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Technical Education and Progressive Industry*

AS a result of a recent visit to France, Belgium, Czechoslovakia and Holland to investigate technical education at the apprenticeship stage and trade schools in particular, two Board of Education inspectors, Messrs. A. Abbott and J. E. Dalton, have produced a valuable report on the relation of technical education to industry in Great Britain. Their conclusions derive greater weight from the moderation of the report.

The report shows clearly that while Continental countries direct their main effort towards giving a severely practical training to recruits before they enter industry, their full-time pre-employment schools being in effect a part of the industrial rather than of the educational system, in Great Britain the whole system of technical education has been built up on the basis of the part-time instruction of young persons *after* they have entered industry. While, for example, we regard the technical school mainly as a place where instruction in the principles underlying industrial practice should be given and have usually left training in workshop methods to the mill or works itself, in France the technical school is looked upon as an institution which combines a good deal of instruction in workshop methods with instruction in the principles underlying this practice. The junior technical school, in fact, remains part of the educational system of Great Britain and is not part of the industrial system; and there is a definite difference in the way in which the burden of training recruits to industry is shared between the community and the employer in Great Britain and on the Continent.

The causes of this divergence are partly to be found no doubt in the greater interest taken in technical education in the countries visited than in Great Britain and particularly in the profound conviction that technical education is a most powerful instrument for maintaining and increasing industrial efficiency. The Belgian Ministry, for example, regards technical education as not merely an attempt to train well-disposed and ambitious individuals to occupy higher posts, but rather a definite effort at training an industrial army, officers and rank and file alike, which by its morale and technique will safeguard and strengthen the economic life of the State.

This view of technical education as organised

* Board of Education. Educational Pamphlets, No. 91 (Industry Series, No. 11): Trade Schools on the Continent. Pp. 110. (London: H.M. Stationery Office, 1932.) 2s. net.

to serve the needs of industry and the State is one to which the report rightly directs our attention and should assist in provoking that much needed public interest in the problems of technical education, from the lack of which it has suffered considerably. The individualistic view of education requires to be replaced by a wide vision of service for industry and the State if either public interest is to be roused or adequate co-operation secured between neighbouring local education authorities and between educational authorities and industry. Apart from the fact that certain of the weaknesses in our institutions for technical education are due to their having been built up too much in response to a demand from below and not enough in response to requirements from above, the only secure basis for developments of technical education in Great Britain is a keener and more widely diffused appreciation of the benefits to be derived from it.

The present report is essentially a further plea for the definite planning of technical education in relation to the needs of industry and society as a whole, rather than in response to individual requirements or ambitions. Technical education is so significant a factor in industrial efficiency that the public interest demands that our system of training craftsmen should be kept abreast of the times. Although up to recent years, when the emphasis was on the personal factor, industry and commerce were able to rely on evening classes for the bulk of our technical education, this form of instruction cannot remain permanently as the chief provision of technical instruction in a modern industrial State. It should be replaced to a considerable extent by a system which involves less strain on the student and yields fuller results. The tradition in Great Britain of evening education should, in the interests alike of the students, of industry, and of the community, play a much smaller part than at present in our educational system.

The justice of this argument is difficult to deny. So far as the cost of extending the volume of technical education for part-time day students is concerned, a considerable amount of accommodation in technical schools is at present vacant during the day and the increased cost would be mainly in payment of instructors. Apart from this, the present unemployment situation and the general problem of leisure with which we are confronted suggest that part-time day instruction is a rational method of completing any deficiencies in the education which the recruit to industry has previously received, and one thoroughly justified on economic grounds even in times of financial stringency.

While placing its main emphasis on the extension of part-time post-employment instruction and particularly its transfer from the evening to the day, the report also advocates a steady but discriminating increase in the number of junior technical schools to meet the needs of a particular type of pupil and of special industries or grades of occupation, as well as an increase in the number of junior vocational schools which are definitely trade schools. It is considered that it would be a mistake to replace the junior technical school as it exists in England by any form of pre-employment training seen on the Continent.

There is, however, a further fundamental problem which is also involved in any deliberate re-planning of technical education in relation to industry and commerce, and to this also the report directs attention. Even educational enthusiasts have often failed to realise that the development of the educational system is a social and economic phenomenon of profound significance, and accordingly the check to the vertical mobility of labour which is becoming apparent under the new conditions of industry and education has yet to receive full examination. Industry itself, for example, has not fully realised the bearing upon industrial recruitment and promotion, of the educational changes which now provide it with two separate streams of recruits differing considerably in quality according to their selection or not at the age of eleven years for admission to schools with a leaving age higher than fourteen years. The number of the selected group inevitably will, as a whole, outstrip those of the unselected group in competition for the more responsible and attractive posts in industry, and the responsible officers of industry will thus come from a group of individuals picked out at an early age for prolonged education.

The question of the educational provision to be made for the rank and file of industry demands increasingly the most serious consideration. Very few of them can hope for much promotion and only very exceptional boys of great ability and determination can look forward to securing posts higher than that of foremen. In addition, technical education, which until quite recently has been mainly post-elementary in character, has to adapt itself to meet more efficiently the needs of the

growing numbers of students who have received a prolonged general education. Both facts—the entrance to industry of considerable numbers of youths with a prolonged general education and the diminished incentive which ambition can provide—may, however, decrease the attendance of the next generation at vocational evening classes. It is probable that, as has been suggested by Lord Eustace Percy, the technical part of such education will best be arranged in part-time day classes while evening classes are reserved for more general instruction involving something in the nature of change and relaxation, and that evening study in particular should be organised on lines calculated to preserve or restore the adaptability of the British workman, the loss of which is under modern conditions as serious for the worker as it is to industry itself. It is only as we are bold enough to make our schools the creators of new social standards, instead of the slaves of existing ones, and to demand a development of those parts of our educational system which can admit men and women to the coveted social status which at present belongs to the professions and the middle and higher walks of commerce, that we can expect to disperse much of the prevailing dissatisfaction and unsettlement in our industrial society. The rigidity of both the skilled or semi-skilled worker, and their reluctance to undertake any other kind of occupation, are due alike to the scarcity of industrial standards entitling the worker to such respect and the fear of losing any scanty rating once acquired with a particular occupation.

Messrs. Abbott and Dalton, in the report before us, have produced a valuable document which enables the whole field of technical education to be surveyed in relation to modern industrial requirements. In addition to their emphasis on technical education as a factor in commercial and industrial efficiency and their discussion of the respective contributions of part-time instruction, the technical school and the senior elementary school, they direct attention to such important aspects of the problem as the training of teachers and the effect of vocational guidance. The whole situation calls for the closest and most careful study and co-operation by industry and by educational authorities. Industrial efficiency and the widest national interests will only be served by wide views and a deliberate policy conceived not in relation to immediate financial contingencies but in regard to the 'long range' requirements of our industrial society. In the present position, this can only be secured as the industrial and commercial professions consciously and actively contribute a liberalising influence to the standards of education like that exerted by the 'liberal' professions in previous centuries, and assist in a firm resistance to any reactionary or short-sighted policy which may jeopardise the future efficiency of industry or the welfare of society. Scientific workers engaged in industry no less than in teaching have a decisive part to play in the formulation of a practical policy of technical education and of a liberal and constructive philosophy capable of taking the wide views so essential if the educational system is to serve its primary purpose of fitting the coming generation to take its place in the life of a scientific age, in which vocational demands are ever increasing.

Max Planck's Theoretical Physics

(1) *Theory of Electricity and Magnetism.* Pp. xii + 247. 10*s.* 6*d.* net. (2) *Theory of Light.* Pp. vii + 216. 10*s.* 6*d.* net. (3) *Theory of Heat.* Pp. viii + 301. 12*s.* net. Being Vols. 3, 4 and 5 of *Introduction to Theoretical Physics.* By Prof. Max Planck. Translated by Prof. Henry L. Brose. (London: Macmillan and Co., Ltd., 1932.)

QUANTUM theory originated in the work of Prof. Max Planck of Berlin in the year 1900. It is significant that the new theory arose out of a discrepancy between theory and experiment in a somewhat recondite field of investigation, described by Lord Kelvin as one of the clouds over nineteenth century physics. The subject of research was the character of the heat radiated from a hot body—at first glance not a very promising field for anyone looking out for startling discoveries. But when we reflect that this 'radiation problem' involves the whole question of radiation and its relations to tangible matter, its importance becomes evident. Planck's paper "On the Distribution of Energy in the Normal Spectrum" was read before the German Physical Society on December 14, 1900. He had already announced his radiation formula, and in this paper he described a method of deducing it from the hypothesis that the rectilinear oscillator (dipole) of Hertz, regarded as a source of radiation, can possess energy only in integral multiples of the quantum $h\nu$. The universal constant, h, of

the radiation law, being the product of energy and time, was called the elementary quantum of action.

Planck himself has always adopted a cautious and conservative attitude towards the new theory, and time and again strove to bring about agreement with the principles of classical dynamics. "Since nothing probably is a greater drawback to the successful development of a new hypothesis than overstepping its boundaries, I have always stood for making as close a connection between the hypothesis of quanta and the classical dynamics as possible, and for not stepping outside of the boundaries of the latter until the experimental facts leave no other course open."

One of the pressing problems for the teacher of physics at the present time is to know how to deal with the ever increasing mass of new material without sacrificing what is essential of the old. For this reason it is a matter of moment that a brilliant and original theorist should have found time to place on record a statement of what he considers of fundamental importance to the student of physics, and we are grateful to Prof. Planck for his successful labours. His earlier works on thermodynamics and heat radiation had led us to expect a well-balanced and lucid account of modern theoretical physics, and in the three volumes now before us we are not disappointed. Volumes on general mechanics and the mechanics of deformable bodies form the first two of the series of five works comprised in Prof. Planck's "Introduction to Theoretical Physics". The translation into English is in the competent hands of Prof. Henry L. Brose.

(1) The volume on electricity and magnetism is essentially deductive in its method. Two fundamental ideas are employed in the development of the subject—the Principle of Conservation of Energy, which is given priority, and the Principle of Contiguous Action. This second principle, which postulates action by contact as opposed to action at a distance, is the basis of Maxwell's theory. "Everything which happens at a certain place at a certain time is completely and uniquely defined by the events which have occurred immediately preceding it in the immediate neighbourhood of the place." It is claimed that this theory owes its sovereign position over all others to its greater definiteness and simplicity. The book accordingly starts in somewhat unusual fashion by giving expressions for the energy of the electromagnetic field, followed by Poynting's vector for the flux of electromagnetic energy. This procedure is of special interest in view of the criticism which Poynting's theorem has received in recent years. From these principles Maxwell's fundamental equations for the electromagnetic field are derived. The electrostatic field and the magnetostatic field are then discussed, together with molecular and ponderomotive actions in the stationary field. Finally, quasi-stationary and dynamical processes are considered and also the limits of the electrodynamics of Maxwell and Hertz. This all too brief summary will serve merely to give some idea of the scope of the work, which deserves the careful attention of the advanced student. The treatment of the different systems of units and the dimensions of electric and magnetic quantities deserves special commendation.

(2) In the first three volumes of the series matter is assumed to have absolutely continuous properties, but in the volume on light the atomic point of view must be adopted. This is necessary in dealing with dispersion, for the interaction between light waves and vibrating particles must then be considered. Some of the more daring speculations in quantum theory were due to Einstein, who in 1905 put forward the hypothesis of 'light quanta', and later applied quantum ideas to account for the thermal capacity of a solid at low temperatures. In the present volume the opportunity is seized of showing how optical theory links up with quantum mechanics. The analogy between classical mechanics and geometrical optics is described, and it is shown how L. de Broglie based on this analogy an explanation of quantum phenomena. Schrödinger afterwards developed the idea further and embodied Hamiltonian and optical principles in his wave equation.

(3) The last volume deals with heat because the theory occupies a special position as compared with other physical theories. The First Law of Thermodynamics is merely a particular case of the Principle of the Conservation of Energy, but the Second Law introduces a new conception which is peculiar to heat. As soon as heat enters into the question, the sequence of events tends to approach a definite end in which a state of thermal equilibrium is established. "Hence all occurrences in which heat plays a part are in a certain sense unidirectional, in contrast with mechanical and electromagnetic events, which can equally well take place in the reverse direction, since for them the sign of the time factor is of no consequence." Perhaps some caution is advis-

able before dogmatising on this difficult question, in view of the limited nature of human experience. In the first two parts of the book the author deals with heat in bodies, and afterwards also with radiant heat. The third part is concerned with the classical laws of radiation and the last part contains a valuable account of Planck's own work on the theory of quanta as applied to the energy distribution in the normal spectrum, and the equation of state of material bodies.

These volumes should take their place in the library of every physicist. H. S. ALLEN.

Antarctica

The Conquest of the South Pole: Antarctic Exploration 1906–1931. By J. Gordon Hayes. Pp. 318 + 24 plates. (London: Thornton Butterworth, Ltd., 1932.) 18*s.* net.

DR. H. R. MILL'S "Siege of the South Pole" was published in 1905. It was a scholarly book, full of the author's enthusiasm for the explorers and their work, and with just sufficient of the popular to recommend it to the general as well as to the informed reader. Many regard it as the best book on the Antarctic, and it is certainly among the first half-dozen, occupying an honoured place with the travel narratives themselves; with Scott's "Voyage of the Discovery", Shackleton's "Heart of the Antarctic", and Shackleton's "South".

Dr. Mill's book ended with the period of the British Antarctic Expedition, led by Capt. Scott in the *Discovery* in 1901–4. Fresh expeditions from that date have followed one another in rapid succession, and in 1911, for example, there were as many as seven separate parties in the field belonging to five expeditions. As Dr. Mill says in his introduction to Mr. Hayes' book, he was soon bombarded by demands for a continuation; and he made up his mind to rewrite and modernise the "Siege". Other factors however intervened, and perhaps providentially. It is doubtful if a sequel or a revision can ever repeat a first success. Dr. Mill in the end had to give up the idea either of rewriting the "Siege" or publishing a fresh book to deal with the last twenty-five years. Concurrently, however, he had found Mr. Gordon Hayes more than willing to undertake the work and anxious also to be guided by his predecessor. The present book is the result, written by Hayes and approved by Mill.

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For the later expeditions, Mr. Hayes prefers the adjective mechanic rather than homeric, but not to the exclusion of heroism. Wilkins, Riiser-Larsen, and Byrd are all flying men, and they have all of them shown how discoveries are now dominated by the machine. There is a limit, however, to the effectiveness of the aeroplane, as exploration, in its widest sense as distinct from discovery, must still be done on the ground. This is driven home both by Hayes and by Mill; the aeroplane may be the eyes of the Antarctic leader; to explore and to conquer is still the work of the man on the ground. The motor sledge will be his ultimate standby; but meantime dogs and men may still make records in the Antarctic. J. M. WORDIE.

