud method are mostly connected with the necessity for taking a very large number of photographs. Approximately

a hundred thousand normal α-trails occur in nitrogen for every one in which disruption of a nucleus takes place, and it is therefore essential to work with recording devices of high efficiency. In the issue of the *Proceedings of the Royal Society* for April 6, P. M. S. Blackett has described a double camera for use with the large Wilson chamber made by the Cambridge Scientific Instrument Company; this takes two sharp photographs of the plane of the chamber on two mutually perpendicular films, a special feature in its design being that the principal plane of each camera lens passes through the line of intersection of the plane of the chamber with that of the corresponding photographic film. Mr. Blackett has made a detailed theoretical investigation of the optimum working conditions for this apparatus, and has shown that the magnification of the cameras should be reduced so far as possible towards the limit set by the resolving power of the photographic emulsions. It is also found that if the number of tracks photographed in each beam of particles is made too large, there is a falling off in the observable number of resolved collisions. Mr. Blackett's paper is illustrated by two interesting plates, one of which shows the camera and Wilson chamber mounted ready for use, and the other some sheafs of α-particles, many of which have secondary δ-trails radiating from them.

SOLID HELIUM.—The issue of *Die Naturwissenschaften* for April 19 contains a short communication from the Physikalisch-Chemisches Institut of the University of Berlin, by F. Simon, announcing a further extension of the melting curve of helium. It had previously been established that helium could be obtained in the solid state at as high a temperature as 20° abs. by the application of a pressure of 1800 atmospheres, and in this new work the transition curve has been followed to 32° abs. and 3500 atmospheres. It is calculated from the data already obtained that it should be possible to solidify helium at the temperature of liquid air under a pressure of 15,000 atmospheres, provided no critical phenomena intervene. As is pointed out, the fact that a substance can exist as a solid at a temperature that is very much higher than the highest temperature at which it can be held liquid when in the presence of vapour—5·2° absolute in the case of helium—may be of considerable significance in connexion with the state of matter in the interior of stars.

RARE EARTHS FOR SPECTROSCOPY.—Adam Hilger, Ltd., have now added a number of rare earths to the list of substances of exceptionally high purity which they can supply for spectroscopic and other purposes. These have been specially prepared for them by Prof. L. Rolla and by Dr. W. Prandtl, and every specimen is guaranteed to contain in general not more than 0·1 per cent of total impurity. The ceria and yttria which are now available have, in fact, been used in a similar state by Hönigschmid and Auer von Welsbach for determinations of atomic weights, and the dysprosia is claimed to be even better than that used by these investigators. Terbium, holmium, erbium, europium, florenzium, and thulium are also shortly to be placed on the market. Considering the enormous labour involved in the isolation of these bodies, the prices asked for them are very moderate, ranging from only a half-guinea for five grams of Rolla's lanthanum oxide to thirty pounds for a gram of Prandtl's dysprosia. Messrs. Hilger also possess a considerable number of scandium compounds which formed part of the collection of Sir William Crookes, which can be had either individually or in the form of mounted museum specimens.

THE ASSAY OF COAL.—In the examination of coal it is found useful to amplify analyses by distillation with measurement of the products so obtained. Such methods give results differing from those of large-scale practice, but, with experience, correlation is possible. One of the many such tests proposed, the Gray-King assay, devised at the Fuel Research Station, has been widely used, and in *Technical Paper* No. 21 of the Fuel Research Board (London: H.M. Stationery Office, 1*s*. net), J. G. King, C. Tasker, and L. J. Edgcombe record experiences with the test covering several years. It is shown how the assay should be modified to deal with widely divergent materials.

VAPOUR PRESSURES AND DENSITIES OF AMMONIUM CHLORIDE AND IODIDE.—The determinations of the vapour pressures and densities of ammonium iodide and chloride made hitherto have shown considerable discrepancies. Purcell and De Lange, whose results are described in the *Journal of the Chemical Society* for February, find that the vapour of ammonium iodide is completely dissociated at all temperatures up to 400°. Their measurements, made between 300° and 400°, are in good agreement with those of Smith and Calvert. The case of ammonium chloride has been investigated by Rodebush and Michalek, and details are given in the *Journal of the American Chemical Society* for March. The vapour pressure of this salt appears to be unaffected by intensive drying, but the rates of vaporisation and condensation are considerably decreased. The vapour was apparently completely dissociated even when the ammonium chloride had been dried for ten days at 60° in a vacuum.

MAGNESIUM ZINC ALLOYS.—The equilibrium diagram of this system has been re-examined by W. Hume-Rothery and E. O. Rounsefell, and the results were presented at the March meeting of the Institute of Metals; the relations between the magnesium-zinc and the magnesium-cadmium diagrams were also discussed. Both series contain analogous rather unstable compounds, $MgZn_2$ and $MgCd_2$, but whilst the Mg-Cd system contains wide solid solution ranges in the parent metals, the Mg-Zn system shows little solubility in the two metals, but forms two very unstable compounds, $MgZn_5$ and MgZn. The evidence indicates that these exist in the solid state only and not as definite molecules in the liquid. It would seem that some of the numerous unstable compounds met with in alloy systems may not correspond to any definite molecule in the chemist's sense of the word. In these circumstances the following suggestions are put forward in connexion with primary solid solutions and compounds of fixed composition. Where two metals form a stable compound there is usually considerable evolution of energy, and we may expect solid solutions to be almost entirely absent. This condition is met with in most of the alloys of the electropositive metals with the border-line metals, such as tin, antimony, bismuth, etc. Where two metals form an unstable compound, primary solid solutions will be formed if the atomic volumes are nearly equal, as are those of magnesium and cadmium. If, however, the atomic volumes differ widely, for example, zinc and magnesium, the tendency is for the main compound to be accompanied by other compounds which exist in equilibrium with the liquid over a very small range of temperature, and may exist only in the solid state representing the patterns into which the different sized atoms can be packed with or without chemical combination, that is, electron transference or sharing.

The Permanently Frozen Soils of Russia.

FOR more than two hundred years it has been known that in the extreme north of Siberia there are soils the lower strata of which are in a perpetually frozen condition. Since then a considerable literature on the problem has accumulated, but it is widely scattered, partly in almost inaccessible local publications, and a general critical survey of the literature, together with the results of original observations, recently published by the Far Eastern Geophysical Observatory in Vladivostok,[1] is therefore of great interest.

The author defines these perpetually frozen soils as those the temperature of which is always below the freezing point, regardless of the presence, or absence, of water in the soil. This definition is more exact than most of the earlier ones, which have been usually based on the soil being cemented by frozen waters. It happens with some sufficiently loose and very dry soils that their particles remain free and the soil loose even after freezing; such soils nevertheless should be classified as permanently frozen.

The geographical distribution of such soils in Russia is at present fairly well known, though the information is still very fragmentary. As a matter of fact, there are 336 places where observations on permanently frozen soils have been made; of course these observations vary widely in their scope and in their value. However, they are sufficient for a map to be prepared from them (Fig. 1). The whole area of permanently frozen soils in Russia occupies about 7,000,000 sq. km., that is, very nearly one-third of the whole territory of Russia, and a little less than the area of Europe, and about the same as the area of the United States or of the whole continent of Australia. The southern boundary of permanently frozen soils is, as will be seen from the map, very irregular; in European Russia it begins at the White Sea shores and runs eastwards, almost parallel to the Arctic Circle and a little south of it, up to Turukhansk in Siberia, where it turns sharply south-eastwards until it reaches latitude 50° N.; its course beyond the latter is not known, being outside Russian territory in Mongolia; near Blagovestshensk and Khabarovsk the southern boundary of the permanently frozen soils again enters Russia, running in a north-easterly direction to the northern part of Kamtchatka about latitude 60° N.

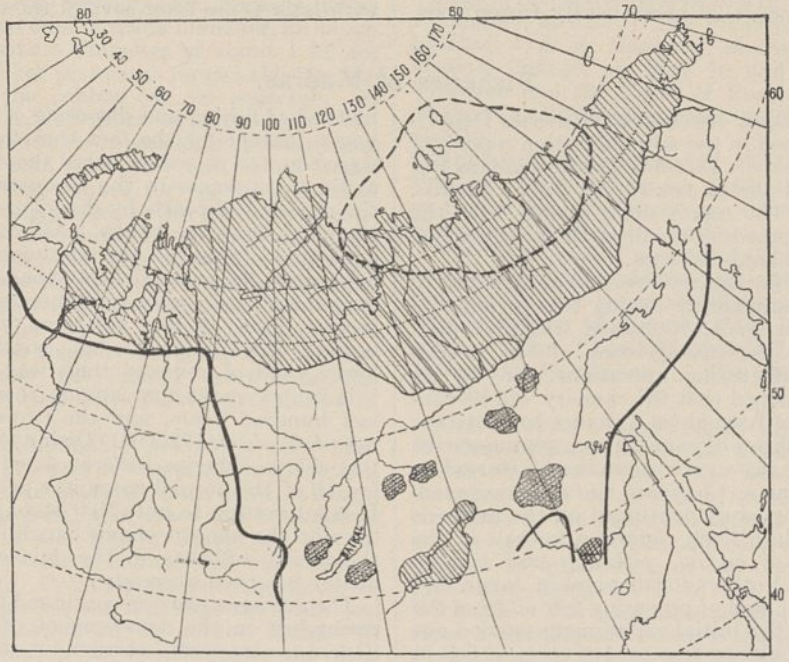

FIG. 1.—Diagrammatic map of permanently frozen soils of Russia (re-drawn after Soumgin). Oblique lines—continuous areas of permanently frozen soils; oblique lines and dots—areas of permanently frozen soils with 'islands' of normal soils; crossed lines—areas of normal soils with 'islands' of permanently frozen soils; heavy continuous black line—southern limit of permanently frozen soils; heavy interrupted black line—the boundary of the area where considerable strata of solid ice are present in the soil.

Inside this enormous region of permanently frozen soils several areas may be distinguished. Thus, a very large continuous area of permanently frozen soils occupies the whole extreme north of Siberia along the shores of the Polar Sea; another compact area is situated in Transbaikalia; in the rest of the region 'islands' of permanently frozen soils are scattered.

The depths to which soils may be in the permanently frozen condition were determined in a number of cases, and fluctuate from 36·3 m. in Pustozersk to 74·68 m. in Taldan, Amur province, and even to 116·4 m. in Yakutsk; in the latter case the actual depth has not been determined, since non-frozen stratum has not been reached. Detailed observations on the temperature conditions of these soils are still very inadequate. Middendorf, in 1848, made some determinations of temperatures in a shaft at Yakutsk and found that the temperature decreased with the depth, reaching −3° C. at 382 ft. below the surface; a constant annual temperature was found at 100 ft. deep. From these figures Middendorf determined the lower limit of the permanently frozen soil in Yakutsk at about 600 ft. below the surface, but all his observations are somewhat doubtful as to exactitude. Much more thorough studies in this respect were made recently at Bomnak, Amur province, but they were restricted to relatively small depths, not exceeding 5 m. The upper limit of permanently frozen soil at Bomnak was found to be at 2·8 m. from the surface.

During the ten years of observations at Bomnak, a correlation has been observed between the thickness of snow and the seasonal fluctuations of the temperature of the soil. In years when snow fell late and was not very thick, the temperature was found to increase with the depth, while in winters with abundant snow it protects the soil from cold and the temperature of the soil decreases with the depth, monthly maxima and minima of temperatures in the soil, at 1·5 metres deep, lagging two months behind the air temperatures. When the upper layers of the soil freeze or thaw, the water contained in them gives up, or absorbs, respectively, the heat energy, thus

[1] "Everfrozen of Soil in the Boundaries of U.S.S.R.", by M. Soumgin. Pp. 372. The Far Eastern Geophysical Observatory, Vladivostok, 1927.

interfering with the distribution of temperatures in the soil. In this way a 'zero curtain' in the soil is formed which is of the greatest importance for the temperature regime of the soil; this 'zero curtain' does not lie at a constant depth, but moves up or down, according to the air temperature. The amplitudes of the monthly mean temperatures at depths exceeding one metre are very small and rapidly decrease with the depth. Observations in other places lead to the conclusion that three different types of the distribution of temperatures in permanently frozen soils may be distinguished, namely: (1) temperature increases with the depth; (2) temperature decreases with the depth; (3) temperature decreases down to a certain depth, then increases. The distribution of temperatures at greater depths has not been studied since Middendorf's work, but it may be safely assumed that it is very complicated.

As regards the origin of permanently frozen soils, many authors consider them to be the result of the present climate, but Soumgin believes that they have remained frozen since the glacial period.

A special chapter of the book is devoted to the study of hydrological conditions in the region of permanently frozen soils, while other chapters deal at some length with the influence of the frozen soils on the surface features, especially the distribution of forest types, and with the practical difficulties in building and other engineering work on frozen soils.

An elaborate programme of studies on permanently frozen soils is put forward by the author, who concludes his interesting monograph with a somewhat startling project for establishing somewhere in the area of permanently frozen soils a refrigerator-museum, where bodies of various animals and men should be deposited in order to be examined and compared with later types after several thousands of years.

Fisheries of Madras.

VALUABLE work by the Madras Fisheries Department is described in the administration report for the year 1926–27 by the Director, Dr. B. Sundara Raj (Madras Fisheries Bulletin, vol. 22, pp. 1-99. Madras. 1 rupee. 1928). The report deals mainly with the commercial development of the department as applied to fish, pearl, and chank fisheries.

The Chaliyam Fish Cannery, which was expected to recommence its manufacture during this period, did not operate, as Sir F. A. Nicholson was prevented from undertaking the management of the experimental and manufacturing operations, due to ill-health. Yet it is hoped that the cannery will be continued, as it has not been given a chance to prove the commercial possibilities of canning as a remunerative industry, especially as two private canneries started on the model of the one at Chaliyam had not prospered. At Tanur, researches were continued on the methods of preserving fish in a fresh condition for sale in the interior markets, of curing, pickling, and tinning bonito, cat-fish, and others for disposal in Japan and other places abroad, and of preparing fish-oil from the liver of sardines. The initial experiments carried out with sodium hypochlorite as a preservative of fish in a fresh condition have shown "that about 200 c.c. of solution (with 1 per cent available chlorine) is sufficient to keep 1 lb. of smaller varieties of fish for over 30 hours". Fish-meal, with a low fat content, was made from chamban (*Caranx crumenopthalmus*), and shrimp by the use of a press more powerful than a hand-press.

Investigations for improving the resources of edible fish in inland waters were continued. Despite adverse seasonal conditions, the experiments at Vellore and Chingleput Fort Moat Farms demonstrated the utility of stocking catla. The catla fry from the Godavari channel grew to a length of 1½ to 2 feet in eight months in these farms. For want of material the Hilsa hatching experiments have not been satisfactorily concluded; the gourami (*Osphromenus sp.*), the tench, and the carp have flourished in inland waters. Experiments are being conducted on the trawling grounds close to the Madras coast to ascertain the possibilities of deep-sea fishing.

In the whole history of Ceylon and Indian pearl fisheries, no more than a single fishery was considered possible in any year. For the first time, a fishery was commenced in the autumn of 1926 on Nov. 6 and lasted until Dec. 4. This small fishery brought a net profit of Rs. 26,801. Another fishery, which excelled all previous fisheries in its excellent organisation of the camp and in the operations at sea, was opened on Feb. 11 and closed on April 30. The time-honoured method of fishing and disposing of the oysters was in vogue, except for the fact that the lots of 500 each were counted at sea on board the depot schooners, to avoid extra wages to the labourers and to minimise the pilfering of pearls by divers on their way back to the shore from the banks. Although the usual difficulties which marred the administration of the pearl fisheries in the past, such as wrong locations of banks, epidemics, etc., were circumvented, other adverse factors, such as bad weather, depreciation of the market value of pearls, etc., contributed towards a lower yield of revenue than was anticipated. Yet this fishery ranks first among those held within the last hundred years, and the Government realised a net profit of Rs. 172,316. Owing to the pearl fisheries, the chank fisheries suffered a set-back, and only a fourth of the normal catch in a good year was fished. It is interesting to note that steps are being taken to develop the ancient chank bangle industry, and that the initial difficulty in the development of this industry has been overcome.