Structure of Crystals

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The principal additions include an introductory chapter, which makes it easier to start reading the book, and new sections on the production of X-rays, the scattering power of atoms, atomic

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The principal additions include an introductory chapter, which makes it easier to start reading the book, and new sections on the production of X-rays, the scattering power of atoms, atomic

sizes and co-ordination. The experimental chapters in Part I, "Methods of Crystal Analysis", have also been arranged in a different order. In Part II, "Results of Crystal Analysis", the old chapters dealing with oxides, chlorides, nitrates, etc., have also been displaced by chapters dealing with the types RX, RX_2, R_2X_3, RX_3, $R_x(MX_3)_y$, $R_x(MX_4)_y$, etc. These are preceded by a chapter on "Elements and Alloys", in which all the data available up to 1930 are summarised, and are followed by chapters on hydrates and ammoniates, silicates and organic compounds, all provided with similar tables and references to the bibliography.

The only fault which the reviewer has discovered is that in the new edition references are given exclusively to these tables, so that it is no longer possible from the index to trace the pages on which such familiar structures as those of rock salt and fluorspar are illustrated. On the other hand, the author has accomplished the unwonted exploit of writing a second edition of which the text is shorter and not less readable than that of the first, in spite of the enormous mass of additional knowledge with which he has had to deal. The new edition is therefore even more useful in 1932 than its predecessor was in 1924, and is likely to be in still larger demand.

Harvey's Successor

Early Science in Oxford. By R. T. Gunther. Vol. 9: *De Corde. By Richard Lower, London, 1669.* With Introduction and Translation by K. J. Franklin. Pp. xxxv + 374 + 8 plates. (Oxford: R. T. Gunther, 5 Folly Bridge, 1932.) 21*s*.

THOSE who follow the trend of human anatomy in England may have noted the appearance of certain additions which Dr. Franklin, of Oriel College, Oxford, has made to our knowledge of the venous system. It is uncommon in these days to find an anatomist or physiologist who, before setting down the contribution he is to make to modern knowledge, takes pains to discover not only what his immediate predecessors know but also what his remote predecessors have discovered, in the particular field of inquiry he has undertaken.

Dr. Franklin has the happy gift of compelling the past to help in unravelling the problems of the present. By rendering into English Richard Lower's "Tractatus de Corde" he has given its author a high and distinguished place amongst anatomists and at the same time has rendered a service to modern anatomy, for beyond doubt, the utility of Richard Lower's investigations is far from exhausted.

Harvey's discoveries were published in 1629; Lower was born in 1631; his tract on the heart was published in 1669, twelve years after Harvey's death. A close study of Dr. Franklin's translation leaves no doubt as to Lower's position; he was, after Harvey, the greatest anatomist produced in England during the seventeenth century. He came against medical men who still doubted the truth of the functional explanation which Harvey had given of the heart and of the blood vessels of the body. Following in Harvey's footsteps, he again submitted the heart to anatomical analysis and experimental proofs and discovered many truths, supplementary to those of Harvey, which have been rediscovered in quite modern times. Even to-day, physiologists have something to learn from him regarding the manner in which the heart is fixed, so that it can serve as a pump; his description of the intricate arrangement of the musculature of the heart and his conception of the manner in which the blood is expelled from the heart by its musculature—"like the wringing of a linen cloth to squeeze out water", come nearer the truth than are to be found in modern textbooks.

In all his investigations, Lower was guided by the assurance that the clue to function was structure, but he also knew that final proof had to be sought in experiment. In the course of his experiments he produced conclusive evidence that it was the absorption of air in the lungs which gave blood its arterial colour.

Lower, it must be admitted, made many mistakes in his attempts to explain the structure of the human body, and his name has come down to modern times attached to one of these. Dr. Franklin reproduces not only a facsimile of the original text of "De Corde" but also of its illustrations. Fig. 1 is a drawing of a heart—which is said to be human. The superior and inferior venæ cavæ are made to enter the right auricle at an angle and so close together that their adjacent margins form a projection or swelling. This projection was described by Lower and has been named the "tubercle of Lower". One may well suspect that the heart figured by Lower was not human, for it shows a prominent caval angle which is characteristic of the heart of quadrupeds and not, as he asserted, of the human heart.

Lower deserved a better fate than to have his name handed down to posterity linked to one of his mistakes. Fig. 1 of Plate V gives a view of the interior of the human left ventricle in which is rendered a most faithful representation of the conducting system of the heart, the true nature of which was discovered by Tawara only twenty-five years ago.

Lower was one of the brilliant band of scientific men who made their home in the University of Oxford during the Commonwealth and founded the Royal Society after the Restoration. Robert Hooke and he were members of Christ Church, and it is right that Dr. R. T. Gunther should have devoted the ninth volume of "Early Science in Oxford" to the work of Lower, since the eighth was given to that of Hooke.

Short Reviews

(1) *How to be Happy though Human.* By Dr. W. Béran Wolfe. Pp. xiv + 374. (London: George Routledge and Sons, Ltd., 1932.) 10*s.* 6*d.* net.

(2) *Discovering Ourselves: a View of the Human Mind and how it Works.* By Dr. Edward A. Strecker and Dr. Kenneth E. Appel. Pp. xiii + 306. (London: Chapman and Hall, Ltd., 1932.) 15*s.* net.

(3) *Effective Thinking.* By Joseph Jastrow. Pp. xiv + 263. (London: Noel Douglas, 1932.) 7*s.* 6*d.* net.

(4) *The Sex Education of Children: a Book for Parents.* By Mary Ware Dennett. Pp. viii + 142 + 4 plates. (London: George Routledge and Sons, Ltd., 1932.) 3*s.* 6*d.* net.

WE notice these four books together because they all bear upon a common theme—the art of living. They all exemplify the fact that medical men and psychologists are partly taking the place formerly occupied exclusively by moralists, in teaching that art. "Mental hygiene," says Dr. Wolfe, "is the science of the hour. In its twenty-five years of existence this infant among the sciences has already contributed a distinctive flavour to the twentieth century." To like effect Drs. Strecker and Appel write—"There seems to be a general need for a more intelligent understanding of mental hygiene." Both these books take the view that, the value of physical hygiene being now everywhere accepted, mental hygiene must have its turn. Dr. Wolfe owns Alfred Adler as his leader. But he stands firmly on his own feet, basing his treatment of the subject largely upon cases from his private and clinical practice. He has written an excellent book, which deserves lengthier notice than it can receive here. The same may be said of "Discovering Ourselves". The authors of this book help the general reader by the use of illustrative diagrams, quite effective in their way. They write sanely and sensibly, and so clearly that no educated reader can miss their meaning. One can say so much, without committing oneself to all their views.

In the third book on our list, we pass from mental to 'logical hygiene'. The author makes it clear that 'effective thinking' does not come entirely by the light of Nature. But instead of the logic of the textbooks, he gives an analysis, popular but not shallow, of the technique of thinking, and of the impediments in the way of accurate thought. He makes us wish that our politicians and journalists and other modern guides could be compelled to make a careful study of his book.

In the fourth book we pass to the much discussed subject of sexual hygiene, certainly a most important factor in the art of living. Limitations of space forbid us to say more than that it is one of the best books of its kind we have seen. It is sane, sound, and admirably written.

A Short History of Atomism: from Democritus to Bohr. By Joshua C. Gregory. Pp. vi + 258. (London: A. and C. Black, Ltd., 1931.) 10*s.* 6*d.* net.

IT is the epic of the successive dynasties of the atom that Mr. Gregory sets himself to recount in his very interesting book. From Democritus, who was the first to discuss atoms, down to the present day, we are given a panoramic but accurate description of the various types of atoms which have held the field of science and speculative philosophy; and though a bibliography would have been helpful, the absence of notes is more than compensated by the specialised knowledge that Mr. Gregory has of this very difficult subject.

It is, of course, the modern period which is considered at great length by the author. We are shown, for example, how Daltonian atomism, striking into thought about midway between the conceptions of Boscovich and Faraday, formed the background of the remarkable labours of Gay-Lussac, Avogadro, Faraday, Prout, Thomson, Rutherford, Helmholtz, Goldstein, Röntgen, Kelvin, Curie and others. But though this revival of the Democritean and Newtonian atom held its own until the end of the nineteenth century, it had finally to give way to the electrical structure of matter, a conception which was steadily invading science when Thomson accepted Kaufmann's hypothesis that the mass of β-particles was entirely electromagnetic. Democritus and Epicurus would have been surprised at the complicated types of atoms that have been constructed since; though they would feel more at home with the spontaneous swerves which, without any apparent cause, hurry the atoms into their disintegrating course. Heisenberg's principle of indeterminacy, coupled with the developments of wave and quantum mechanics, will no doubt lead

us into new conceptions about the atoms. Besides their scientific and perhaps practical interest, the question arises whether the new atomic theories, now in their period of gestation, will lead us away from instead of into reality. T. G.

Laboratory Manual of Organic Chemistry. By Dr. Harry L. Fisher. Third edition, revised. Pp. xvii + 368. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1931.) 13*s.* 6*d.* net.

ADDITIONS in the third edition of this manual include general notes, sixty-eight experiments and a large section devoted to methods of quantitative organic analysis. The style is clear and the subject matter has been brought up to date. The book differs from most of the other practical organic chemistry books in that, instead of describing a large number of preparations from which some can be selected for the student to perform, all the experiments described can be and are intended to be completed by the student during his course, and on completion he should have practical experience of all the processes described in the book.

The experiments, to each of which a series of questions is appended, appear to have been chosen to give the student a wide experience of the manipulation of the various types of apparatus used in organic preparation. The manufacture by young students of such materials as dry metallic acetylides and molecular sodium is, however, not without risk.

The chief merit of the book is the inclusion of a surprisingly large number of those little tips which make the difference between the technique of the student and the capable research worker and which are usually left to be learnt from personal experience and one's fellow workers. The book is well worth the attention of those responsible for laboratory courses. L. C. N.

Müller-Pouillets Lehrbuch der Physik. Elfte Auflage. Herausgegeben von A. Eucken, O. Lummer, E. Waetzmann. In 5 Bänden. Band 4: *Elektrizität und Magnetismus.* (1) Teil 1: *Grundlagen der Lehre von der Elektrizität und dem Magnetismus.* Bearbeitet von Siegfried Valentiner. Pp. xxi + 734. 47.50 gold marks. (2) Teil 2: *Technische Anwendungen der Elektrizitätslehre* (*Elektrische Maschinen, Kraftübertragung, Telegraphie*). Bearbeitet von H. Decker, E. Flegler und G. Möller. Herausgegeben von Siegfried Valentiner. Pp. xvi+462. 30 gold marks. (Braunschweig: Friedr. Vieweg und Sohn A.-G., 1932.)

"MULLER-POUILLET" needs no bush. The fourth volume of this standard treatise is divided into two parts, dealing with the fundamentals of the 'classical' part of electricity and magnetism, and with certain technical applications respectively. The treatment is full and thorough, while remaining elementary in character, and emphasis is laid on descriptions of measurement and instruments, rather than on developments of a formal mathematical type. The technical applications dealt with are those of most concern to the physicist, and are handled in thoroughly interesting and competent fashion. The volume is well illustrated and documented, and the teacher of physics will find it a most useful addition to his bookshelves. A. F.

Economic Geography of Europe. By Prof. W. O. Blanchard and Prof. S. S. Visher. Pp. ix + 507. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1931.) 17*s.* 6*d.* net.

THERE was need of a textbook on the economic geography of Europe that discussed broad issues and was not overburdened with facts and figures. This volume largely fills the gap. It was prepared for American students but that is no disadvantage since it appears to be singularly free from bias and treats the whole of Europe impartially.

The first part of the book treats Europe as a whole, starting from the essentials of physical geography. The second and longer part takes the different countries in turn, and this part is perhaps the most valuable, though apt to be superficial in places. It is written in a readable style and care has been taken not to clog the pages with facts of location or figures of trade, though these are not neglected where necessary.

There are many excellent maps and diagrams and careful bibliographies to each chapter. In an end pocket is a large folded 'physiographic diagram' of Europe which is in the nature of a pictorial map of surface features. This should prove useful even in the absence of a key to the regions.

The Open World: Three Lectures on the Metaphysical Implications of Science. (The Terry Lectures.) By Prof. Dr. Hermann Weyl. Pp. vi + 84. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1932.) 9*s.* net.

THIS book, which makes delightful reading, expresses the conviction that modern mathematics and physics make the world appear more and more as an open one; that is, they point to a world beyond the actual structures by which science describes the bounds of our positive knowledge. Science can do no more, however, than show us this open horizon; we must not by including the transcendental sphere, attempt to establish anew a closed though more comprehensive world. This main thesis is developed in three lectures on God and the universe, causality, and infinity. The profound and provoking opinions put forward by Prof. Weyl are a valuable addition to the testimonies expressed by prominent scientific workers as to the real value of their professional experiments and studies. T. G.

Tropical Plant Diseases: Their Importance and Control*

By Dr. E. J. BUTLER, C.M.G., C.I.E., F.R.S.

IN the great tropical and subtropical plantation industries, such as tea, rubber, coffee, cocoa, citrus fruits, etc., large areas of permanent crops are cultivated on capitalistic lines with uniform and usually white control. On an estate of hundreds or even thousands of acres, often under highly intelligent supervision and where the produce may be worth a great deal of money, it is comparatively easy to get adopted improvements which are the results of scientific research, whether in the control of disease or in any other direction. It is quite a different matter, however, when one comes to deal with the crops grown by the indigenous people of the tropics for their own use. Their agricultural practices are rigidly traditional, their standard of intelligence may be low, money is scarce or even absent, and their crops are raised in small holdings, often subdivided to an almost incredible degree. I once had occasion to acquire 17 acres for expansion of an agricultural research station in India and found 30 families and 91 individual plots represented in this piece of arable land. In such conditions—and they are those under which a great part of the population of the world lives—"the cultivator's ways and the sheep's ways tend to be much the same", as an Indian proverb says, and however well the traditional agricultural methods are followed, the cultivator is apt to be helpless in an emergency as, for example, an outbreak of epidemic plant disease.

It is not surprising that the earlier plant pathologists who worked in the tropics, from the time when Marshall Ward went to Ceylon in 1880 to fight coffee leaf disease when it was already too late to save the industry from ruin, should have concerned themselves mainly with the diseases of the great export crops. A study of the reports of fifteen or twenty years ago will show that for practical purposes, India was the only tropical British possession in which it was the policy of the agricultural departments to devote much of their attention to the crops grown by the people of the country for their own use. During the past ten years, however, there has been a considerable improvement in this respect in the British Colonies, especially those of tropical Africa. Most of the colonies have one, and a few have two, plant pathologists attached to the agricultural departments and where as in several of them there are no plantation crops, the needs of the village cultivators are receiving attention. Even in some of the more advanced 'plantation' colonies such as Ceylon and Malaya, the large plantation industries have now organised their own research departments, leaving the Government departments of agriculture free to concentrate on the improvement of the local crops and methods of farming.