The marine aquarium continued to be popular. The researches on the development of the edible oyster (*Ostrea madrasensis*), carried out in the laboratory of the aquarium, revealed the fact that the Indian oysters fatten and breed only in low salinities, whereas the English oysters flourish when there is a rise in salinity. The tiles put out at Ennur to collect oyster-spat were attacked in such large numbers by a molluscan pest (*Modiola sp.*) that it is proposed to abandon oyster culture in this locality. It is proposed that, if the Marine Biological Station at Krusadai Island is established, its immediate lines of inquiry should be: (1) Biological investigations with special reference to pearl and chank fisheries; (2) hydrographic and meteorological investigations; and (3) technical and industrial researches with special reference to fishing methods. Further, it is suggested that the following laboratories, aquaria, etc., are required to start the proposed lines of research: (1) The establishment of three new research laboratories, in addition to the one at Calicut, with adequate facilities; (2) the construction of aquaria at Rameswaram and at Vizagapatam; and (3) the establishment of a bio-chemical laboratory equipped with requisite apparatus and staff to deal with the technology of fishery industries. It is very gratifying to note that the Fisheries Department has continued with success the introduction of elementary education to children of the fishing population, the organisation of the co-operative movement on a wide scale, and the promotion of temperance and other social benefits to the community.

New Rubber Plant from Madagascar.

DR. CHARLES F. SWINGLE, of the U.S. Department of Agriculture, was working in the Department of Botany of the University of Leeds during the winter of 1927–28 making a study of the vegetative propagation of plants from the anatomical point of view. A problem of practical plant propagation then arose through the decision of the U.S. Department of Agriculture to try to introduce the rubber plant, *Euphorbia intisy*, from Madagascar into the United States. Dr. Swingle sailed from England at the end of May 1928, joining Prof. Henri Humbert, of the University of Algiers, in a collecting expedition in the uplands of Madagascar, and a statement of the results obtained has been issued by Science Service, of Washington, D.C.

Euphorbia intisy grows to be a small tree, some of the largest specimens seen by Dr. Swingle being about 12 ft. high and 5 in. in trunk diameter, although trees 20 ft. high with a diameter of about 1 ft. are reported. As a rubber plant it is remarkable for the ease with which the rubber can be collected. It separates itself from the latex on exposure to air, no elaborate coagulation or smoking process being necessary. Years ago, when the natives of Madagascar were collecting rubber for the French, they would simply cut long gashes in the bark of the tree, and then go round next morning and peel out strips of rubber. Unfortunately, this primitive collecting took place in a time of high rubber prices, with the result that the tree was almost exterminated. Outside Madagascar the species seems to be practically unknown, and there is probably not another living plant outside the island, apart from the specimens now growing in a locked greenhouse in Washington.

These plants will probably provide a very considerable practical problem in vegetative propagation. The species can be propagated from stem cuttings, but it is of slow growth, and years will be required before the stock in the United States can be increased to a point where commercial experiments can be undertaken. Probably its peculiar habit of growth is responsible for the fact that the plant has survived its exploitation in its native haunts in Madagascar. According to Dr. Swingle, the root system consists of chains of tuberous thickenings strung together after the fashion of sausages. These tubers are storage organs for water, enabling the plant to survive in the desert through a drought as long as six rainless years. With this system of underground life assurance, the remnants of the rubber forest were able to survive the massacre, and to begin life over again after the activities of the rubber hunters had ceased.

University and Educational Intelligence.

CAMBRIDGE.—The President of the Committee of the Privy Council for Scientific and Industrial Research has approved the application for a grant of £1500 to the University for the erection of the liquid hydrogen plant at the magnetic laboratory.

The following grants have been made from the Worts Fund: £100 to the Zoological Station at Naples, £40 to H. G. Watkins and J. M. Scott towards the expenses of a surveying expedition in Labrador, £50 to Miss S. M. Manton for researches on the fauna of the Great Barrier Reef, £15 to Dr. H. Hamshaw Thomas towards the expenses of a fossil-collecting journey in South Africa. A grant of £25 has been made from the Balfour Fund to J. T. Saunders for investigations on the hydrobiology of the Swiss Lakes.

A Denman Baynes Scholarship at Clare College for research in mathematics, physics, or chemistry, of the annual value of £100, will be awarded in July. Preference will be given to graduates of the University of Cambridge and, *ceteris paribus*, to members of Clare College. Applications should be sent to the tutor of Clare College on or before July 1, with such evidence of qualifications as candidates think fit to submit, and a statement, if possible, of the proposed course of research.

LEEDS.—The degree of D.Sc. has been conferred on Mr. H. C. Versey for a thesis entitled "Studies in the Tectonics of the North of England".

LONDON.—The following courses of free public lectures are announced: "The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications", by Dr. W. R. G. Atkins, at the Imperial College of Science (Royal School of Mines), on May 14, 15, and 16, at 5.30; "The Physiology of Glycogen", by Prof. J. J. R. MacLeod, at the London Hospital Medical College, on May 16 and 17, at 5.30; and "Sweden and the North of Europe", by Prof. Sten de Geer, at Birkbeck College, on May 24, 28, and 30, at 5.30.

Applications are invited for the University Studentship in physiology, value £100. Applications must reach the Academic Registrar of the University, South Kensington, S.W.7, by May 31 at latest.

The first annual memorial lecture, instituted in memory of Lord Haldane, late president of Birkbeck College, will be given at Birkbeck College by Lord Justice Sankey on Tuesday, May 14, at 5.30 P.M., the subject being "Lord Haldane's Life and the Adult Education Movement". The Earl of Lytton will preside.

MANCHESTER.—Applications are invited for the Sir Clement Royds memorial scholarship in chemistry of the value of £300. The scholarship is for the encouragement of advanced study and research in chemistry in the faculty of science of the University, and is open to British subjects of British descent, born in or inhabitants of the County of Lancaster, preference being given to the county borough of Rochdale. The latest date for the receipt of applications, which should be sent to the Registrar, is June 1.

Applications are invited for the Dr. Robert Angus Smith scholarship, value not exceeding £150, the object of which is the encouragement of research in sanitary science. Applications must reach the Registrar of the University by June 1.

THE Ramsay Memorial Fellowship Trustees will consider at the end of June applications for a British Fellowship for chemical research. The value of the Fellowship will be £250 per annum, to which may be added a grant for expenses not exceeding £50 per annum. Particulars as to the conditions of the award are obtainable from the Secretary of the Ramsay Memorial Fellowships Trust, University College, London (Gower Street, W.C.1).

VACATION Courses at Leyden, Holland, in August, in glass-blowing and instrument-making, have been arranged for by the Society for the Advancement of the Training of Instrument Makers. Particulars of the courses may be obtained from Dr. C. A. Crommelin, Physical (Cryogenic) Laboratory, the University, Leyden, to whom applications should be sent before June 8.

ON Jan. 1 the Rockefeller Foundation took over the work in Europe which was previously under the administration of the International Education Board. Dr. Lauder W. Jones, of Princeton University, has been

appointed associate director for the natural sciences of the Rockefeller Foundation. Dr. Jones assumed his duties at the beginning of April and will have his headquarters in Paris, carrying on the work as successor to Dr. Augustus Trowbridge.

THE Salters' Institute of Industrial Chemistry is again offering a limited number of fellowships to chemists of post-graduate standing, the object being to afford additional and special training at home and abroad, preparatory to a career in industrial chemistry. The value of each fellowship will be from £250 to £300, and applications must reach the director of the Institute, Salters' Hall, St. Swithin's Lane, E.C.4, not later than June 1. The Salters' Institute will in July allocate a limited number of grants-in-aid to young men and women employed in chemical works in or near London who desire to extend their education for a career in chemical industry. The latest date for the receipt of applications is June 7.

A NUMBER of studentships — 'research' and 'advanced study'—not exceeding ten in all, are being offered by the Empire Cotton Growing Corporation for the purpose of (*a*) enabling graduates who believe that they have a leaning towards research to equip themselves for posts in which work of that type is required, and (*b*) enabling men to receive such specialised instruction as their previous qualifications and experience show to be most desirable in order to equip them for agricultural posts in cotton-growing countries wherever opportunities for employment may present themselves. The value of each studentship is £250 a year, with certain additional allowances for travelling expenses, books, etc. Forms of application can be obtained from the Secretary, Empire Cotton Growing Corporation, Millbank House, 2 Wood Street, Millbank, S.W.1. The latest date for the return of forms is June 4.

THE Colston Research Society, which exists to assist research work in the University of Bristol by means of money collected annually, has received this year, in addition to the ordinary collection, the sum of £5000 from one of the Society's oldest subscribers, Mr. R. H. Mardon. The money is to be maintained intact to provide a fund annually for investigation in agriculture or industry in the University of Bristol which is likely to be of benefit to any portion of the British Empire. This is the first permanent endowment which has been received. The Colston Research Society was founded thirty years ago, and of recent years has collected annually £700 to £800. Mr. Mardon's gift encourages the hope that further endowments may be forthcoming.