Such improvements are likely to increase the responsibilities of the plant pathologists. New and improved varieties of crop plants are liable to become attacked by diseases from which the old ones had become immune through age-long selection, and more intensive methods of farming often have a similar result. The great activity in crop improvement that has been characteristic of agricultural development in the United States and Canada since the beginning of the present century, has been accompanied by such an increased call on the services of plant pathologists that each of the staple crops has, not one but many, men engaged in the study of the cause and control of the diseases to which it is liable. As similar efforts are made to improve the staple food crops of the tropics similar needs will be felt. There are clear indications from the work on rice in Japan that even in a crop such as this, which in India is one of the healthiest of all the field crops, there is a number of diseases capable of becoming formidable obstacles to the introduction of improved varieties.

The two tropical cereals next in importance as food crops, sorghum and the bulrush millet, are much more subject to disease than rice, but very little work has been done on them in the tropics and even the full life-history of several of the common bulrush millet parasites is unknown. Still less is known of the diseases of the tropical pulses and other plants of economic importance, except those that are grown for export. Tropical plant pathology has not much to boast of in the study and control of village and field crop diseases; the number of man-years of work put into this branch of agricultural science is too small to have yielded much result and the difficulty of getting the native cultivator to change his ways, as well as his lack of means and general backwardness, has helped to induce a pessimistic outlook amongst those who are charged with the control of agricultural research and amongst the research workers themselves. Nevertheless, not only because there is great preventable loss of crops from disease in the tropics but also because a solid knowledge of the pathology of each crop plant is a necessary concomitant of all attempts at crop improvement, means must be found to surmount these difficulties. Little by little, openings for successful attack on them will appear, and however slow progress may be at first, the next fifty years are bound to see a great improvement in the crops and in the general agriculture of even the most primitive of the African Colonies. In this advance plant pathologists will have to bear an ever increasing share.

The work which has been done in India during

* From a semi-popular lecture delivered before Section K (Botany) of the British Association at York on Sept. 2.

the past twenty-five years or so illustrates some of the problems that the tropical pathologist has to face in dealing with village and field crops. When the Indian agricultural department was formed thirty years ago, extremely little was known of the diseases of tropical plants, though there were a few exceptions, such as sugar cane. The first work done in the mycological branch, therefore, was to make a survey of the diseases of the more important crops, and when many of these were found to be undescribed, a more intensive study of a few was undertaken and lasted a number of years. Two of them, one on palmyra and coconut palms and the other on rice, broke out in epidemic form and had to be dealt with on emergency lines, invoking the aid of the administrative services and leading, in the palm disease campaign, to legislation of the kind that is familiar in more advanced countries, where it becomes an actionable offence to own a diseased plant without reporting or dealing with it as prescribed. In the campaign against this disease, which was exterminating the palmyra in an area where this was the dominant tree and by far the most useful,* nearly a million diseased palms were cut out to save the rest. This and the subsequent legislative action and the discovery that many trees could be saved by removing the bud sheaths in the early stages of attack have been successful in preventing the spread of the disease and in keeping it within manageable proportions. The campaign cost the Government about £20,000; but the value of the palms cured by treatment was estimated at about £28,000 in 1921, and the number saved from infection must run into millions.

In other cases it soon became evident that the variety of the crop grown was exceptionally liable to disease either because of inherent susceptibility or because disease had been allowed to accumulate in the stock and was being transmitted when diseased material was used for planting each successive crop. In such cases the agriculturists of the department, each of whom had a district under his charge, became invaluable collaborators, both in observing the injury done to particular varieties and in introducing new or more healthy ones.

Then there were the cases where one had to make a direct attack on the parasite and try to kill it or to prevent its spores germinating by the use of fungicides. This at once brought one face to face with the economic limitations of village agriculture in countries like India, where the cultivator usually has little actual money at his disposal and can only borrow at exorbitant rates of interest.

Copper and sulphur have remained to the present day the chief weapons in the hands of the plant pathologists in their direct attack on fungal parasites. In India they have been used chiefly on the more valuable orchard and garden crops or as seed disinfectants on field crops.

* An ancient Sanskrit poem professes to enumerate eight hundred and one separate uses for the palmyra palm.

The relative infrequence of destructive epidemics of disease amongst indigenous crops in the tropics as compared with the great plantation crops is not due, I think, as is sometimes assumed, to the circumstance that the latter generally occupy larger continuous areas under the one crop, so that disease germs can multiply and infect more readily. In India there are large areas of village lands mainly under a single crop, as rice in 70 per cent of the cultivated land in parts of Bengal or cotton in 60 per cent of Khandesh. Freedom from disease in these cases is probably mainly due to disease resistance having become, through long experience, the determining factor in the selection of the varieties grown, the quality of which is liable to be a secondary consideration and is often decidedly low. In the plantation industries, on the other hand, quality which will enable the produce to compete in the markets of the world is so important that hardiness may be sacrificed. Examples of destructive epidemics in these crops are numerous and are not, as in the other category, usually due to newly introduced parasites. They are just as often due to an old parasite finding in a new variety a congenial host. They are sometimes also due to the considerable financial return leading to expansion of a plantation system into areas not naturally affording optimum conditions for the growth of the plant, so that its environment may become more favourable to the parasite than the host.

The recent wave of epidemic disease that has ravaged the cotton plantations of the Sudan may perhaps find a partial explanation in these considerations. When the great Gezira irrigation scheme, due in its inception to the genius of Garstin and Kitchener, was opened in 1925, it was already established that the highest quality Egyptian long-stapled cotton could be successfully grown in this previously arid waste. At the present time, approximately 200,000 acres of irrigated Sakel cotton is grown as the major crop in the gigantic plantation of 600,000 acres under uniform control and cropping, surely the largest arable farm in existence. During the first five years after the dam was built across the Blue Nile, cotton worth more than £12,000,000 was produced from the Gezira, and 150,000 people had settled where before there was only a scattered famine-stricken population.

The cotton disease known as blackarm occurs in all the cotton-growing parts of Africa, but it seldom causes much injury to the varieties grown by the people of the tropical regions, and the long-stapled kinds grown in Egypt escape damage apparently because the climate of Egypt does not suit the parasite. In the Egyptian varieties grown in the Sudan it became a formidable pest, being one of the main factors in reducing the yield per acre from 479 lb. in 1925–26 to 129 lb. in 1930–31. This represents a loss of more than 60,000,000 lb. of cotton on the area grown in the latter year, worth even at the low prices then prevailing, more than £800,000. As the disease is carried mainly

on the seed, an elaborate scheme of seed disinfection with the dust known as 'Abavit B' was carried through before the last season's crop was sown, the whole of the seed for this great area, representing more than 30,000 bags, being treated by specially devised seed dusters. Various other steps were also taken to combat the disease, and the yield, when harvest was completed last spring, was found to have risen again to a little more than 400 lb. per acre, or not far short of that of the earlier years.

In this case there is far more at stake than the saving of an industry, however important. The whole future of a province is in the balance. I cannot refrain from quoting a foreign observer who visited the Sudan two or three years ago. "The Sudan is the latest thing in European exploitation and it is the best." There has been "created a corps of agriculturists and entomologists to destroy the pests that attack the native crops ; a group of veterinarians to look after and improve the native cattle ; and a quite unrivalled body of biologists, bacteriologists, laboratory workers and doctors to fight native diseases. Trekking through the land are the government biologists and entomologists, experimenting, destroying pests, noting processes, giving advice. You rarely find them in the same place for two weeks running ; these hardy scientists do even more work in the open than in their laboratories."

The West Indies present a very different picture from the Sudan. There, in some of the oldest of the British Colonies, generations of planters and settlers have been engaged in the tropical and subtropical cultivations of lands favoured by Nature to an unusual degree. Jamaica is the largest banana exporter of the British Colonies, having sent out 24,000,000 bunches in 1930, representing more than 50 per cent of the total value of her exports. In 1912 the first cases of the now notorious Panama disease of bananas in the island were examined by S. F. Ashby. Rigid quarantine measures were promptly introduced by the Director of Agriculture, Mr. H. H. Cousins, impressed by the ruin from this disease which had befallen the banana-growing enterprise in the Dutch Colony of Surinam between 1906 and 1910. As soon as a diseased plant was discovered, it and all the surrounding ones on an area of four chains had to be destroyed and the area fenced in. As a result, spread was slow, the number of cases annually not surpassing 1000 until 1921. Increase since has been at the rate of about 50 per cent a year, until by 1929, there were about 85,000 cases, involving nearly 140,000 plants. In the parish of Portland, the most diseased, some 9000 acres, or approximately one-tenth of the total estimated banana acreage of the island, have now been abandoned, for it has been found that commercial banana growing is impossible on land once infected, and the great United Fruit Company has already abandoned nearly 100,000 acres from this cause in Central America. The expenditure by the Government of some £60,000 in Portland no doubt prolonged the life of the plantations by ten years or more, but in the end has proved unavailing.

As there is no direct method of fighting this disease, which is due to a soil fungus, attempts to procure resistant varieties are being energetically carried out both in Jamaica and at the Imperial College of Tropical Agriculture in Trinidad. Varietal tests have shown that the Cavendish species of banana and some others are either highly resistant or totally immune. Botanists both from Kew and the West Indies have toured the world in search of varieties for trial and hybridisation and these are grown under quarantine and inspection at Kew before being sent on to Trinidad. Very large numbers of crosses have been made in Trinidad and Jamaica and some of the immune seedlings produced in the latter island have given bunches which were acceptable to the trade during the past year. The Trinidad seedling I.C.1 (Imperial College No. 1), a cross between the commercial Gros Michel and a wild species, has also shown remarkable immunity during six years tests, but the fruit still requires improvement.

It is estimated that within the next five to seven years, at the present rate of increase of the disease and the amount of suitable banana land left, the Jamaican export will begin to decline, and the decline is likely to be rapid unless a satisfactory resistant variety can replace the Gros Michel. The breeding work is difficult and slow. It is not easy for the stricken farmers to be patient. The whole population in the coastal parts of the parish of Portland has been brought up to the cultivation of the banana before anything else, and though an alternative crop of marketable value is desperately needed, it will take a long time to break down prejudices in a one-crop population. Many of the people have migrated, but many have remained to make a living as best they can. It is cold comfort to tell them, as there have not been wanting even scientific men to say, that these coastal lands, extraordinarily fertile though they be, are unsuited to the banana because the damp soil favours attack by Panama disease. The local Department of Agriculture has never taken that view but has striven hard to fight the disease, and the extra lease of life that it has given the industry, though insufficient in Portland, may yet save the banana cultivation of the island as a whole.

In the examples selected to illustrate the importance and control of the diseases of tropical plants, there is every gradation in severity from the sorghum smut which levies a moderate toll of about ten per cent of the crop on some millions of acres in India, to the Panama disease which completely exterminates the susceptible bananas and precludes replanting within any reasonable time. The success of the measures which have been adopted to control these diseases also shows every gradation from the complete control which is easy to obtain by disinfection against sorghum smut or by growing Cavendish bananas in Panama-diseased land, to mere alleviation which appears to be all one can hope for, but is yet sufficient,

against rubber mildew or the root diseases of limes. A consideration of these measures—ruthless eradication, the complete replacement of susceptible varieties, hybridisation or selection to obtain resistant plants, budding or grafting on resistant stocks, modifications in agricultural practices like stubble burning or pre-watering, and, finally, the direct attack on the parasite by steeping, spraying or dusting—indicates how varied is the task of the plant pathologist and how wide must be the foundations of his knowledge if he is to perform it successfully. The old conception of the mycologist, student of the fungi that cause disease, as adequately equipped to fulfil the duties of a plant pathologist, dies hard but it is dying. Like bacteriology in the realm of medicine, pure mycology is a necessary foundation and the mycologist a necessary collaborator, but he is not equipped either as a general practitioner or a specialist in particular diseases.

The practical man is often slow to admit that a destructive disease in a plant is due to agencies outside his control. Confronted with such he is inclined to seek for explanations other than the true one. He looks first for some disorder brought about by cultivation or inbreeding, or meteorological phenomena. Or he thinks that the soil is unsuitable or has become exhausted, or that the plant, if an exotic, has failed to become acclimatised. It is often not until all these have been tested and found wanting, that the true cause is fully realised. Experience has shown that it is unfortunately rare to find the explanation of serious disease in these directions and the dominating factor is usually the presence of a parasite, however much its activities may be favoured by secondary causes.

Failure to recognise the very varied weapons used by modern plant pathology and undue weight given to the secondary factors in the causation of disease have led, no doubt, to the suggestion which I have heard that the 'mycologist', as he is still called in most of the British Colonies, may be in danger of losing his position as one of the most essential members of any team of tropical research agriculturists. In actual fact there can be no question that, looked on as a member of a team and relying on the collaboration that must exist between him and the plant breeders and agriculturists, the plant pathologist is more needed now than ever. Improvement in the crops of the people and the quest of quality or the satisfaction of market fancies in the plantation crops can be relied on to be followed by increase in disease. Unless plant pathologists well versed in the pathology of the crop concerned are available—and they cannot be produced at a moment's notice—the examples I have given will be paralleled in every Colony in the British Empire.

The Cambridge Philosophical Society

THE Cambridge Philosophical Society was incorporated in 1832, by Royal Charter, through the grace and favour of William IV, and the centenary of that event has been celebrated recently. (See NATURE of November 19, p. 769.)

The history of this scientific organisation, which has maintained a high standard in past years, and remains unfailingly hopeful of the future, should be of interest, not only to historians of science, but also to laymen. The Cambridge Philosophical Society is of older origin than its royal grant by some twelve or thirteen years. In October 1819, as the outcome of conversations amongst a few interested persons, a notice was issued, signed by thirty-three members of colleges, inviting assistance in promoting a society "as a point of concourse for scientific communications". Success having followed this venture, the designated name was approved, rules were made, and a council elected for the year ensuing. The Chancellor of the University, H.R.H. the Duke of Gloucester, accepted the office of patron; that of president being assigned to the Rev. William Farish, Jacksonian professor of natural and experimental philosophy. In all the foregoing movements, Prof. A. Sedgwick, J. S. Henslow (afterwards Prof.), and Dr. E. D. Clarke (professor of mineralogy, 1808–22), were prominent. At an inaugural gathering, the last-named gave an address on the new project (separately distributed*). Reference was broadly made to the philosophical contributions of members of the University as being hitherto "frittered and squandered away" in detached and distant parts, almost to be without existence.

The first half of the nineteenth century witnessed the establishment of many scientific societies. The apprehensions of Sir Joseph Banks for the welfare, even the continuity of the parent tree, the Royal Society, were seen to have been needless, and indeed, at his death, in 1820 (whilst in office), however chequered in progress certain of the newcomers were, the writing was already on the wall in regard to alarmist notions. Among the new bodies were: the Horticultural (1804), Geological, London (1807), Geological, Penzance (1814), Institution of Civil Engineers (1818), Astronomical (1820), Zoological (1826), Geographical (1830), Entomological (1833), Chemical (1841). Cognate organisations were formed at Manchester, Glasgow, Hull, and other centres. Neither in the perplexing era of the seventeenth century, nor in the industrial nineteenth, were scientific societies born secure in the knowledge of powerful support. In all the instances above, initiation was *ex collegium*. In the case of the Cambridge Society, there certainly was an ample measure of University support and

*The Patent Office Library, London, possesses a copy (bound) on the title page of which is the pencilled signature, "J. Henslow, 1821," and there are textual annotations in the same hand.

favour, coupled, by the way, with financial help from the syndics of the University Press.

A few words are due to the Rev. W. Farish, first president of the Cambridge Philosophical Society. Born in 1759, he was educated at Carlisle Grammar School. He graduated in 1778, being senior wrangler and first Smith's prizeman. Farish was instituted Jacksonian professor of natural and experimental philosophy in 1813, succeeding the Rev. F. J. Hyde Wollaston, a brother of William Hyde Wollaston. Earlier (1794) Farish had been chosen professor of chemistry. In 1796 he published a plan of a course of lectures on arts and manufactures in relation to chemistry, a scheme in all likelihood derived in the main from his predecessor, who himself was responsible for "A Plan of a Course of Chemical Lectures". Farish was the author of six papers read before the Society, one of them (1820) under the title "On the Mode of Conducting Polar Navigation".

Space would forbid other than cursory notice of memoirs read in the first half-century of the Society's career. The chief publication began in 1820, entitled *Transactions*, supplemented in 1843 by *Proceedings*. They both enjoy a world-wide circulation now. In the spring of 1820, J. F. W. Herschel communicated three papers, and in 1835 came letters from the Cape of Good Hope detailing meteorological observations made there by him. Similarly, at the same meeting, letters were read from Charles Darwin containing accounts of the geology of certain parts of the Andes and South America. Very much later (in 1860), Darwin is writing thus to Lyell: "I had a letter from Henslow this morning, who says that Sedgwick was . . . to open a battery on me at the Cambridge Philosophical Society. Anyhow, I am much honoured by being attacked there, and at the Royal Society of Edinburgh". Faraday had written in 1823 accepting honorary membership. Airy, whilst yet a student at Trinity College, communicated a paper, followed by others, down to 1840. Whewell provided many papers. But such records are readily capable of indefinite extension, reaching into another half-century, and that is not practicable. Suffice that the names of some of the best-known exponents of science in almost all departments appear in the lists of past presidents. We learn that to-day, tea before meetings, as in "another place", fortifies those numerous authors whose memoirs have, of necessity, to be "taken as read". The separate publication of *Biological Reviews and Biological Proceedings* is an undertaking of recent years which has proved of great value.

It is of interest to record that at the annual general meeting in 1895, Prof. J. J. Thomson, president, in the chair, the subjoined resolution was adopted: "That the Fellows of the Cambridge Philosophical Society at this their first meeting since the death of Professor Thomas Henry Huxley desire to express their sympathy with Mrs. Huxley, and to record their sense of the depth of his influence on modern thought, and on the progress of biological science".

In its youthful period, aided by the lively interest of Prof. Henslow, the Society took pains to form collections exemplifying natural history. In process of time this important nucleus of a great museum was given accommodation elsewhere (1865). There has been gradually brought together a reference library of most creditable size, and it includes numerous runs or sets of scientific periodicals. The adequate and safe housing of this library—none too well assured at present—is receiving attention.

The Cambridge Philosophical Society, unlike many other scientific institutions, has no trust funds of its own, and has never had the good fortune to receive a legacy or other special benefaction.

T. E. JAMES.

Obituary

SIR DUGALD CLERK, K.B.E., F.R.S.

BY the death of Sir Dugald Clerk on November 12, following comparatively closely on that of Sir Charles Parsons, Great Britain has lost the two greatest engineers in history, at least in the field of power production.

To the imagination, to the detailed scientific research and still more to the lucid and admirable teaching of these two men, are due the whole modern system of power production as we see it to-day, on land, on the water, and in the air. Just as Sir Charles Parsons by his development of the turbine revolutionised and revived the use of steam until none but his methods are employed to-day, so Sir Dugald Clerk nursed the internal combustion engine almost from the day of its birth as a sickly infant of little more than medical interest, nursed and reared it, until to-day it has become the greatest factor in modern engineering —indeed one might almost say in modern civilisation. In the early stages of its infancy, when 'doctors' differed and none knew how to feed or tend it, it was Clerk who first explained to the faculty how its delicate interior functioned, how its growth and strength could best be fostered, and where its frailties lay. Since that day, Clerk watched ceaselessly over and reared this child and its offspring through many generations, until to-day it has peopled the earth, the sea, and the sky. Many thousands of 'doctors' in all the countries of the world have since adopted and specialised in the care of this fertile breed, but one and all, consciously or unconsciously, have drawn their inspiration and their methods from the teachings of Sir Dugald Clerk.

We are prone to set great store by invention, and Clerk's inventions in this field were many and important, the best known perhaps being that

of the two-stroke cycle engine ; but inventors are plentiful and inventions mark phases only. The great value of Clerk's work lies rather in his brilliant analyses of the working processes, in his lucid presentations of these in a form which appeal alike to the student, to the purely scientific investigator, and to the practical engineer—these will live for ever.

In his earlier work Clerk could rely for his observations only on the very imperfect and erratic instruments which were available, but he sifted and supplemented these often conflicting observations with such judgment and insight, and with such a breadth of imagination, that all his deductions have stood the test of time and hold good to-day.

The value of Clerk's scientific work was enhanced greatly by the extraordinary charm of his personality, by his kindliness and encouragement and by the almost limitless trouble he took to assist and encourage all the younger generation. My first meeting with Sir Dugald Clerk was some twenty-five years ago. As a very young man I had invented, or thought I had invented, an improved type of engine ; I had submitted this invention to a manufacturing firm, who had referred it to Sir Dugald Clerk. Sir Dugald sent for me and explained that, reluctantly, he had turned down my invention ; he explained exactly why and urged me not to be discouraged—he suggested many ways in which the idea could be improved, and invited me to call on him at any time for any help or advice he could give. At once I fell a victim to his charm and the obvious sincerity of his kindness—a kindness which he bestowed on me from that time until the day of his death.

Too often one has to record the great work of a man left unrecognised and unappreciated until after his death. Fortunately this does not apply in Sir Dugald Clerk's case : his work was known and recognised all the world over and he was honoured, as was his due, by the leading scientific institutions of his day and by his innumerable friends and admirers. His scientific lectures were always a joy to attend, not alone for the value of the material they contained, but also for the sheer joy of listening to his beautiful diction and his pleasant voice. H. R. RICARDO.

MR. T. G. SLOANE

THOMAS GIBSON SLOANE, of Moorilla Station, Young, New South Wales, who died on October 20, combined the unusual association of sheep-breeder, philosopher, naturalist in general and entomologist in particular. One of five sons of Alexander Sloane, of Mulwala, Murray River, a well-known merino expert, he was educated partly at the Scot's College, Melbourne, partly by tutor at home. There was a strong literary taste in the family, and a fine knowledge of the English poets was a background of his well-stored mind. He was sent to Sydney to learn business methods and returned to manage Moorilla for the firm of Alexander Sloane and Sons, which he inherited as his life-long home. Here he won numerous prizes for sheep at various shows ; had a stud of his own registered in the flock book ; kept accurate records of wool weights and was a regular attendant at Sydney sheep sales.

In Sydney, however, Sloane also met Sir W. Macleay and his scientific henchman, the late J. J. Fletcher, who became his lifelong friend ; and in 1888 contributed his first paper on Carabidæ to the Linnean Society of New South Wales. Natural history was his passion, and I have never met any man who so closely and enthusiastically studied Darwin, especially "The Origin of Species".

As an entomologist Sloane was soon recognised as the Australian authority on the Carabidæ, though he later included the Cicendelidæ in his studies. But his mental horizon was too wide to allow himself to be limited to collecting and describing new species. Phylogeny and distribution greatly occupied him. His paper on the "Faunal Subregions of Australia" has often been quoted by later authors, while his "Classification of the Family *Carabidæ*" (*Trans. Ent. Soc. London*, 1923) has received wide notice. Sloane's "Table of Tribes" has been adopted as being the most satisfactory classification in existence.

Sloane contributed some sixty-one papers to various societies—the great majority to the Linnean Society of New South Wales—and described 595 new species, of which 557 were Carabidæ, including a few from New Guinea. With a world-wide correspondence, he found time to help his brother entomologists generously by naming their collections, until later years brought those economic worries that have especially troubled Australian pastoralists.

I accompanied him on many a distant trip through Queensland, Western Australia, New South Wales and Victoria. He was a delightful companion and a lovable friend, with an unlimited stock of yarns, and a good 'mixer' with bush folk, whom he understood. A retentive, but not a wide, reader, he avoided modern fiction, but collected a good library especially on Australian exploration and traveller naturalists. Generous in excess to others, sparing in his own needs, a stoic by nature and will, his last years were spent in hard work on his homestead. He passed away at the Burrangong Hospital, Young, a victim to cardiac asthma, leaving a widow, two sons and four daughters to mourn his loss. H. J. CARTER.

MR. G. B. SCOTT, C.I.E.

BY the death of Mr. G. B. Scott, which took place at Bournemouth on November 20 at the age of eighty-eight years, a distinguished Indian frontier surveyor passed away.

Scott's memory carried him as far back as the stirring times of the Second Sikh War. He was educated at the Lawrence Military Asylum at

Kasauli, through which place, as a boy of thirteen years of age, he saw the British regiments march on their way from Simla to take part in the siege of Delhi.

Scott joined the Survey of India in 1863, and then began an adventurous career on the North-West Frontier. His camp was attacked by the tribesmen on several occasions and he had more than once to repel, with his small guard, determined onslaughts of much larger numbers. On one occasion in particular, he repulsed an attack of several hundred Allahiwals while he was on survey duty, having with him a guard of only twenty sepoys. For the gallantry he displayed on this occasion he was rewarded by Government with an honorarium and a sword of honour.

Some years later Scott repulsed a determined attack on his survey party by the Mohmands while at work in the Khyber Pass. He had to fight his way back to Fort Michni, losing three killed and four wounded, one of which he carried out of fire. He took part in the Black Mountain, Jowaki–Afridi and the Zob Valley expeditions, as well as the Second Afghan War.

Scott did some valuable work in map compiling at army headquarters at Simla, which earned him, in 1885, the commendation of the Commander-in-Chief (General Roberts). After five years surveying in Upper Burma he was appointed in 1894 to be superintendent of Land Record Surveys in the United Provinces, a post which he retained until his retirement in 1901.

This, however, did not end Scott's career, for he was employed to superintend the Cadastral Surveys in the Bundelkhand States of Central India. From 1910, for nearly three years he was surveying for the Anglo-Persian Oil Company, in West Persia, and in 1912–13 was engaged on the survey of tin mines in the Karenni country of south-east Burma.

Scott was the author of a Pushto vocabulary, "Twenty Years on the North-West Frontier", "Afghan and Pathan" and "Religion and Short History of the Sikhs". He was the holder of two medals and four clasps, and in 1914 the Companionship of the Indian Empire was conferred on him. He was much liked by everyone who had the privilege of knowing him.

H. L. C.

WE regret to announce the following deaths:

Viscount Dillon, C.H., who was president of the Society of Antiquaries from 1897 until 1904, on December 18, aged eighty-eight years.

Prof. John Glaister, emeritus professor of forensic medicine in the University of Glasgow, whose best-known textbook was "Medical Jurisprudence, Toxicology and Public Health", on December 18, aged seventy-six years.

Dr. W. J. Holland, emeritus director of the Carnegie Museum, Pittsburgh, known for his work in museum administration and entomology, on December 13, aged eighty-four years.

Mr. H. A. Roberts, for more than thirty years secretary of the Appointments Board of the University of Cambridge, on December 18, aged sixty-eight years.

News and Views

Bicentenary of Sir Richard Arkwright, 1732-1792

ON December 14 at the Science Museum a public lecture was given by Mr. F. Nasmith, under the auspices of the Newcomen Society, to commemorate the bicentenary of the birth of Sir Richard Arkwright, the inventor of the spinning machine known as the water frame and the founder of the factory system of cotton manufacture as we know it to-day. In introducing Mr. Nasmith, Mr. H. W. Dickinson, president of the Society, said that it is one of the aims of the Society to direct attention to the great inventors and engineers who are among the world's chief benefactors, and it is of interest to recall the remark of Lecky the historian, who said that it was largely the cotton mill and the steam engine which enabled Great Britain to stand the strain of the Napoleonic wars, and that Arkwright and Watt deserved statues as much as Wellington and Nelson.

To understand fully the remarkable influence of Arkwright's work on the development of the factory system in the cotton industry, Mr. Nasmith said it is necessary to realise the conditions which prevailed when he commenced to take an interest in spinning. Textile manufacture when he was born was a purely domestic industry, carried on by manual labour and with crude appliances. Turning from his barbering and wig-making, Arkwright learnt all he could about spinning and in 1769 took out the patent which laid the fortunes of himself and hundreds of others. The novel feature in his new spinning machine was the use of several pairs of rollers for drawing out the cotton fibres before they were spun, and this principle is applied on a very extended plan to-day. But he was more than an inventor, for he envisaged and put into action the plan of setting out in ordered fashion in one building machines, different in character and design, and driven by mechanical power, arranged to secure a continuous flow of material from the raw state through the various processes until it emerged a finished yarn. This idea of a complete cotton-spinning factory shows genius of a high order and Arkwright may be regarded as the 'first master cotton spinner'. Arkwright, it may be added, died at Cromford, Derbyshire, on August 3, 1792, at the age of fifty-nine years. His portrait by Wright is in the National Portrait Gallery.

Cancer Research at Nottingham

AT the annual meeting of the Court of Governors of University College, Nottingham, on December 15, under the presidency of His Grace the Duke of Portland, it was reported that a scientific research fellowship had been founded through the generosity of Mrs. Massey and Mrs. Massey Stewart. The purpose of the fellowship is to develop the physical methods for the diagnosis and cure of cancer. The Council appointed to this fellowship Dr. L. A. Woodward, who has had a distinguished career at Oxford and Leipzig. The local branch of the Imperial Cancer Campaign has made contributions of £500 for the purchase of additional instruments required and £50 to cover travelling expenses in connexion with the investigations. Accommodation has been found for the fellow in the Department of Physics, and the general equipment and facilities of the Department will be available for his use. The assistance of a biochemist in Dr. Woodward's work has been secured by the appointment of Dr. H. H. Barber, towards whose salary the Nottingham branch of the British Empire Cancer Campaign is contributing a sum of £100 a year for a period of three years in consideration of this assistance. A Joint Cancer Research Committee has been set up, consisting of the Principal, the heads of the Departments of Biology, Chemistry and Physics, and Dr. F. H. Jacob, Dr. R. G. Hogarth and Dr. A. M. Webber as representatives of the local branch of the British Empire Cancer Campaign.