THE Rockefeller Medical Fellowships for the academic year 1929–30 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 1. These fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation and are awarded to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. In special circumstances the fellowships may be tenable at centres of research not in America. A fellowship held in America will have the value of not less than £350 a year for a single fellow; travelling expenses and some other allowances will also be paid. Forms of application are obtainable from the Secretary, Medical Research Council, 38 Old Queen Street, Westminster, S.W.1.

Calendar of Patent Records.

May 14, 1655.—The patent granted to Sir Edward Ford on May 14, 1655, for his method of "drayning of lands, raysing of water to serve citties or houses, as likewise for cleering, drayning, and avoiding of springs from mynes and quarries" is the only one to be found on the Commonwealth patent rolls. Ford erected pumps, worked by a horse-gin, on a site between Somerset House and Arundel House, opposite the present Surrey Street, for supplying water to London direct from the Thames. The pumps remained working for several years, but were ordered to be pulled down by Charles II. because "the great fabric of wood" was a nuisance, especially to Denmark House, the residence of Queen Henrietta Maria.

May 14, 1825.—Sir Goldsworthy Gurney's steam road-carriage, which he patented on May 14, 1825, was provided, in addition to the ordinary piston engine driving the wheels, with adjustable propelling legs which acted successively against the surface of the road to assist the coach up hills. A contemporary drawing shows that it was a six-wheeled vehicle.

May 15, 1824.—The machine for making solid-headed pins which was the subject of the English patent granted to the American, Lemuel Wellman Wright (on behalf of a kinsman in the United States), on May 15, 1824, was not the first of its kind to be patented, but was the first to achieve commercial success, though it was many years before pins made by the old process dropped out of the market. The manufacture started by the inventor in London failed, but the patent was acquired by Messrs. Taylor and Co., of Stroud, Gloucestershire, who spent a large sum of money in perfecting the machine. The life of the patent was extended for five years by the Privy Council.

May 15, 1832.—The steam plough with stationary engine and cable was patented by John Heathcoat on May 15, 1832. The patent foreshadowed also the use of 'caterpillar' wheels for agricultural machinery. To enable the apparatus to be worked on soft ground, the engine was fixed on a carriage of large dimensions and mounted on a series of wheels which conducted "an endless flexible floor, railroad, or way," within and upon which the carriage was caused to travel. The 'flexible floor' was made of painted or tarred sail-cloth stretched on strips of metal.

May 15, 1844.—The first industrial application of gutta-percha was in the manufacture of cork stoppers and other articles, and was patented by Charles Hancock on May 15, 1844. The new material only became known in England the previous year, when specimens of it were exhibited for the first time at the Society of Arts.

May 16, 1674.—The patent granted for seven years to George Ravenscroft on May 16, 1674, for "his new invention or art and manufacture of a certaine christeline glasse resembling rock christall not formerly used in this kingdome" was a landmark in the history of English glass. From it dates the introduction of the flint glass industry of England which dominated the European markets for many years.

May 16, 1862.—The bicycle did not become popular until about 1865, when Ernest Michaux of Paris introduced what became generally known as the 'boneshaker,' which had pedals fitted directly to an enlarged front wheel. But a notable contribution to its success as a means of transport was made by Albert Louis Thirion, a Belgian resident in London, who on May 16, 1862, was granted in England the first patent for roller or ball bearings for use on velocipedes.

Societies and Academies.

LONDON.

Royal Society, May 2.—J. S. Haldane, W. Hancock, and A. G. R. Whitehouse: The loss of water and salts through the skin, and the corresponding physiological adjustments. The paper contains data as to the nature and percentage amounts of salts lost from the skin without sweating and in different stages of free sweating. The disturbance produced when loss of salts and water is replaced by gain of pure water is ordinarily prevented by the compensatory action of the kidneys and a natural craving for salt. What is kept practically constant is the diffusion pressure of water within the body, in accordance with Claude Bernard's conception of the blood as an internal environment maintained constant by the co-ordinated action of organs.—F. H. A. Marshall and J. Hammond: Œstrus and pseudo-pregnancy in the ferret. 'Heat' is prolonged in absence of coitus. The vulva enlarges to about fifty times its anœstrous size and persists to cessation of heat. Ovulation occurs at any time during heat, but only after coitus. Details are given of the uterine changes. All changes are apparently controlled by the corpus luteum. The vulva affords no external indication of the luteal phase which is the main factor in the developmental changes.—R. G. Canti and F. G. Spear: The effect of gamma irradiation on cell division in tissue culture *in vitro*. The fall in the number of cells undergoing mitosis was followed by a rise which, with a certain exposure and intensity, was compensatory to the fall. With longer exposures, though there was a tendency to rise, the number of cells undergoing mitosis never reached the normal.—R. B. Bourdillon, C. Fischmann, R. G. C. Jenkins, and T. A. Webster: The absorption spectrum of vitamin D. By the action of ultra-violet radiation on ergosterol three substances (or groups of substances) are produced in succession. The first shows an absorption band roughly similar to that of ergosterol (maximum 280$m\mu$), but more than twice as intense, and has great anti-rachitic activity. It is probably vitamin D. Neither the second nor the third substance has antirachitic activity, though the former shows a strong absorption band at 240$m\mu$. The actual percentage of vitamin D present in the purest preparations studied is estimated as above 50.—G. E. Briggs: Experimental researches on vegetable assimilation and respiration (20).—R. J. Lythgoe and K. Tansley: The relation of the critical frequency of flicker to the adaptation of the eye. The critical frequency due to the cones falls during dark-adaptation and with decreasing levels of light-adaptation and is highest with equally bright surrounds. That due to the rods behaves in the opposite fashion. The peripheral cones are functionally not identical with the foveal cones. The brightness of the surrounds is the most important factor in determining whether the critical frequency relations are of the rod or cone type, bright surrounds encouraging the cones and dark surrounds the rods.—R. Hill: Reduced hæmatin and hæmochromogen.—G. R. de Beer: The development of the skull of the shrew.—J. W. Pickering: The influence of Witte's 'peptone', and of digestion on blood platelets and plasma.—F. W. R. Brambell and A. S. Parkes: Compensatory hypertrophy of the untreated ovary after unilateral X-ray sterilisation.—W. Moppett: The differential action of X-rays in relation to biology, chemistry, and physics (Part 1).—C. H. Browning, J. B. Cohen, S. Ellingworth, and R. Gulbransen: The trypanocidal action of some derivatives of anil and styryl quinoline.

PARIS.

Academy of Sciences, April 8.—P. Villard: The devitrification of glass. Experiments are described leading to the conclusion that devitrification of glass is the consequence of a loss of sodium or potassium, and practical suggestions are made for working glass before the blowpipe so as to reduce devitrification to a minimum.—G. Vranceanu: The three points of view in the study of non-holonome spaces.—Georges Giraud: The solution of the problem of Dirichlet for linear equations.—Krawtchouk: The approximate solution of linear integral equations.—Mlle. Nina Bary: Some mixed forms of the finite representation of an arbitrary continuous function.—J. A. Lappo-Danilevski: Fundamental problem of the theory of functions in the class of matrices satisfying systems of differential equations with rational coefficients.—Benjamin Meisel: The approximate definition of the relative kinetic energy of a liquid filling a rotated vase.—E. Sevin: The Compton effect and its inverse.—Antoine Willemart: The absorption spectra of the rubrenes. Curves are given of the absorption spectra of the three known rubrenes, rubrene, dimethyl-rubrene, and bibenzorubrene. Each has the same number of bands similarly placed, and the three maxima on each curve have identical wave-lengths.—H. Damianovich and J. J. Trillat: Researches on the action of helium on platinum. Under the influence of an electric discharge at low pressure, platinum retains large quantities of helium. Examination of the substance produced by means of the X-rays, using the Debye-Sherrer method, did not give very definite results, but there were some indications of the presence of a new micro-crystalline compound, probably a combination of helium and platinum.—Galibourg: The effect of extension and ageing on the elastic limit of metals.—J. Cournot: The influence of the dimensions of the test pieces in measurements of the viscosity of metallurgical products. The dimensions of the test piece have a marked influence on the flow of the metal: the practical limit of the viscosity increases with the diameter of the test piece. Data are given for aluminium wires.—Lespieau and Wiemann: The preparation of acetylenic hydrocarbons with the aid of epidibromhydrins. Details of the products of the reaction between methyl magnesium bromide and the epidibromhydrin containing five atoms of carbon.—V. Agafonoff: The determination of the mass of carbon and constitutional water contained in the soils of the terrestrial globe.—Henry Hubert: The monthly rainfall curves at Madagascar.—Guilliermond: New remarks on the Golgi apparatus: the Golgi apparatus in the yeasts. Additional proofs, with illustrations, are given of the author's view that there exists no Golgi apparatus independent of the chondriome and the vacuome.—L. Marrassé: Hexamethylenetetramine and formaldehyde are true foods for the bean. The conclusions of E. and G. Nicolas, based on the method of cultures, are confirmed by a cytophysiological method: hexamethylenetetramine and formaldehyde, in proportions of 0·2 per thousand of the former and 0·16 per thousand of the latter, form true foods for the cells of the bean.—I. D. Strelnikov: The fauna of the Sea of Kara and its ecological conditions.—G. Frank and M. Popoff: The mitogenetic radiation of the muscle in contraction. The mitogenetic radiation can only be the product of the explosive glycolysis which occurs precisely at the period of latent irritation and at the commencement of the contraction.—P. Delanoë: The presence of the *Ornithodorus* of Morocco in the burrows of porcupines and foxes and in human habitations. Its existence in eastern Morocco. Frequency of a recurrent spirochæte in the *Ornithodorus* of these burrows.