Science and War

IN a speech delivered in the House of Commons on November 10, which has been reprinted by the *New Commonwealth* under the title "The Warning", the Right Hon. Stanley Baldwin deals with the moral and ethical consequences of the application of scientific discoveries or inventions to destructive purposes. Science has completely transformed the character and offensive powers of modern warfare. To the air attack there is no possible defence save in counter-attack, and aviation affords an outstanding example of an instrument of war the consequences of which are so terrible and deadly that the safety of mankind lies in the renunciation of its use. So far as the air is concerned, Mr. Baldwin agrees that only the abolition of flying offers any prospect of complete disarmament. Prohibition of the bombardment of the civil population and reduction of the size of aeroplanes are suggestions that are unlikely to stand the stern test of war. The abolition of flying is, however, an inconceivable step. Mankind has never yet consented to forego a new power which he has once claimed and the practical question which remains is the use to be made of this new power. Mr. Baldwin suggests that a thorough investigation of the problems involved in the international control of aviation is called for, apart altogether from the possibility of abolishing all air forces. Scientific workers should be among the first to respond to the moral appeal underlying Mr. Baldwin's speech, that with the winning of new powers for mankind there should be won also a finer sense of moral responsibility and a determination to oppose the prostitution of such powers to base purposes. Only such a sense of values and of responsibility on the part of every individual citizen can save mankind from the destruction and disorder which seem the inevitable outcome of the present state of international relations.

The Royal Dublin Society

IT is recorded in the *Irish Times* of December 2 that Viscount Powerscourt has taken over the office of president of the Royal Dublin Society, in succession to Prof. J. Joly, whose term of office (three years) has come to an end. In the course of his Lordship's remarks, Lord Powerscourt, who is a leading member of the Agricultural Section of the Society, stated reasons for believing that the policy of the present governing body in Ireland must result in very grave effects upon the agricultural work of the Society. These fears are supported and very strongly emphasised by Dr. Bohane, the official director of the Society, in the *Irish Times* of December 3, whose remarks are mainly directed to financial considerations connected with the agricultural work of the Society. We are informed by Prof. Joly that the scientific work of the Society must also suffer seriously, seeing that the Society expends considerable funds in support of scientific research and on the publication of its *Scientific Proceedings and Transactions* as well as on fees paid to experts who lecture upon scientific subjects in various rural districts of Ireland. The Irish Radium Institute—which is legally affiliated to the Society—must also suffer, considering that the distribution of radium emanation devolves upon a senior and highly responsible member of its paid scientific staff. Those who wish for a full account of the Society's work at the present day will find it detailed by expert members of the Council in a volume issued recently in commemoration of the two-hundredth anniversary of its work for the prosperity of Ireland.

Statistical Method of Control in Industry

AN important aspect of the part which statistical method may play in industry in the improvement of the production process and in increasing efficiency in the fitting of supply to satisfy the wants of the consumer was discussed on December 20 at a meeting of the Royal Statistical Society, when Dr. E. S. Pearson contributed a paper on the statistical control of quality in mass-production industry. Whether the manufacturer is concerned with the tensile strength of malleable iron, the length of life of lamps, or the durability of cloth, he cannot succeed in producing exactly the same article again and again. Quality must, in fact, be expressed not only by an average but also by some measure of variation about this average. Yet if this is so, it is also important that there should be uniformity in this variation. For example, if the variability in the length of life in electric lamps can be reduced below a certain level, this may be of little value to the ordinary householder; but a large-scale consumer such as a borough council may then find it a more economic proposition to

renew all its street lamps after a fixed number of hours of burning than to wait till each lamp burns out, and then send a man to replace it. For a number of years individual firms have here and there made use of statistical theory in laying out efficient research programmes to improve the quality of production or to establish sampling plans to reduce the cost of inspection. But it is only in the last few months that an attempt was made to organise concerted action, when the British Standards Institution appointed a small committee to investigate the problem from the point of view of standardisation and specification. Direct contact between the industrialist and the statistician is of first importance. The former has not hitherto fully realised the potentiality of the statistical tool, while the latter has not understood the lines along which theory could be most helpfully developed.

The Roman Wall in Scotland

AT the Friday evening discourse on December 16 at the Royal Institution, Sir George MacDonald discussed the Roman Wall in Scotland. So far as its chances of survival were concerned, the Wall was unfortunately situated. Stretching, as it did, from Forth to Clyde, it ran, for the most part, through arable land and also traversed what was destined to become a great industrial belt. Nevertheless its remains are still considerable. The date of its erection was about A.D. 142, soon after the accession of Antoninus Pius, and it is quite certain that it was abandoned before the end of the century. Soldiers say that, as a piece of military engineering, the line which it followed was admirable, much superior to that selected for the Wall of Hadrian. The barrier consisted of three main elements—a rampart, a ditch, and a military road—and there were nineteen supporting forts, planted at intervals which averaged two miles in length. Despite its excellent construction, the road has been destroyed almost everywhere. On the other hand, the ditch, which was usually about 40 ft. wide and 12–15 ft. deep, has left an enduring mark. Even where it has been entirely filled in, digging will always reveal its position. Within the last twenty years its course has been determined for practically the whole 37 miles of its length, and this will be noted on future issues of the Ordnance Survey maps. A group of seventeen inscriptions, unique in the Roman world, yields extremely interesting information as to the distribution of the work among different bodies of legionaries. The purpose of the Wall is often misunderstood. What it contemplated was not a state of war, but a state of restless peace. Excavation has proved that the forts were twice evacuated and twice restored before the final abandonment, and has also brought us to some extent into personal touch with the men who maintained the *pax Romana* in North Britain in these troublous days. They were not Romans, in the strict sense of the term, but a motley crew, levied chiefly in Gaul and the Low Countries, having Latin as a common language and welded into a unity by iron discipline.

A New Academy of Sciences in Western China

THREE years ago there was organised in the Little Gorges near Chungking of Szechuan province an Academy of Sciences of Western China. This institute is supported primarily by private contributions. It has now an annual budget of 40,000 Mexican dollars. Research and survey work along the lines of geology and biology will be pursued in the Academy. At present, with the help of Dr. H. H. Hu, director of the Fan Memorial Institute of Biology at Peiping, a herbarium and a botanical garden have been established by the Academy, with the view of exploring botanically all parts of that vast province and eastern Tibet, and collecting seeds, cuttings, and bulbs, etc., for planting in the botanical garden. It is intended shortly to establish a nursery where seeds and bulbs will be provided for sale or exchange. For example, the collector was instructed to collect seeds of *Rehderodendron*, a new genus of three species of ornamental trees of Styracaceæ, recently described by Dr. Hu. Seeds of other interesting and ornamental plants will also be collected. The Arnold Arboretum of Harvard University will be the first botanical institute in the United States of America to share a part of this collection. This year two parties have been sent out by that institute to collect herbarium specimens and seeds, one to eastern, another to south-western Szechuan. The latter is exploring the bordering districts along the Szechuan-Yunnan-Tibet borderland. In the winter the collector will bring herbarium specimens and seeds to the Fan Institute for study and identification, as that institute has a large herbarium and a large botanical library, and furthermore a unique collection of some 17,000 photographs of the type-specimens of Chinese and other Asiatic countries taken in various European herbaria.

"Terrestrial Magnetism and Atmospheric Electricity"

THE September issue of *Terrestrial Magnetism and Atmospheric Electricity* forms a memorial number in honour of the late Dr. Louis A. Bauer, who founded the journal in 1896 and edited it almost until his death early this year. It contains two admirable portraits of Dr. Bauer. The number is of unusual length, containing 220 pages, and (besides subsidiary matter) thirty-seven articles by authorities on terrestrial magnetism and electricity from all over the world. Some of these are of unusual interest, and among them may be mentioned those of Adolph Schmidt, J. Bartels, and L. Vegard. Schmidt deals with the secular magnetic variation, and shows that many of its larger features can be explained in a simple way as due to the rotation of a component of magnetic polarity, about an axis through the points where the Greenwich meridian crosses the equator, so that the poles of this component move in the meridians of longitude 90° and 270°, the complete rotation taking about 480 years. This simple conception explains the main features of the secular variation but does not agree so well with the long-continued decline of the earth's magnetic moment during several decades past. The article by Bartels

is on statistical methods for research on diurnal variations, and contains both important conclusions and interesting suggestions for future work in this difficult field.

THE paper contributed by Prof. L. Vegard is a brief account of an investigation of the temperature of the auroral region by the use of the rotational series of the negative nitrogen bands, shown on auroral spectra obtained by long-continued intermittent exposures over several weeks or months. The results obtained in two different ways agree in giving the value of 240°K. This is much lower than the high temperature for this region first proposed by Lindemann and Dobson on meteoric evidence, and confirmed by the abnormal propagation of sound, by reflection at a height of about 40 km. In this connexion, Vegard mentions experiments he has made tending to show that the laws of propagation of sound at low densities are different from those that apply at normal densities. The paper is an interesting contribution to a controversial subject. Another interesting paper, by Prof. V. F. Hess, reviews the present state of knowledge concerning cosmic rays, mentions the co-operative scheme of work started on his initiative in order to examine whether the irregular fluctuations of the rays occur simultaneously in different places, and gives some preliminary results of the work of his cosmic ray observatory on the Hafelekar ridge, near Innsbruck.

Exploration of the Upper Atmosphere

THE International Commission for the Exploration of the Upper Atmosphere has recently published the collected results of upper air work done during 1924, under the title "Comptes Rendus des Jours Internationaux, 1924". As in the case of the first and pioneer volume of the kind, for 1923, the compilation has been made under the supervision of Sir Napier Shaw, honorary president of the Commission; the 1924 volume has unfortunately been delayed by his illness, and by financial difficulties. The latter have been lightened by the use of the Replika process in the production of the volume, the price of which is 45*s*.; the later volumes (of which that for 1925 has already appeared, under the title "Ergebnisse der Aerologischen Messungen, 1925"), are being published by Prof. Hergesell, president of the Commission, at the regrettably high price of 60 gold marks. The present volume is in two parts, one containing tabular details of the ascents of sounding balloons, together with synoptic charts for the international days, and the other containing 'tephigrams' representing graphically the results of individual ascents.

Rainfall and Water Supply

IN an article by F. J. Garland entitled "Rainfall and Water Supply" in *Progress and the Scientific Worker* for September and October 1932, stress is laid on the importance of the work of the voluntary rainfall observers whose records supply a very large proportion of the material for the annual volumes of "British Rainfall", the old-established publication of the British Rainfall Organization now compiled by the Meteorological Office. The article contains interesting facts about springs and artesian wells, and some particulars about the practical side of the engineering problems involved in conveying water to distant towns from catchment areas. On these subjects the writer is on his own ground, but when he passes to purely meteorological matters connected with rainfall, some very inaccurate statements are made. Thus, he says (p. 49) that the greatest recorded rainfall in England in 24 hours may be taken to be about three inches. The annual volumes of "British Rainfall" show however that falls greatly in excess of three inches occur in most years; that 9·56 in. fell in one day in 1917 at Bruton, Somerset, and 9·40 in. at Cannington once in 1924. The incorrect statement is also made that there is no satisfactory record of the amount of rain that fell during the Louth cloudburst of May 29, 1920, whereas, thanks to the records of voluntary observers, enough information was available for the rainfall to be mapped by means of isohyetal lines for the whole area of the storm, and this information is available not only in "British Rainfall" for that year, but also in the report of the special investigation undertaken by the Meteorological Office (Professional Note, No. 17, of the Meteorological Office. London: H.M. Stationery Office).

Scots Pine Timber

BULLETIN No. 15 (Dec. 1931) of the Forest Products Research Laboratory deals with a detailed analysis of "The Timber of Home Grown Scots Pine (*Pinus sylvestris*)". The primary considerations in connexion with the utilisation of home grown Scots pine, the resources of which timber in Great Britain were so depleted during the War, are the general grade of the timber and its mechanical properties. The investigations which have been undertaken at the Laboratory indicate that the home grown timber in different localities varies considerably in weight, and ranges from 25 to 45 lb. per cub. ft. at a moisture content of 12–15 per cent. The darker colour of the heart wood, which is an indication of the durability, is more marked in the home grown than in the imported timber, while the percentage of heart wood is dependent on locality and age. The average rate of growth of the timber in the four consignments examined varied from 4 to 23 and the average of individual consignments from 7 to 12 rings per inch. The bulletin deals in sections with structure, seasoning, mechanical and physical properties, antiseptic treatment, working and utilisation, and pests of the species. One of the problems facing the newly formed plantations of pine in Great Britain is to find or create a market for the small material which will come out in the early indispensable thinnings; while, it is pointed out, to produce best quality timber the time must be given to obtain at least 12 rings to the inch radius, and for lower grades at least 9 rings per inch are necessary. Straight-grained timber, as free from knots as possible, is demanded by the markets.

Illuminating Engineering

THE paper on the electric lighting of buildings read by A. B. Read and Dr. J. W. T. Walsh to the Institution of Electrical Engineers on November 3 illustrates the change that has come over the art of illumination during recent years. Originally the aim was to provide as much light as possible for the very limited consumption of energy available. Happily, owing to the great advances made in the means of light production, engineers are no longer trammelled by tradition and new and daring experiments are being made in illuminating engineering similar to those made possible in architecture and decoration, due to the use of new constructional methods and materials. The second part of the paper deals with the engineering and physiological principles which govern design and gives a brief description of the new materials now available to the 'artist in light'. Architects now provide electric 'points' on their plans not for 'a light of some sort' but for a fitting in character with the room. Lighting by electricity can be done in many ways. It can be used to enhance the restful atmosphere of a place of worship, dignify a great public building, serve as a decorative element in a small house, or bring sparkle and gaiety to a restaurant. The latest development in light production is the gaseous discharge tube. The use of various mixtures of the rare gases provides a wonderful range of hues in the light available. The efficiency of the lamp also has been greatly improved. It gives three or four times as much light as the ordinary tungsten filament gas-filled lamp. The authors conclude by discussing the effects of glare, contrast, shadows and colour. The paper proves that the task of the lighting engineer is a difficult one.

Report of the Strangeways Research Laboratory

THE Trustees' Report for 1931 on the Strangeways Research Laboratory, Cambridge, records as the outstanding event of the year the extension of the laboratory, made possible by a bequest of £5000 from the late Sir Otto Beit, and refers to the additional connecting links between the laboratory and the biological departments of the University which afford opportunities for valuable collaboration, for example, in zoology, nutrition and radiology. A résumé of the work in progress shows that Dr. H. B. Fell and her colleagues are carrying out with skilful technique investigations of great interest on tissue culture. Reference is made to the better results in the study of osteogenesis due to improvements in technique. Of the other work recorded we note Dr. P. D. F. Murray's studies on the development *in vitro* of the primary red blood corpuscles of the chick. Portions of fowl embryos removed from the egg after periods of incubation ranging from 1 to 18 hours were cultivated in a fluid medium composed of serum and embryo extract. Red blood corpuscles developed in all the cultures made from the posterior half of the primitive streak at the stage immediately preceding the formation of the head-process, but portions of the anterior half, although differentiating into central nervous system and somites, formed no blood. All the stages in erythrogenesis could be followed in the living material. The first sign was a thickening in the tissue; the cells of this thickening diminished considerably in size and displayed great mitotic activity. Eventually they lost their adhesiveness, formed loose groups in the tissue or fell into the culture medium as a cloud of free erythroblasts in the cytoplasm of which hæmoglobin began to develop.

Industrial Models at Hull Museum

THE crushing of linseed and rape seed obtained from the plants of northern Europe has long been a staple industry at Hull, which now claims to be the largest oil-mill centre in the world. In view of this, it is interesting to learn that the Museum contains a remarkable series of models of seed-crushing plant illustrating both old and new methods. The models were described in the *Model Engineer and Practical Electrician* in April last and the articles have now been published in pamphlet form as Hull Museum Publication No. 176. The models have been made by Mr. W. Marshall, who began his connexion with the industry as a blacksmith in 1869, rose to be manager of some of the largest mills and became a manufacturer of oil-mill plant. The beginning of the oil-seed industry is lost in the mists of antiquity but in certain parts of the world to-day very primitive plant is used. From these primitive devices came the lever press, the wedge press and the screw press, and in more modern times the hydraulic and steam power presses. These are all illustrated by Mr. Marshall's models, which are described in the pamphlet.

Publications of the University of Bombay

IN order to encourage research among teachers and students, the authorities of the University of Bombay have decided to issue a periodical publication, which will contain communications from members of the university and others dealing with research in the subjects of the University curriculum. The *Journal of the University of Bombay*, as the publication is to be called, will appear six times in each year, two of the parts being devoted to history, economics and sociology, two to arts and law, and one each to the physical sciences and the biological sciences. In addition to the original articles, there will be reviews of books, abstracts of academic theses and notes on current topics. The first issue, which has recently appeared, covering history, economics and sociology, contains several communications dealing with points in the history of sixteenth century India, India's trade and commercial relations, Indian art and sociology, the bearing of certain traditions on the origin of Konkan Brahmins, and articles of a more general character on trade unions and the League of Nations. Especially noteworthy is a lecture delivered in Bombay by M. Elie Faure on the interpretation of Indian art, in which it is suggested that a meeting-ground for Europe and India might emerge from their common inheritance from Greece. There is also an obituary notice of the late Sir Patrick Geddes, which does full justice to his work for India.

Infra-Red in Photomicrography

THE photography of small insects by transmitted light has hitherto been complicated by the necessity of employing screens transmitting only the red end of the spectrum, if detail of both body and wings is to be secured on the same plate. Recent improvements in the sensitising of plates to infra-red enable much darker screens to be used with relatively shorter exposures. An interesting example of this has recently been given by Mr. A. E. Smith (*Watson's Micro. Rec.*, No. 27) who publishes a photograph of a phorid fly in which the venation of the wings and the structure of the external genitalia are shown at the same time as the minute detail of body armature. The exposure of only five seconds through the almost opaque Ilford infra-red screen is a remarkable tribute to the speed of the plates, which quite evidently open a new field for the photomicrographic worker in all subjects.

Memorial to Prof. W. D. Halliburton, F.R.S.

ON December 17, Sir F. Gowland Hopkins unveiled a plaque which has been placed in the Halliburton laboratory of physiology at King's College, London, in memory of Prof. W. D. Halliburton, who was professor of physiology at the College from 1890 until 1923. When Prof. Halliburton was appointed, the laboratory was on the Embankment in small and badly lit rooms where Ferrier and Lister had worked. Yet, by his enthusiasm, he managed to attract many young physiologists to the College. The present laboratory is the result of his great efforts during his tenure of office as professor of physiology. Prof. Halliburton was elected a fellow of the Royal Society in 1891 and died on May 21, 1931, aged seventy years.

Duddell Type Oscillographs

THE Cambridge Instrument Co., Ltd., has issued a new list of oscillographs developed from the Duddell type (List No. 118). As usual in the catalogues of this firm, there is a valuable discussion of the design of the instruments, but the present list is noteworthy for the large number of examples of their use. These include the study of wireless 'echoes', of speech wave forms and of mechanical vibrations in turbine blading. In view of the modern development of large units in electrical engineering, there is a particular interest in the installations for investigating short-circuit and circuit-breaking phenomena and in the reproductions of very beautiful oscillograms obtained by their use.

Christmas Lectures at the Royal Institution

THE Christmas Lectures at the Royal Institution are to be given this year, starting on December 27, by Prof. Rankine. Prof. Rankine, who is president of the Physical Society, has carried out laboratory researches on the determination of the sizes of numerous gaseous molecules, as deduced from measurements of viscosity. During the War he investigated the possibilities of transmitting speech by light, using the selenium cell, and invented an instrument for this purpose, the photophone. In recent years his scientific work has taken him farther afield. He has been concerned in the latest developments of the science of geophysics, particularly in regard to its use in prospecting for minerals, including oil, and has made expeditions to Persia and Australia in connexion with this work. The subject of Prof. Rankine's lectures, 'The Round of the Waters', is full of possibilities. The subject lends itself to experiment in a great variety of ways, and this, the one hundred and seventh course of Christmas Lectures, should certainly not be wanting in interest and instructiveness.

Announcements

AT a meeting of the Royal Academy of Belgium held on December 15, Prof. P. Zeeman, professor of experimental physics in the University of Amsterdam, and Prof. T. Levi-Civita, professor of rational mechanics in the University of Rome, were elected foreign associates of the Academy.

THE Hopkins prize for the period 1924–27 has been awarded by the Cambridge Philosophical Society to Prof. G. I. Taylor, Yarrow research professor of the Royal Society, for his researches on hydrodynamics and on the deformation of crystals; and the prize for the period 1927–30 to Prof. P. A. M. Dirac, Lucasian professor of mathematics in the University of Cambridge, for his researches on the theory of quantum mechanics.

WE have received the report of the Victorian Bush Nursing Association for the year ended June 30 last. This Association, of which Sir James Barrett is secretary, provides trained nurses and other requisites for sick and injured persons in country towns and districts. It is run on a co-operative basis, a householder paying a small annual subscription, usually £1, and has 65 nursing centres and 29 cottage hospitals. Maternity and child welfare are important branches of the work. In spite of the financial stringency in Australia, the Association had a credit balance of £1,900 at the end of the year. Full reports are given of the activities in the various centres.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A male junior assistant metallurgist for the Royal Small Arms Factory, Enfield Lock, and a male junior assistant chemist at the Royal Gunpowder Factory, Waltham Abbey—The Principal Clerk, Central Office, Royal Gunpowder and Small Arms Factories, Enfield Lock, Middlesex (Jan. 7). An assistant in the Department of Manuscripts and Records of the National Library of Wales—The Librarian, National Library of Wales, Aberystwyth—(Jan. 16). A University professor of physics at Birkbeck College—The Academic Registrar, University of London, S.W.7 (Feb. 10). A director (professor) of the Research Laboratory in Botany at the University of Madras—The Registrar, University of Madras, Triplicane, P.O. (April 1); further information from the High Commissioner for India.

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.*]

'Protective' Adaptations of Animals

WITH regard to recent correspondence in NATURE[1] following an article based on my paper on the effectiveness of protective adaptations,[2] I would remark, in the first place, that since neither Prof. Poulton, Prof. Huxley, and Mr. Nicholson appears to have seen my paper, their criticism should have been deferred. As to the points raised, I offer the following suggestions :

Prof. Poulton's main point would seem to be expressed in the following quotation : "To search with the compound microscope for butterfly wing-scales scattered through the contents of 80,000 avian digestive tracts would be a serious business, and if it had been accomplished I venture to believe that far more positive results would have been obtained." On p. 6 of my paper the use of compound microscopes in making all stomach examinations is noted. The alleged difficulty of identifying remains of adult Lepidoptera in bird stomachs is discussed on p. 59. Instead of encountering difficulty in recognising lepidopterous remains, I may say that when Lepidoptera have been eaten, the fact usually is evident to the practised eye at a glance due to the fuzzy felted appearance of the stomach contents caused by the distribution of hundreds of scales throughout the mass. The story is just as plain as that told by the contents of a killing bottle in which other insects have been carried with Lepidoptera ; there seem to be scales enough to cover everything. If only a few scales were present, they might be missed, but in such cases in all probability the wing membranes with their characteristic venation, or the antennæ, head, or some other diagnostic part would be present and identifiable.

In 1912 I published the statement that remains of butterflies were found in only 5 out of 48,000 bird stomachs, while the 1932 paper records 87 from some 80,000 stomachs. Prof. Poulton now says that I attempt no explanation or defence of the earlier figures ; on p. 60 of my paper, it is stated that all save 18 of the records pertain to a single bird, the pigeon hawk, and that the specimens of this hawk were taken at a point in a migration path of butterflies. The instance is a striking one supporting my general thesis as to the great effect abundance and availability of prey have upon choice of food by birds.

As a matter of fact, some of the other records also were from other hawks collected at the same locality (Fisher's Island, N.Y.), so that the 18 instances of butterfly captures by birds under supposedly normal conditions is still further reduced and the not alarming disproportion of 18 records for 80,000 to the 5 for 48,000 stomachs previously reported is correspondingly lessened.

Prof. Huxley's ship illustration, whether paralleling Nature or not, does not have his own confidence as he says, "Even if the proportionality [of destruction relative to type] were exact, it would have little significance." He pins his faith on the necessity of adaptations and says, "In general, the fallacy is that of forgetting that no species of organism could exist which was not a bundle of adaptations."

As to organisms necessarily being adapted, we find in almost every environment species of such diverse 'adaptations', if the use of that too meaningful term is permissible, as to prove that particular 'adaptations' cannot have been essential to survival. Huxley's picture of an organism that could not survive as one "conspicuous in colour and in habits, sluggish, palatable, juicy and soft, and with low fecundity" is in fact realised in some of the spiders—nevertheless they survive.

Quoting Prof. Huxley again, "The fact that 'some birds' . . . eat ants freely does not imply that ants are not rejected, relatively or entirely, by most birds." Ants are not rejected either relatively or absolutely by any potential predators. As nearly as may be, they are eaten by every kind of predator and freely by most of them.[3]

As to Mr. Nicholson's criticism, it appears to have little bearing. He says, "While it is evident that the book contains a vast array of statistical data on the contents of birds' stomachs, no mention is made of a similarly exhaustive survey of the food that was available to the birds, and, in fact, it is inconceivable that such a survey could be made adequately." Like my other critics, Nicholson had not seen my paper, hence does not know of the effort that was made in it to indicate the relative abundance of available prey. If he really believes that this information is unobtainable, then he should not criticise me for not presenting it.

Selectionists in an attempt to advance their cause have habitually appealed to unknown factors, and cited examples from largely unknown faunas (for example, of the tropics), to which doings Nicholson's remark, "such work can throw no light upon the process of natural selection", exactly applies.

The remainder of Mr. Nicholson's paper seems to have little application to mine. Nicholson is a mutationist, while the theory of natural selection during most of its history has relied chiefly on the preservation of small variations. As most critics of the theory have remarked, it is inconceivable that an initial slight variation in a favourable direction could have selective value. This is a fatal objection to old style natural selection theories all along the line. Whether there are enough 'large variations' or mutations to satisfy theoretical demands is another question which need not be debated here.

In general, as a reply to all critics, I would say that the importance of predators in controlling animal populations has always been over-rated. The grand factors are meteorological, and these as well as some of the other checks are by their nature barred as selective agents so far as 'protective adaptations' of the kind under discussion are concerned. This fact, in addition to consumption by predatory forms being very closely proportional to population, indicates that selection if it exists at all is a force so weak that it cannot have guided the course of evolution so as to account for the structure and characteristics of all existing organisms in detail, which is practically what is attributed to natural selection by its extreme proponents.

I would emphasise that natural selection is still merely a hypothesis, and a vigorously challenged one at that. In 1894, Alfred Russel Wallace said : "It is of course admitted that direct proof of the action of Natural Selection is at present wanting,"[4]

and in 1932, Hugh B. Cott still has to admit with regard to the selectionist explanation of 'protective adaptations', "The hypothesis is of a sort which is incapable of proof."[5]

Darwin's great service was in pointing out the apparent probability of evolution, and we should not be considered as failing in respect if we doubt that he formulated a satisfactory explanation of the process. It would have been miraculous if Darwin had been able to anticipate the developments of more than a half-century of the most intensive biological investigation the world has seen. Hence we should not be surprised that all of the main points in his theory to explain evolution, namely, (1) the severity of the struggle between organisms for existence, (2) the preservation of individuals possessing slight favourable variations, (3) the inheritance of these variations, and (4) the similarity of natural to artificial selection, in the light of present day information must all be radically challenged.

I hope sometime to assemble and publish the notes on these matters that I have been making for years. For the present I would remind supporters of selectionist doctrine regarding protective adaptations that they are only bolstering a single pillar of a structure, the whole of which is adjudged by many biologists as doomed to collapse.

W. L. McATEE.

Bureau of Biological Survey,
Washington, D.C.

[1] NATURE, **130**, 202, 696; 1932.
[2] Smiths. Misc. Coll., vol. 85, No. 7, 201 pp., March 1932.
[3] Bequaert, J., "The Predacious Enemies of Ants", *Bull. Amer. Mus. Nat. Hist.*, **45**, 271–331; 1922; in addition to my paper, pp. 92–97.
[4] *Nat. Sci.*, Vol. 5, p. 177.
[5] *Proc. Zool. Soc. Lond.*, Pt. II, p. 492; 1932.

IN his review in NATURE[1] of a publication by W. L. McAtee, entitled "Effectiveness in Nature of the so-called Protective Adaptations in the Animal Kingdom"[2], "B.P.U." apparently expresses agreement with that author in interpreting what he believes to be 'proportional predation' as evidence of indiscrimination in the choice of food by birds and other predatory animals. Mr. A. J. Nicholson has pointed out that the examination of birds' stomach contents, by itself, can give no evidence of proportional predation.[3] There is, however, another aspect of the subject to which I would direct attention.

Even were it demonstrated, as McAtee claims, that birds prey upon animals approximately in proportion to their numbers, it is difficult to follow him when he says "This means that. . . . predation takes place much the same as if there were no such thing as protective adaptations". McAtee's figures have reference to the various groups of food-animals eaten by "a wide range of species of all the families of birds occurring in the region". The food of these is considered collectively, and herein lies the fallacy in his argument.