GENEVA.

Society of Physics and Natural History, Feb. 21.—E. Cherbuliez and P. Plattner: A new method of separation of the amino acids in the form of their acetyl esters. The principles of this separation are as follows: (1) hydrolysis by hydrochloric or sulphuric acid at the boiling point, (2) esterification of this solution by alcoholic hydrochloric acid, (3) acetylation of the syrup obtained by concentrating the solution of the hydrochlorides of the esters by treatment with acetic anhydride and sodium acetate in excess.—E. Cherbuliez and S. Ariel: A new method of disintegrating the proteids and the problem of the size of the molecules of the scleroproteins. The authors have studied the solubility of the following scleroproteins in acetamide at 200° C. and in urea at 140° C.: fibroin, keratin (dog's hair, ox hair), elastin (ox). The latter is insoluble in both solvents at the temperatures given above, the keratins are both soluble, the fibroin soluble in urea and partially soluble in acetamide (28 per cent in 30 minutes). The process of solution is accompanied by a profound modification of the chemical character of the proteids utilised, and this is probably due to an intramolecular transposition.—G. Dejardin: The progress realised in the preparation and use of thermionic cathodes. The author describes particularly the cathodes consisting of a metallic nucleus with a superficial layer, probably monatomic, of another metal. The cathode nucleus is a tungsten wire covered superficially with an oxide, such as copper oxide, susceptible of being reduced by barium vapour at a moderately high temperature. The barium salt of hydrazoic acid, BaN_6 is utilised.—R. Chodat: The theory of generalised mutation and mutations in *Chlorella rubescens*. By cultures derived from a single cell, carried out with the micromanipulator of Janse and Peterfi, the author ascertains from several generations that the general law is not constancy but micromutation. In the colonies, the micromutants are, as it were, merged in the whole and escape observation.—Arnold Pictet: The reconstitution of a dominant character by crossings between recessives.—Ed. Parejas: Geological observations in Corsica (2). The autochtone sediment of Popolasca. At Popolasca, the Mesozoic presents facies comparable with those of Malm and of the Helvetian Infravalanginian (autochtone of Gastern and Doldenhorn stratum). One of these limestones contains authigen albite. A thin layer of granite not hitherto pointed out overlaps the series of Popolasca.—G. Tiercy: Concerning the gain and loss of chronometers (2). To the considerations developed in an earlier note, where the author gives the relation correction = −(rate) he adds some further remarks taken from the meaning attributed to the word 'etat' in finance and in rational mechanics. He stresses the fact that the word 'etat' (rate) is employed in relation to watches, not only at the Geneva Observatory but also at Kew and at Besançon.

ROME.

Royal National Academy of the Lincei, Jan. 20.—F. Severi and B. Segre: Further with regard to a topological paradox (2).—G. Giorgi and Ernesta Porcu-Tortrini: Motions of deformation in space represented by means of matrix calculus.—U. Cisotti: The triple tensor of Christoffel.—F. Zambonini and Silvia Restaino: Double sulphates of the rare earth and alkali metals. (12) Cerous and cæsium sulphates. Study of the isotherm of the system, $Ce_2(SO_4)_3 - Cs_2SO_4 - H_2O$, at 25° indicates the existence of the compound $Ce_2(SO_4)_3$, Cs_2SO_4, $8H_2O$, which is stable within moderately wide limits.—S. Franchi: Non-existence of the great faults known as the Monte Rosa bowl and of the Great St. Bernard bowl in the Western Alps. Study of the tectonics of the Franco-Italian Cottian Alps indicates that the Monte Rosa bowl (V.) and the Great St. Bernard bowl (IV.) have no real existence, and that, in the western Alps, the contact between the permian, attributed to fold IV., and the calc-schisto, attributed to V., is a normal contact.—B. Segre: Construction of a simple oblique Jordan's curve.—A. Mambriani: A particular differential equation. Scorza Dragoni has recently indicated briefly the method, to be published fully later, used to demonstrate the existence and unicity of the solution of the differential equation, $y'' = y^{\frac{1}{2}}\, x^{-\frac{1}{2}}$, with the limiting conditions $y(0) = 1$, $y(+\infty) = 0$, which arises from certain physical investigations of Fermi. It is now shown that the existence and unicity of the equation in question may be deduced at once from classical propositions on ordinary differential equations, in conjunction with elementary observations on the particular form of the equation.—Rita Liceni: The form F_2 of Fubini. For the surfaces in a four-dimensional space S_4, Fubini found a form indicated by him by F_2 which has a projective character. Later, in the study of certain varieties, Vitali encountered a form F_2, also of projective character, and showed that, in the case of the surfaces in S_4, his F_2 coincides with that of Fubini. The author now develops the analytical passage from one form to the other.—J. Kaucký: Surfaces of which a canonical straight line passes through a fixed point.—F. Cecioni: Conform representation of pluri-connected areas belonging to a Riemannian surface.—A. M. Bedarida: Systems of arithmetical progressions.—G. Krall: Upper limitations for the dynamic displacement in elastic systems. Higher limits are assigned to the displacement of an elastic body, vibrating under the action of either constant or time-variable forces, starting from the more general initial circumstances of the motion.—A. Carrelli: The new diffusion phenomenon: the Raman effect. It is shown that, as for Tyndall light, the intensity of Raman light is directly proportional to the fourth power of the emitted frequency and is dependent also on magnitudes characteristic of the lines in the dispersion formula of the substance considered.—T. G. Levi: Dithioformic acid (2). Various derivatives of dithioformic acid, obtained by the action of chloroform on potassium sulphide. The acid, now isolated in the pure form as a white solid melting and decomposing at 55°-60°, decomposes into hydrogen sulphide, carbon disulphide, carbon, and sulphur, when heated. The results of molecular weight determinations indicate that the acid and its esters exist as trimerides, and a cyclic structure with alternate carbon and sulphur atoms is suggested. Two isomeric benzyl esters exist, the isomerism being probably of the cis-trans type.—F. Rodolico: Crystallographic investigations on cinnabar from Idria.

VIENNA.

Academy of Sciences, Feb. 21.—E. Beutel and A. Kutzlnigg: The action of potassium ferrocyanide on silver and some slightly soluble silver compounds.—W. Leithe: The natural rotation of polarised light by optically active bases (2). The rotation of *d*-α-phenyl-ethyl-amine and its chlorhydrate in solution, with remarks on the rotation of active tetra-hydroquinaldine.—E. Haschek: A contribution to the theory of photochemical phenomena. Concerning the retina of the eye.—K. Schnarf: The embryology of Liliaceæ and its systematic significance.—M. Holly: Three new fish forms from Persia. *Barbus* and others, including a cyprinodon from warm springs.

Official Publications Received.

BRITISH.

The Tea Research Institute of Ceylon. Bulletin No. 3: Annual Report for the Year 1928. Pp. 67+3 plates. (Kandy.)