This collective treatment of data takes no account of discrimination in the choice of food by *species*. I am not aware that any exponent of the selection theory claims for 'protected' animals immunity from attack. Every zoologist knows that specially defended insects suffer predatory assault. For example, ants have hosts of enemies, including many forms which eat practically no other food, such as Agamid lizards, some tree frogs and toads, woodpeckers, tamanduas and pangolins, besides numerous more casual predatory forms. Whether these so-called 'protected' insects are preyed upon in proportion to their numbers is still open to question. But the real point at issue is to determine whether this proportion—whatever it may be—would remain unaltered in the absence of the adaptations the effectiveness of which McAtee attempts to disprove. In other words, are these adaptations effective against *some* enemies? To this question McAtee's figures provide no answer.

The best method of approaching the problem is by the comparative examination of the stomach contents of predatory forms living in the same habitat, where the same food is available for different species. Viewed in this light, marked differences are observed in the food of different species in relation to that actually available: and selective discrimination, so vigorously denied by McAtee, is found to be the rule rather than the exception.

In NATURE of November 5, Mr. B. P. Uvarov[4] pays me the compliment of referring to a paper of mine, in which he states I have found "that ants constitute more than 90 per cent of the food of frogs". This statement refers accurately to four of the seven species of tree frogs examined by me. In this paper[5] is presented a considerable body of evidence of discrimination in the choice of insect food by tree frogs. In a more recent detailed investigation of the food of British batrachians I find strong evidence in support of this view. This is not the place to go into details which it is hoped will be published later. But it is pertinent to mention here that in a collection of frogs and toads taken both in the same habitat and under uniform conditions, the stomach contents of the two species differ markedly. Thus in 17 frogs and 45 toads collected on the heath-land association of Land's End during the past summer, the following striking differences in food animals were noted:

Food	*Rana temporaria* (per cent)	*Bufo vulgaris* (per cent)
Mollusca . .	24·8	0·6
Lepidoptera . .	13·4	2·4
Diptera . .	9·1	0·9
Formicidæ . .	0·4	41·4

These figures do not look like 'proportional predation'. Rather do they illustrate how a comparative study of predatory habits in insectivorous animals points to selective discrimination in the choice of food.

HUGH B. COTT.

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Nov. 29.—It remains for me to add that the above was written before the Editor let me see a proof of Mr. McAtee's reply to his critics. Considerations of space forbid comment here upon more than one point raised in his present letter.

With reference to the protective adaptations of ants, I would add to the data given above that in a careful examination of the alimentary tracts of 238 frogs and toads (collected between June 7 and October 30 in different habitats in Cornwall, Gloucester and Sussex, and at almost every hour of the day and night), the analysis of some 9,000 food-animals works out in reference to ants as follows:

4,103 ants were recovered from 126 out of 148 toads examined:
7 ants were recovered from 6 out of 90 frogs examined.

In the face of facts such as these, Mr. McAtee would do well to reconsider his sweeping assertion that "Ants are not rejected either relatively or absolutely by any potential predators".

HUGH B. COTT.

[1] 'B.P.U.', NATURE, **130**, 66, July 9, 1932.
[2] McAtee, Smithsonian Miscellaneous Collections, **85**, 7; 1932.
[3] Nicholson, NATURE, **130**, 696, Nov. 5, 1932.
[4] Uvarov, NATURE, **130**, 696, Nov., 1932.
[5] Cott, *Proc. Zool. Soc. Lond.*, 471; 1932.

The New Infra-Red Band System of the CO Molecule

THE transition of the CO molecule from the upper electronic state of the Hopfield-Birge absorption bands to the upper level of the Cameron bands, gives rise to a system of bands degraded towards the red, and extending from the infra-red region to about λ5660 A. These new bands, as they were called, were photographed by Asundi,[1] who also gave their gross vibrational analysis. On Asundi's plates the bands showed a diffuse multiplet structure. Measurements were made only on the first and the last heads.

It does not seem to be generally known, however, that McLennan, Smith and Peters[2] previously recorded the same bands as a series of triplets, using different conditions of excitation. The wave numbers of the first and the third head in each of the triplets agree closely with those of Asundi's, and in addition, measurements on the second head are also available. Making use of the equation given by Estey[3] for the new bands, McLennan's results fit in well in the expression:

$$V = (9284)\ {}^{9325}_{9233} + (1173n' - 9n'^2) - (1726\cdot5n'' - 14\cdot4n''^2)$$

The value (9284) in the above equation, for the electronic energy of the second band-head, is obtained from the triplet separations as observed by McLennan.

In addition to all the transitions recorded by Asundi, those corresponding with (9, 2) (10, 2) (11, 2) (10, 3) and (11, 4) are to be noticed in McLennan's data, but transitions (2, 0) and (4, 1) are missing.

Johnson[4] and Asundi[5] put forward the view that the final level of these bands which is the same as the third positive and the associated bands is a quintet level, while Birge[6] and Mulliken[7] hold that it is a triplet one. It is of interest therefore to note that in the light of McLennan's results, the level appears to be a triplet one, unless some bands too faint for observation were missed. The unweighted mean of the triplet separations in the direction of the degradation of the bands is 37 and 46.

B. K. VAIDYA.

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Bangalore.
Nov. 3.

[1] *Proc. Roy. Soc.*, **124**, 277; 1929.
[2] *Trans. Roy. Soc. Canada*, **19**, 39; 1925. Also, "Tables Annuelles Internationales de Constantes", vol. 7, Pt. 1, p. 697; 1930.
[3] *Phys. Rev.*, **35**, 309; 1930.
[4] *Trans. Faraday Soc.*, **25**, 649; 1929.
[5] *Loc. cit.*
[6] *Phys. Rev.*, **28**, 1157; 1926.
[7] *Rev. Modern Phys.*, **4**, 53; 1932.

Absorption Spectra of Metallic Colloidal Solutions, and Emission and Absorption of Metallic Films

Absorption of solutions and films. The absorption curve of films of silver has been recently published by Mohler[1]; and we have recently published the absorption curves of colloidal solutions of silver and gold.[2] The absorption curves of the colloidal solutions of silver and of the films of this element are almost exactly coincident, as may be seen on Fig. 1, where the axis of the ordinates for curve I (solutions of colloidal silver) shows the values of $\log I/I_1 = \alpha d$, and for curve II (silver film at a temperature of 300° K) the values of $\log J/J_0 = (4\pi nkx/\lambda) \log e$. The agreement between these curves confirms Mie's theory[3] that metallic colloidal particles have the same

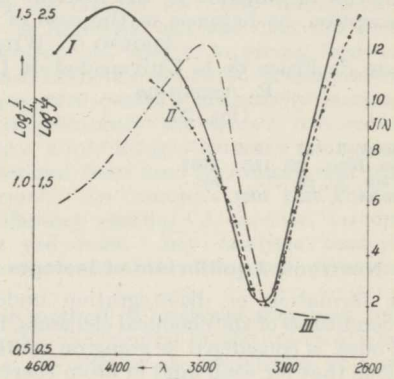

FIG. 1.

optical properties as a macroscopic mirror of the same substances.

Emission and absorption of the films. The films of tungsten, aluminium, beryllium, gold-calcium alloy, thorium and platinum bombarded with 7 volt electrons emit, according to Mohler and Beckner,[4] radiations similar in their intensity and in its distribution; the distribution of the spectral energy is constant between 6,400 A. and 2,400 A. Exceptions to this characteristic property are offered by copper,

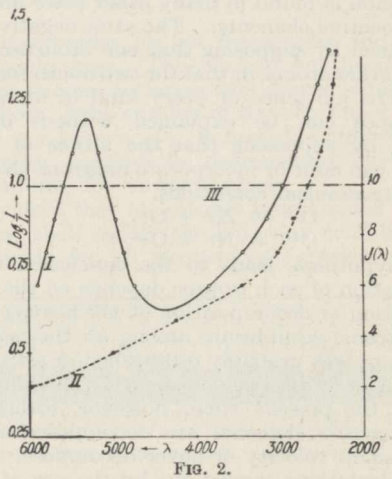

FIG. 2.

which shows a marked increase of emission in the red, and silver, which emits strongly between 3,600 A. and 3,200 A., the maximum emission being at this latter wave-length (Fig. 1, Curve III), which is near the maximum of absorption. In this instance there appears to be a relation between the maxima of emission and absorption. On the other hand, in the case of colloidal solutions of gold, there is no relation between the maxima of absorption and the spectra of emission of the films bombarded with electrons. In Fig. 2, curve I represents the absorption of colloidal solutions of gold (Bredig method), curve II

the same property for colloidal solution of gold (chemical method), and curve III is the emission of a gold film.

It would be of interest to determine whether the absorption curves of a metallic film are always identical with the absorption curves of the colloidal solutions of the same metal, as they are in the case of silver, with the view of ascertaining if Mie's theory is applicable to all metallic colloidal solutions; and also whether there is a correspondence between the characteristics of emission of the metallic films and their absorption, as happens in the case of silver.

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R. Argentina.
Oct. 20.

[1] *J. Research*, **8**, 357; 1932.
[2] *J. Chem. Phys.*, **29**, 117; 1932.
[3] *Ann. Phys.* (4), **25**, 377; 1908.
[4] *J. Research*, **7**, 751; 1931.

Neutronic Equilibrium of Isotopes

IF the formation or disintegration under astronomical conditions of the chemical elements, including the light ones, is considered as going on continuously, it is obvious that for each kind of atom there must be present its parent and its succeeding element. It can be proved, however, that the emission of α-, β- or even H·-particles by disintegration, or the entry of the α-, H·-particles or the electrons into the nuclei, is unable to explain the existence of every isotope. For example, it is impossible to explain in this way the formation of Sc^{45} by decomposition of Ti^{48}, Ti^{50} and V^{51}, or by emission of an electron from Ca^{44}. Likewise it is impossible to explain the formation of Ti^{50} by means of the entry of α-, H·- or β-particles into the nuclei of any one known atom. The same phenomenon is found in many other cases among the non-radioactive elements. The same negative results are obtained by supposing that one atom decomposes into two other atoms, or that the two nuclei form a new atom. The existence of every kind of atom and of all isotopes can be explained without difficulty, however, by supposing that the atoms of different elements can emit or incorporate neutrons (Nr)—even under astronomical conditions.

$$O^{18} \rightleftarrows Nr + O^{17}$$
$$O^{17} \rightleftarrows Nr + O^{16}$$

This hypothesis leads to the conclusion that the concentration of each isotope depends on the velocity of formation or decomposition of the heavier isotope. The neutronic equilibrium among all the isotopes of one element was probably established in astronomical conditions of formation of elements. This equilibrium exists at the present time, however, although the non-radioactive elements are decomposed with extremely small velocity or never decompose.

The calculations carried out by the use of Aston's table of isotopes show that the emission of a neutron by an element is connected with a loss of mass equal to 0·9997 (average value for 18 isotopes). If we accept the data given by Chadwick for the mass of a neutron, its emission involves the introduction of a considerable amount of energy. If, however, the mass of a neutron is less than unity, this process is an exothermal phenomenon.

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Time Determination

IN NATURE of October 29 appeared a letter on the above subject from Dr. de Graaf Hunter. A consideration of the geodetic literature of the last few years seems to indicate that he is a little pessimistic in his estimate of the errors likely to creep into longitude determination through the imperfect elimination of 'personal equation' by the modern transit micrometer.

Be that as it may, Dr. Hunter's proposed method of transit observation has much to recommend it. The general tendency in precise measurement, especially where it involves time as a measured quantity, is to make the whole thing automatic. This tendency needs to be combated or adopted guardedly because increased mechanism is undesirable in itself and because it frequently leads to unsuspected systematic error. For example, having occasion to use the rhythmic time signals both from Nauen and Rugby in connexion with gravity pendulum work, I found a systematic difference of 0·02 seconds in the estimation of this 2·1 hour interval by two observatories where good time-keeping is done. This means that the reaction of any automatic receiver to wireless signals depends upon some quality, possibly strength only, in the signals.

It will be noticed that Dr. Hunter eliminates one train of mechanism—the electrical contacts, the electro-magnetic pen and the chronograph—but inserts another and simpler mechanism—the electromagnetic shutter near the focal plane of the transit instrument. To this extent I think his method leaves something to be desired. The progressive flashing of the star in the field of view renders the observation almost precisely the same as that of the visual timing of a gravity pendulum. As a result of experience with the latter I formed the opinion that the electromechanical link in the chain—the so-called flash-box—was a weak one. In order to eliminate this link a chronometer (a Kullberg Mean Time instrument) was adapted to give direct flashes without the intervention of any electric current and without interfering in any way with its mechanism. A small plane metallic mirror was attached rigidly to the balance-wheel, which was then re-balanced in such a way as to give once more the excellent time-keeping for which the instrument had previously been noted. Although this arrangement gives four flashes per second, its use with an oscillator not differing in period by more than about one per cent from n times that of the wheel is found to be quite manageable. Further, the accuracy with which a single reading of a flash can be made lies between 0·001 second and 0·003 second, a figure which puts it out of court altogether as a possible source of error in determining the time of swing of the pendulum.

How, then, is it possible to preserve the spirit, so to speak, of Dr. Hunter's method of transit observation and yet do away with his mechanical shutter? Doubtless thinking on the same lines as he, I suggested in a report on longitudes to the meeting of the International Geodetic Union at Stockholm in August 1930 that if it were possible to communicate to the star image a small vertical oscillation the determination of time would be made with great accuracy by the unaided eye. The difficult judgment of *when* the image crossed a line would be replaced by the incomparably easier judgment of *where* it crossed.

As shown above, the comparison of the auxiliary

oscillator implied in this scheme with a chronometer or clock would be carried out to great accuracy with purely optical arrangements.

The practical details of my scheme present great difficulties but, surely, not insuperable ones.

Finally, I may add that the free gravity pendulum, which is the best time-keeper known over a few hours, has already been used on occasion to check the clock or chronometer during a longitude determination. Astronomers now prefer to place reliance on time-keepers rather than on star-places in determining the difference of longitude between two places.

H. L. P. JOLLY.

Ordnance Survey Office,
Southampton.
Nov. 16.

Fourier Analysis and Vowel Curves

ATTEMPTS were made recently to apply the Fourier harmonic analysis to a collection of very large vowel curves traced off from a gramophone record through the courtesy of the Gramophone Company (His Master's Voice) of Hayes. One such wave in the actual size is reproduced in Fig. 1. The wave was first analysed by measuring 24 ordinates (12 harmonics). When a new curve was constructed from the results it showed scarcely the faintest resemblance to the original. The most important characteristics did not appear at all, and all the characteristics shown were erroneous. Owing to the small vibrations, at least 200 ordinates would have to be employed in order to produce any resemblance. This would require that number of schedules. At present the highest number for which schedules have been drawn up is 72 (published in my "Studies of Speech Curves", Carnegie Institution Publication No. 44). The work with 150 ordinates for a single wave would keep a person busy for several months.