Memoirs of the Department of Agriculture, Trinidad and Tobago. No. 4: The Useful and Ornamental Plants of Trinidad and Tobago. By W. G. Freeman and R. O. Williams. Second edition, revised. Pp. iv+192. (Trinidad, B.W.I.: Government Printing Office, Port-of-Spain.)

Ceylon Journal of Science, Section A, Botany: Annals of the Royal Botanic Gardens, Peradeniya. Edited by A. H. G. Alston. Vol. 11, Part 2, March 12th. Pp. 113-211+plates 16-24. (Peradeniya: Director of Agriculture; London: Dulau and Co., Ltd.) 3 rupees.

The Indian Forest Records. Entomology Series, Vol. 13, Part 5: Epidemic Attacks by the Sal Heartwood Borer (*Hoplocerambyx Spinicornis*, Newm., fam. Cerambycidae) in the Forests of South Mandla Division, Northern Circle, Central Provinces, with special reference to the Period 1924-25 to 1926-27. By Wm. Angus Muir. Pp. ii+76+12 plates. (Calcutta: Government of India Central Publication Branch.) 2.10 rupees; 4*s*. 9*d*.

British Museum (Natural History). Picture Postcards. Set F29, British Trees: Smooth-leaved Elm. 2 cards in Colour and 2 in Monochrome. 6*d*. Set F30, British Trees: Wych Elm. 2 cards in Colour and 2 in Monochrome. 6*d*. Set F31, British Trees: Scotch Fir. 2 cards in Colour and 2 in Monochrome. 6*d*. Set F35, British Trees: Common Oak. 2 cards in Colour and 2 in Monochrome. 6*d*. Set F37, British Trees: Hazel. 2 cards in Colour and 2 in Monochrome. 6*d*. (London: British Museum (Natural History).)

Australia: Commonwealth Forestry Bureau. Third British Empire Forestry Conference, Australia and New Zealand, 1928. Papers Presented. Pp. 905. Commonwealth Handbook. Pp. 42. Summary Report, Resolutions and Reports of Committees. Pp. 67. (Canberra, F.C.T.: H. J. Green.)

Empire Forestry Conference, Australia and New Zealand, 1928. Forestry Handbook for New South Wales. Pp. 48. (Sydney, N.S.W.: Alfred James Kent.)

Report of the Kodaikanal Observatory for the Year 1928. Pp. 4. (Calcutta: Government of India Central Publication Branch.)

Education (Scotland). Report for the Year 1928, by the Director, on the Royal Scottish Museum, Edinburgh. Pp. 9. (Edinburgh.)

The Journal of the Institution of Electrical Engineers. Edited by P. F. Rowell. Vol. 67, No. 388, April. Pp. 437-556+xxxvi. (London: E. and F. N. Spon, Ltd.) 10*s*. 6*d*.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1190 (Ae. 352): Wind Tunnel Experiments on the Design of an Automatic Slot for R.A.F. 31 Section. By F. B. Bradfield and F. W. G. Greener. (T. 2656.) Pp. 11+5 plates. (London: H.M. Stationery Office.) 9*d*. net.

Reorganisation and the Teaching Profession. Being a Statement, supplementary to the "Hadow Report and After", by the Executive of the National Union of Teachers, upon some of the Professional Problems which arise in connection with the Reorganisation of Public Elementary Schools now Proceeding. Pp. 32. (London: National Union of Teachers.) Free.

World's Poultry Congress, Crystal Palace, London, England, July 22-30, 1930. Preliminary Announcement. Pp. 24. (London: Ministry of Agriculture and Fisheries).

History of the West Kent Scientific Society (1852-1921). By John M. Stone. Revised to 1928 and including List of Past Presidents and Secretaries. (London: Hon. Secretary, 15 St. German's Place, S.E.3.)

Proceedings of the Royal Society of Edinburgh, Session 1928-1929. Vol. 49, Part 1, No. 7: The Correlation between Product Moments of any Order in Samples from a Normal Population. By Dr. John Wishart. Pp. 78-90. 1*s*. Vol. 49, Part 2, Nos. 10, 11, 12: Studies in Embryonic Mortality in the Fowl. i. The Frequencies of various Malpositions of the Chick Embryo and their Significance, by F. B. Hutt; ii. Chondrodystrophy in the Chick; iii. Chick Monsters in relation to Embryonic Mortality, by F. B. Hutt and Dr. A. W. Greenwood. Pp. 118-155+5 plates. 5*s*. Vol. 49, Part 2, No. 13: The Hydrogen-Chlorine Flame. By Dr. E. B. Ludlam, H. G. Reid and G. S. Soutar. Pp. 156-159+1 plate. 9*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

University of Leeds. Publications and Abstracts of Theses by Members of the University during Session 1927-28. Pp. 31. (Leeds.)

The Scientific Proceedings of the Royal Dublin Society. Vol. 19, N.S., No. 19: Coniferae; Keys to the Genera and Species, with Economic Notes. By H. M. FitzPatrick. Pp. 189-260+plates 9-15. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 8*s*.

Canada. Department of Mines: Mines Branch. Investigations of Mineral Resources and the Mining Industry, 1927. (No. 694.) Pp. iv+60. (Ottawa: F. A. Acland.)

The Hudson Bay Region. By F. H. Kitto. Pp. vii+50. (Ottawa: Department of the Interior, Natural Resources Intelligence Service; London: High Commissioner for Canada.)

Journal of the Federated Malay States Museums. Vol. 8: Results of an Expedition to Korinchi Peak, Sumatra. Part 3: Invertebrates. Pp. 175-204. (Kuala Lumpur.) 50 cents; 1*s*. 6*d*.

Queensland. Department of Mines: Geological Survey of Queensland. Publication No. 276: Geology of the Bowen River Coalfield. By J. H. Reid. Pp. viii+107. (Brisbane: Anthony James Cumming.)

Abstracts of Dissertations approved for the Ph.D., M.Sc. and M.Litt. Degrees in the University of Cambridge for the Academical Year 1927-1928. Published by Authority. Pp. 88. (Cambridge: At the University Press.)

The National Physical Laboratory. Report for the Year 1928. Pp. vi+283+13 plates. (London: H.M. Stationery Office.) 9*s*. net.

The Welsh Journal of Agriculture: the Journal of the Welsh Agricultural Education Conference. Vol. 5. Pp. 260. (Cardiff: University of Wales Press Board.) 2*s*. 6*d*.

Union of South Africa. Report of the South African Museum for the Year ended 31st December 1928. Pp. ii+12. (Cape Town.)

Committee of Civil Research. Radium Sub-Committee Report. (Cmd. 3303.) Pp. 31. (London: H.M. Stationery Office.) 6*d*. net.

Journal of the Indian Institute of Science. Vol. 12A, Part 1: Phototropic Compounds of Mercury. By Bh. S. V. Raghava Rao and H. E. Watson. Pp. 16. 1 rupee. Vol. 12A, Part 2: Photoelectric Emission from Phototropic Mercury Compounds. By Bh. S. V. Raghava Rao and H. E. Watson. Pp. 17-29. 12 annas. Vol. 12A, Part 3: Attempts to Synthesise *Ortho*-thiolphenylhydrazine. By Praphulla Chandra Guha and Tajendra Nath Ghosh. Pp. 31-35. 6 annas. Vol. 12A, Part 4: i. Characterisation of very small Quantities of Proteins by Van Slyke's Method, by Nuggihalli Narayana and Mothnahalli Sreenivasaya; ii. The Determination of Pyruvic Acid, by Basettihalli Hanumantha Rao Krishna and Mothnahalli Sreenivasaya. Pp. 37-51. 12 annas. (Bangalore.)

Department of Scientific and Industrial Research. Building Science Abstracts. Compiled by the Building Research Station and published in conjunction with the Institute of Builders. Vol. 2 (New Series), No. 3, March. Abstracts Nos. 400-589. Pp. v+97-132. (London: H.M. Stationery Office.) 9*d*. net.

FOREIGN.

Smithsonian Miscellaneous Collections. Vol. 81, No. 8: Parasites and the Aid they give in Problems of Taxonomy, Geographical Distribution and Palaeogeography. By Maynard M. Metcalf. (Publication 3010.) Pp. 36. Vol. 81, No. 11: Atmospheric Ozone; its Relation to some Solar and Terrestrial Phenomena. By Frederick E. Fowle. (Publication 3014.) Pp. 27. (Washington, D.C.: Smithsonian Institution.)

Department of the Interior: U.S. Geological Survey. Bulletin 797-C: Preliminary Report on the Sheenjek River District, Alaska. By J. B. Mertie, Jr. (Mineral Resources of Alaska, 1926-C.) Pp. ii+99-123+1 plate. 10 cents. Bulletin 797-D: Surveys in Northwestern Alaska in 1926. By Philip S. Smith. (Mineral Resources of Alaska, 1926-D.) Pp. ii+125-142+1 plate. 5 cents. Bulletin 805-A: Platinum and Black Sand in Washington. By J. T. Pardee. (Contributions to Economic Geology, 1928, Part 1.) Pp. ii+15. 5 cents. Bulletin 810-A: Mineral Industry of Alaska in 1927, and Administrative Report. By Philip S. Smith. (Mineral Resources of Alaska, 1927-A.) Pp. ii+85+xiii. Water-Supply Paper 589: Surface Water Supply of the United States, 1924. Part 9: Colorado River Basin. Pp. v+159. 25 cents. Water-Supply Paper 597-A: Geology of Reservoir and Dam Sites with a Report on the Owyhee Irrigation Project, Oregon. By Kirk Bryan. (Contributions to the Hydrology of the United States, 1928.) Pp. iv+72+10 plates. 30 cents. (Washington, D.C.: Government Printing Office.)

State of Illinois, Department of Registration and Education: Division of the Natural History Survey. Bulletin, Vol. 17, Art. 12: The Bottom Fauna of the Middle Illinois River, 1913-1925; its Distribution, Abundance, Valuation and Index Value in the Study of Stream Pollution. By R. E. Richardson. Pp. 385-475. (Urbana, Ill.)

Smithsonian Institution: Bureau of American Ethnology. Bulletin 84: Vocabulary of the Kiowa Language. By John P. Harrington. Pp. v+255. (Washington, D.C.: Government Printing Office.) 75 cents.

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 44: Report on the Water Resources of Connecticut. By Prof. Roscos Henry Suttie. (Public Document No. 47.) Pp. 168. (Hartford, Conn.)

Bernice P. Bishop Museum. Bulletin 50: The Breadfruit of Tahiti. By Gerrit Parmile Wilder. Pp. 83. Bulletin 51: Fossil Marine Mollusks of Oahu. By Jens Mathias Ostergaard. Pp. 32+2 plates. Bulletin 52: Cornaceae and Allies in the Marquesas and neighbouring Islands. By Forest B. H. Brown. (Bayard Dominick Expedition, Publication No. 13.) Pp. 22. Bulletin 53: Archæology of Nihoa and Necker Islands. By Kenneth P. Emory. (Tanager Expedition, Publication No. 5.) Pp. 124+23 plates. Bulletin 54: String Figures from Hawaii, including some from New Hebrides and Gilbert Islands. By Lyle A. Dickey. Pp. 169+2 plates. Bulletin 55: Fringing and Fossil Coral Reefs of Oahu. By James B. Pollock. Pp. 56+6 plates. Bulletin 56: Check List of Hawaiian Land and Fresh Water Mollusca. By Edward L. Caum. Pp. 79. Bulletin 57: Report of the Director for 1927. By Herbert E. Gregory. Pp. 38. Memoirs of the Bernice P. Bishop Museum, Vol. 10: The Fishes of Oceania. By Henry W. Fowler. Pp. iii+540+49 plates. (Honolulu, Hawaii.)

Meddelande från Lunds Astronomiska Observatorium. Ser. 2, Nr. 52: On the Distribution of the Apparent Magnitudes of the Foreground Stars of Dark Nebulae. By W. Gyllenberg. Pp. 25. (Lund: C. W. K. Gleerup.)

Publications of the Astronomical Institute of the University of Amsterdam. No. 2: Researches on the Structure of the Universe. By A. Pannekoek. 2: The Space Distribution of Stars of Classes A, K and B, derived from the Draper Catalogue; 3: The Cape Photographic Durchmusterung. Pp. ii+87. (Amsterdam.)

United States Department of Agriculture. Technical Bulletin No. 89: Biology of the European Red Mite in the Pacific Northwest. By E. J. Newcomer and M. A. Yothers. Pp. 70. (Washington, D.C.: Government Printing Office.) 15 cents.

Zoologica: Scientific Contributions of the New York Zoological Society. Vol. 10, No. 1: The Fishes of Port-au-Prince Bay, Haiti; with a Summary of the known Species of Marine Fish of the Island of Haiti and Santo Domingo. By Dr. William Beebe and John Tee-Van. Pp. 279. (New York City.)

Smithsonian Miscellaneous Collections. Vol. 81, No. 10: Tropisms and Sense Organs of Lepidoptera. By N. E. McIndoo. (Publication 3013.) Pp. 59. (Washington, D.C.: Smithsonian Institution.)

Ministry of Public Works, Egypt: Physical Department. The Measurement of the Discharge of the Nile through the Sluices of the Aswan Dam: Final Conclusions and Tables of Results. By Dr. H. E. Hurst and D. A. F. Watt. (Physical Department Paper No. 24.) Pp. v+44+5 plates. (Cairo: Government Press.) 10 P.T.

CATALOGUES.

Catalogue of Books on Chemistry and Chemical Technology. Pp. 56. (London: H. K. Lewis and Co., Ltd.)

Zenith Resistances and Rheostats. Pp. 36+16+12. (London: Zenith Electric Co., Ltd.)

Photography in Comfort. Pp. 36. (London: Burroughs Wellcome and Co.)

Diary of Societies.

FRIDAY, MAY 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Prof. E. Hertzsprung: The Pleiades (George Darwin Lecture).—E. A. Kreiken: On the Dwarf Nature of Double Stars.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—Dr. W. E. Sumpner: Heaviside's Fractional Differentiator.—J. H. Awbery: A Simple Method of Fitting a Straight Line to a Series of Observations.—E. W. H. Selwyn: Arc Spectra in the Region λ1600-λ2100.—Dr. K. R. Rao: The Spectrum of Trebly-ionised Thallium.—G. A. Wedgwood: The Elastic Properties of Thick Cylindrical Shells under Internal Pressure.—A Demonstration relating to Standards of Length and Mass, by J. E. Sears.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (at Abbey Hotel, Kenilworth), at 5.30.—Discussion on Stare Bridge, D. H. Brown; Kenilworth: Castle and Town, S. Douglas.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Annual General Meeting.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Special General Meeting.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 8.—Captain P. Johnston-Saint: An Outline of the History of Medicine in India (Sir George Birdwood Memorial Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (Annual General Meeting) (at Victoria Hall, Criterion Restaurant), at 8.30.—Discussion on How can the Chemical Engineering Group best assist in the Development of the Science and Practice of Chemical Engineering?

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. A. E. Boycott: The Twist of Snail Shells.

SATURDAY, MAY 11.

BIOCHEMICAL SOCIETY (in Department of Biochemistry, University Museum, Oxford), at 3.—K. H. Coward, K. M. Key, and B. G. E. Morgan: Some Evidence of the Existence of a Further Factor Necessary for Growth of the Rat.—H. Bainbridge, E. Boock, and J. Trevan: The Growth of Rats on Synthetic Diets.—C. R. Harington and D. A. Scott: Observations on Insulin.—F. H. Carr, K. Culhane, A. T. Fuller, and Dr. G. W. F. Underhill: A Reversible Inactivation of Insulin.—W. L. Dulière, R. H. Morton, and Dr. J. C. Drummond: The Alleged Relation between Carotene and Vitamin A.—H. J. Phelps: The Mechanism of the Adsorption of Weak Electrolytes.—H. W. Kinnersley and R. A. Peters: Observations upon Carbohydrate Metabolism in Avitaminous Birds.—R. A. Peters: The Third Factor of Williams and Waterman.—B. Woolf: The Enzymes in *B. coli communis* which act on Fumaric Acid.—E. Boyland: The Lag between Phosphate Esterification and Carbon Dioxide Evolution in Alcoholic Fermentation.—Demonstrations:—Tachycardia in Rice-fed Pigeons, by C. W. Carter and R. A. Peters.—Bios Testing, by Dr. G. L. Peskett.

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 3.—Miss E. H. Walters: Is there a Common Factor of Sensorial Retentivity, and is it Influenced by Conation?—S. E. W. Taylor: A Balance Showing the Relation of Blood Distribution to Mental Activity.—J. W. Caughey: Some Factors Involved in the Performance of Single Routine Tests.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (South Wales District) (at Council Chamber, Swansea), at 3.15.—Discussion on Some Road and Other Schemes at Swansea, R. Hudson; Swansea Main Drainage Scheme and Flood Relief Schemes, J. Hassall; Llansamlet Sewage Pumping Scheme, Swansea, M. E. Habershon.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Sections) (at Harrogate).—Annual Meeting.

MONDAY, MAY 13.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—E. B. Worthington: The Life of the Albert Nyanza and Lake Kioga.

TUESDAY, MAY 14.

PHYSICAL SOCIETY (jointly with Society of Glass Technology) (in Research Laboratories of the General Electric Co., Ltd., Wembley), at 4.—Prof. W. E. S. Turner and F. Winks: A Study of the Thermal Expansion of Glass up to the Softening Temperature.—R. F. Proctor and R. W. Douglas: The Measurement of the Viscosity of Glass at High Temperatures by Means of the Rotating Cylinder Viscometer.—F. C. Harris: The Photo-Elastic Properties of Glass.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Pharmacology Sections), at 5.—Annual General Meeting.

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—G. B. Maxwell and Dr. R. V. Wheeler: Flame Characteristics of 'Pinking' and 'Non-Pinking' Fuels. Part II.

INSTITUTION OF CIVIL ENGINEERS, at 6.—Annual General Meeting.

ILLUMINATING ENGINEERING SOCIETY (at Home Office Industrial Museum, Horseferry Road), at 6.45.—G. H. Wilson: The International Commission on Illumination and the International Congress held in the United States in 1928.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—J. A. Speed: Flashlight in Natural History Work.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Dr. H. A. Baylis: Life-histories of Parasitic Worms.

ROYAL SOCIETY OF MEDICINE (Psychiatry Section) (Annual General Meeting), at 8.30.—Dr. F. L. Golla: Some Recent Work on the Pathology of Schizophrenia.—Dr. W. M. F. Robertson: Gastro-intestinal Focal Infection in Relation to Oral Sepsis, with Special Reference to Anaerobes, occurring in 6 Cases of Mental Disorder.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Dr. A. F. Ashley-Montagu: The Tarsian Hypothesis in the Descent of Man.

WEDNESDAY, MAY 15.

SOCIETY OF GLASS TECHNOLOGY (at University College), at 2.30.—Prof. W. E. S. Turner: The Glass Industry of North America in 1929.

IRON AND STEEL INSTITUTE (in Mappin Hall, Sheffield), at 2.30.—The Hon. Sir Charles Parsons and H. M. Duncan: A New Method for the Production of Sound Steel.—Third Report on Heterogeneity of Steel Ingots, by a Committee of the Institute.—G. A. Hankins and Miss G. W. Ford: The Mechanical and Metallurgical Properties of Spring Steels as Revealed by Laboratory Tests.—L. B. Pfeil: The Oxidation of Iron and Steel at High Temperatures.—G. R. Bolsover: Brittleness in Mild Steel.—H. Sutton: The Influence of Pickling Operations on the Properties of Steel.

ROYAL METEOROLOGICAL SOCIETY, at 5.—J. E. Clark, I. D. Margary, R. Marshall, and C. J. P. Cave: Report on the Phenological Observations in the British Isles, December 1927 to November 1928.—D. Brunt: The Index of Refraction of Damp Air, and the Optical Determination of Lapse-rate.—Dr. J. R. Ashworth: The Influence of Smoke and Hot Gases from Factory Chimneys on Rainfall.

ROYAL SOCIETY OF ARTS, at 8.—R. Burrell: The Reform of the British Patent System.

EUGENICS SOCIETY (at Linnean Society), at 8.

FOLK-LORE SOCIETY (at University College), at 8.—Dr. M. Taylor: Norfolk Folk Medicine.

ROYAL MICROSCOPICAL SOCIETY, at 8.—E. Heron-Allen and A. Earland: Some New Foraminifera from the South Atlantic. No. 1.—R. Paulson: The Form of the Chromatophore of the Bright Green Gonidium common to many Lichens.—D. Bryce: On Three Cases of Encystment among Rotifers.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases Section) (Annual General Meeting), at 8.15.—Prof. Besredka: Vaccine Therapy.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section).—Annual Business Meeting.

THURSDAY, MAY 16.

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—Prof. C. G. Darwin: The Refraction and Scattering of Light (Lecture).

INSTITUTE OF PATHOLOGY AND RESEARCH (St. Mary's Hospital), at 5.—Prof. F. T. G. Hobday: The Value of Research into Animal Diseases as an Aid to the Study of the Diseases of Man.

INSTITUTION OF MINING AND METALLURGY (at Geological Society of London), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.—Annual General Meeting.

CHEMICAL SOCIETY, at 8.—Prof. T. M. Lowry: The Validity of Drude's Equation.—A. I. Vogel: The Dissociation Constants of Organic Acids. Part I. The Primary Dissociation Constants of some Alkyl Malonic Acids.—Prof. T. M. Lowry and W. V. Lloyd: The Properties of Nicotine and its Derivatives. Part I. Molecular Extinction-coefficients. Part II. Optical Rotatory Power and Rotatory Dispersion.—A. I. Vogel: The Dissociation Constants of Organic Acids. Part II. The Primary Dissociation Constants of some Cyclic 1:1-dicarboxylic Acids.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at 11 Chandos Street, W.), at 8.15.—Dr. V. Hodson: Pulmonary Tuberculosis in the Tropics, followed by a Discussion by Col. S. L. Cummins and others.

BRITISH INSTITUTE OF RADIOLOGY (Annual General Meeting), at 8.30.—Dr. G. W. C. Kaye and W. Binks: The Evaluation of the Pastille Dose in r Units.—Dr. G. W. C. Kaye and W. F. Higgins: An Instrument for the Rapid Visual Identification of Radium Tubes and Needles.

FRIDAY, MAY 17.

ROYAL SANITARY INSTITUTE (at Town Hall, Devizes), at 5.30.—R. T. Rhodes and others: Discussion on The Milk and Dairies Order, 1926.—L. B. Densham and others: Discussion on Meat Inspection.

ROYAL PHOTOGRAPHIC SOCIETY (Pictorial Group, Practical Meeting), at 7.

SATURDAY, MAY 18.

ROYAL SANITARY INSTITUTE (at Town Hall, Devizes), at 10 A.M.—H. R. Hooper and others: Discussion on Some Aspects of Local Government on Air, Water, and Sewerage.—A. W. Jakeway and others: Discussion on The Devizes Sewage Works and Small Type Refuse Destructor.

PUBLIC LECTURES.

TUESDAY, MAY 14.

BIRKBECK COLLEGE, at 5.30.—Lord Justice Sankey: Lord Haldane's Life and the Adult Education Movement (Haldane Memorial Lecture).

IMPERIAL COLLEGE OF SCIENCE (Royal School of Mines), at 5.30.—Dr. W. R. G. Atkins: The Photo-electric and Photo-chemical Measurement of Light, with Biological Applications. (Succeeding Lectures on May 15 and 16.)

THURSDAY, MAY 16.

UNIVERSITY OF BIRMINGHAM, at 4.—Dr. M. B. Ray: The Spa Treatment of Chronic Non-tuberculous Arthritis.

ROYAL SOCIETY OF ARTS, at 5.15.—Sir Norman Walker: The Progress of Dermatology over Fifty Years (Malcolm Morris Memorial Lecture).

LONDON HOSPITAL MEDICAL COLLEGE, at 5.30.—Prof. J. J. R. MacLeod: The Physiology of Glycogen. (Succeeding Lecture on May 17.)

CONGRESSES.

MAY 15 TO MAY 20.

ROYAL INSTITUTE OF PUBLIC HEALTH CONGRESS (at Zurich).

Section I.—State Medicine and Municipal Social Hygiene.
Section II.—Industrial Hygiene and Industrial Diseases.
Section III.—Child Welfare, School Hygiene, and Women and Public Health.
Section IV.—Pathology, Bacteriology, and Biochemistry.
Section V.—Tuberculosis.
Section VI.—Climatology and Sports Hygiene.
Section VII.—Veterinary Medicine and Meat Hygiene.

MAY 15 TO MAY 23.

WORLD POWER CONFERENCE ON COMPLETE UTILISATION OF WATER POWER RESOURCES (at Barcelona).—Subjects to be dealt with:—General Hydrological Problems; Technical Problems of Water Power Utilisation; Economic and Financial Problems; Legal Problems; Protective Measures and Defence Works of Undertakings.