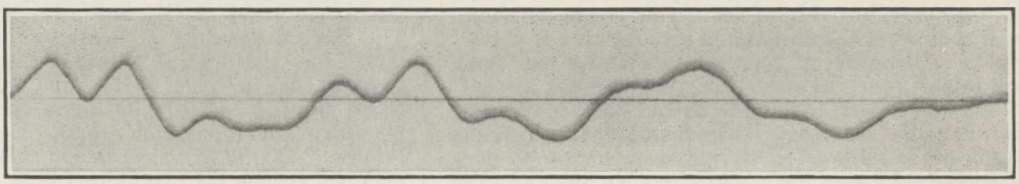

FIG. 1.—Part of a vowel curve traced from the words, "A day", from a phrase spoken by H.R.H. The Prince of Wales on November 11, 1927. Actual size.

Owing to the failure of measurements, the Mader harmonic analyser was then used. The point travelled over the curves and thus used every ordinate in producing the result. Even these curves were scarcely large enough to bring reliable results. The Henrici-Coradi harmonic analyser can be depended on to give reliable results when the wave is enlarged to 400 mm. horizontally. For large curves this would appear to be a satisfactory method except for one reason that will be stated later.

Fig. 2 reproduces a few waves of the sound track of the vowel in a film record of 'hatch' made through the courtesy of R.C.A. Photophone Ltd., and Pathé, London. The curve shows fine details that cannot be brought out by a Fourier analysis on the basis of measurements with less than 500 measurements. Apart from the fact that schedules for such high numbers of ordinates do not exist, such an analysis of a single wave would probably require a year or so of calculation. Neither the Mader nor the Henrici-Coradi analyser can be used because the small waves are so steep that accurate readings cannot be made even in an enlargement. A decisive reason why no form of harmonic analysis can be used appears the moment we observe that every vowel wave begins with a strong upward jerk and fades away to almost nothing at the end just before the upward jerk of the next wave. The vowel wave is thus seen to have a strong decrement as one of its most important characteristics. A harmonic analysis does not provide for this decrement but uses it in giving false values to the assumed harmonic elements. A harmonic analysis of a decremental curve is necessarily erroneous. As pointed out previously[1] the curve of a vowel vibration represents a triple integration over the wave-length, the frequencies from zero to infinity and the *factors of decrement*. An analysis on this basis would give satisfactory results. A method for doing this does not yet exist. Any analysis that does not take the decrement into account gives erroneous results.

Another method of analysis[2] measures the apexes of the peaks and depths of the interior waves, and interprets the results as amplitudes of component harmonic sine waves. The method is superior to that of the Fourier analysis. It gives quite different results in that it provides for all frequencies and not the few harmonic ones. The method has been applied with great success to larger non-decremental curves, such as those of the number of travellers on a railway, drawings in a lottery, etc. It furnishes only erroneous results when applied to decremental curves and cannot be used for vowel analysis.

It is evident that an entirely new method must be found that shall satisfy the following conditions: It must provide for all frequencies between zero and infinity. It must provide for all factors of decrement that may be present. It must present its results in the form of numbers that have a useful meaning. It must not involve any assumption that the vibration is built up of simple sine movements. On the basis of sound tracks of the vowels, I am at present developing such a method and hope to have the result ready shortly.

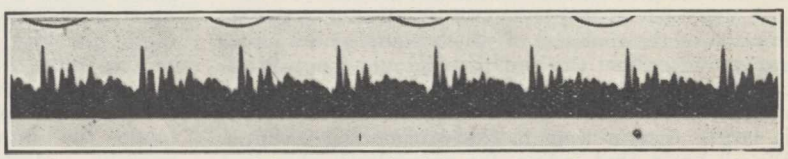

FIG. 2.—A few waves of the sound track of the vowel in a film record of 'hatch'.

The necessity for basing this and most other work concerning the physics of sound on sound tracks arises from the fact that the requirements of the film industry have produced a method of recording of very great accuracy. A comparison with the vowel

curves obtained by other means shows that they all lack the finer details that appear in the sound tracks and that all except a very few are so distorted that they can scarcely be said to be vowel curves at all. Of all the previously published vowel curves, only those obtained from gramophone records by myself and the Gramophone Company, those obtained by Miller with an oscillating mirror, those of Crandall with a special oscillograph, and those of Gemelli with a cathode ray oscillograph, resemble those in the sound tracks; even these lack the finest details.

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[1] NATURE, **130**, 275, Aug. 20, 1932.
[2] Vercelli, "Analisi delle periodicità nei diagrammi (Cimanalisi)", *Att. Ist. Naz. Assicurazioni*, **3**, 1; 1930.

Just Intonation

IF the tones *C* and the seventh harmonic of *A*♭ are sustained together in the ratio 5 : 7, the two chief resultant tones are *A*♭ and *E*♭, the four tones together giving the true form of the accord known as the German sixth, 2 : 3 : 5 : 7, expressed in cents by the numbers 814, 316, 1,200, 583.

Now if the highest of the four tones is raised 20*c*. to 603*c*., and *C* remains, these two are as 12 : 17, and with their two resultant tones, *A* and the seventh harmonic of *F*, they form the accord 5 : 7 : 12 : 17, in cents 884, 267, 1,200, 603. This is the true form of the chord of the diminished seventh.

The difference of 20*c*. is one-fifth of an equal semitone.

The tenor part, moving from and back to *C* major on the notes 386, 316, 267, 204, 471, 386, divides the semitone *E*♭–*D* in the enharmonic proportions proposed by Archytas, contemporary of Plato, as recorded and rejected by Ptolemy, namely:

$\frac{36}{35} \times \frac{28}{27} = \frac{16}{15}$, or $49 + 63 = 112c$.

The succession in the bass, meanwhile, is simply *G*, *A*♭, *A*, *G*, *G*, *C*, that is, 702, 814, 884, 702 and 0 (1,200)*c*.

WILFRID PERRETT.

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Nov. 29.

Distribution of Molybdenum

A VERY few elements constitute all save a minute fraction of the material of which plants and animals are made; but the small residuum contains a considerable, even a large, number of elements, stored up and accumulated by the organism and so present in larger amount than in the surrounding medium. We all know that iodine, for example, is abundant in seaweeds though the amount present in sea-water is very small indeed; and molybdenum is another element in much the same case. M. Eugène Cornec, several years ago, demonstrated the spectrum of molybdenum and of no less than seventeen other metals besides in the ash of seaweeds; and now I have succeeded in separating and estimating the molybdenum present in various plants and animals.

I happened to be analysing a certain coal-ash, and found traces in it of a metal the sulphide of which was soluble in sodium sulphide; by working on large quantities I was able to isolate enough of this metal for identification, and it proved to be molybdenum. One kilogram of coal was found to contain 0·21 mgm. of the metal, or 21 parts in a hundred million. I then began to look for molybdenum in all sorts of plants and vegetable products, and always found it, though the quantities were always small. The largest amount was found in beans and peas, namely, 3 to 9 mgm. per kilo; cereals come next in order, with 0·2 to 0·6 mgm.; while wood, leaves, and various fruits and vegetables contain only minute traces—cucumbers, for example, with 0·01 mgm. per kilo. Demarçay[1] had already demonstrated molybdenum in wood-ash, spectroscopically; my own method is a colorimetric one, based on the orange colour exhibited when a sulphomolybdate is heated in solution with ammonium chloride.

Ordinary plants must draw their supply of molybdenum from the earth, and accordingly I began to search for this element in various samples of soil; in a fertile soil I found from 0·1 to 0·3 mgm., on a moor I found 0·01, and on a barren sandy waste only 0·005 mgm. per kilo. I next analysed a number of mineral waters; but the only one (out of nineteen different samples) which contained an appreciable amount of molybdenum was the Source Perrière of La Bourboule, which contained 0·13 mgm. per litre. Mineral oils were found to contain molybdenum, sometimes in large quantity; the least amount was found in Persian crude oil, namely, 0·013 mgm., the largest in Mexican crude, which yielded no less than 5·55 mgm. per kilo. I then proceeded to look for molybdenum in the tissues of man and animals. The largest amounts I found in liver, and in the milt: for example, 1·5 mgm. per kilo, in the liver of ox or pig; while much smaller quantities, from 0·14 to 0·03 mgm. per kilo were to be found in blood, bile, milk, eggs and sundry tissues. Cod's liver contained 0·12 mgm. while haddock (whole fish) contained 0·03 mgm. per kilo; but in contrast to this I was unable even to detect molybdenum in a sample of forty litres of sea-water.

A relatively large quantity of molybdenum is contained in *Azolla*, a little aquatic plant which has become very abundant on the smaller canals in the neighbourhood of Delft. 264 gm. of the dried plant gave 0·298 mgm. of molybdenum, or 1·13 mgm. per kilo; and another sample, of 226 gm., gave 1·12 mgm. per kilo. On the other hand, the amount of molybdenum present in the canal water was very small indeed; it was necessary to operate on 23 litres before a titration could be made; and the amount obtained was only 0·021 mgm., or 0·0009 mgm. per litre. *Azolla* is remarkable for having a minute alga, *Anabæna Azollæ*, living in symbiosis in its tissues, and this alga is believed to be capable of fixing atmospheric nitrogen. Now H. Bortels[2] has made the interesting discovery that a certain microbe, *Azotobacter chroococcum*, which also possesses the power of fixing atmospheric nitrogen, is dependent for its healthy growth on the presence of molybdenum; and one begins to wonder what part the metal plays in *Azolla* and its symbiotic *Anabæna*. It has not been possible to separate these two symbiotic plants for purposes of analysis; and the amount of molybdenum which I have ascribed to *Azolla* is that of the two plants in their normal association.

H. TER MEULEN.

Delft.

[1] *C.R. Acad. Sci.*, **130**, 91; 1900.
[2] *Arch. Mikrobiol.*, **1**, 333; 1930.

General Transformation Theory in Hilbertian Space

ONE can write the Dirac's wave equation

$$\{\alpha_1 p_1 + \alpha_2 p_2 + \alpha_3 p_3 + \alpha_4 mc\}\psi = \lambda\psi \qquad (1)$$

in the matrix representation

$$\sum_{\sigma,\varkappa}\{(\alpha_1)_{\tau\sigma}(p_1)_{\iota\varkappa} + (\alpha_2)_{\tau\sigma}(p_2)_{\iota\varkappa} + (\alpha_3)_{\tau\sigma}(p_3)_{\iota\varkappa} + (\alpha_4)_{\tau\sigma}mc\}\psi_{\sigma\varkappa} = \lambda\psi_{\tau\iota} \qquad (2)$$

which will be invariant under any unitary transformation of the Hilbertian spaces of spins and momenta ($(p_1)_{\iota\varkappa}$ denote the components of the momentum matrix in the Hilbertian space).

Usually one considers only the Cartesian systems in Hilbertian space, but from a general point of view one is led to investigate the invariance of quantum laws under more general affine transformations. To assure this invariance one has to introduce the 'metric matrices' $\gamma^{\sigma\varrho}$ and $g^{\varkappa\lambda}$ for the two Hilbertian spaces as new dynamical variables, and to write equation (2) as follows

$$\{(\alpha_1)_{\tau\sigma}\gamma^{\sigma\varrho}(p_1)_{\iota\varkappa}g^{\varkappa\lambda} + (\alpha_2)_{\tau\sigma}\gamma^{\sigma\varrho}(p_2)_{\iota\varkappa}g^{\varkappa\lambda} + (\alpha_3)_{\tau\sigma}\gamma^{\sigma\varrho}(p_3)_{\iota\varkappa}g^{\varkappa\lambda} + (\alpha_4)_{\tau\sigma}\gamma^{\sigma\varrho}mc\}\psi_{\varrho\lambda} = \lambda\psi_{\tau\iota} \qquad (3)$$

(where the covariant and the contravariant characters of the indices as usual are distinguished by their position).

To account for an external electromagnetic field, one usually introduces in the Dirac equation the potentials of the field, which causes a corresponding change in the eigenvalue spectrum of the equation. But if one starts from the general equation (3), one can always by an appropriate choice of the 'metric matrices' $\gamma^{\sigma\varrho}$ and $g^{\varkappa\iota}$ ensure that this equation gets a given eigenvalue spectrum. This follows from the well known fact that by a simultaneous non-unitary transformation any two quadratic forms $H_{\iota\varkappa}$ and $G_{\iota\varkappa}$ may be transformed into diagonal forms, one of them becoming the unit form. We can thus formulate the principle of general transformation as follows:

It is impossible to distinguish between a set of states described by a Dirac equation for a free particle in a non-unitarian Hilbertian space and a corresponding set of states, described by the usual Dirac equation in a given external field.

Thus the electromagnetic field appears to be an expression of the non-unitary metric in the Hilbertian space in the same way that the gravitational field is an expression of the non-Euclidian metric of the space-time world.

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Room Comfort

IN a note in NATURE of Nov. 12, p. 743, reference was made to the kata-thermometer as being considered too small for its purpose as an indicator of comfortable conditions in a room, and to the larger electrically controlled instrument, the eupatheoscope, described by Mr. A. F. Dufton, the surface of which is automatically kept at 75° C., a temperature corresponding to that of the clothed surface of the body in ordinary room conditions. This instrument was considered more suitable owing to its size.

The kata-thermometer does not indicate the rate of cooling of the body but of the bulb of the thermometer, which approximately is at the temperature of the skin of the face. The range of cooling powers which are best for comfort were fixed empirically in conditions which were admittedly fresh and pleasant. Like the skin of the face, the kata-thermometer is very sensitive to the cooling effect of wind.

I have shown that the infra-red rays from dull red and dark sources of heat produce uncomfortable sensations in many people. They tend reflexly to congest the nose and make it stuffy, the congestion lessening the nasal air-way. These effects are set aside by cool air, for example, by a fan blowing on the face. As the kata-thermometer is very sensitive to cool warming air, it is an excellent indicator of those conditions which give a fresh feeling. The mere securing of a certain cooling power and temperature of the clothed surface is not sufficient to give comfort, and as the small size of the kata-thermometer is actually an advantage, its utility is not surpassed by that of the eupatheoscope.

LEONARD HILL.

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Dec. 10.

Colour-blind Motorists and Red Danger Signs

IT is not, I think, realised what a menace the colour-blind have become under present conditions; their contribution to the toll of the roads, for example, is never even mentioned. Most colour-blind persons are blissfully unaware of their abnormality and in Great Britain there are probably one hundred thousand colour-blind persons licensed to drive motor vehicles. Would-be drivers of railway trains are tested as a matter of course and some four per cent are rejected for defects in colour-vision, but no tests are imposed upon those who use the roads.

The peril of the roads is enhanced by our use of red as the sign of danger—the one colour which the ordinary colour-blind person cannot see at all—and it is instructive to don a pair of blue spectacles (copper glass) and to learn how the world appears to a daltonian. The danger is greatest, of course, at night, when the red rear-lights of vehicles, road obstruction lamps, reflectors on bicycles and *beacons* at cross-roads are well-nigh invisible and fail to convey any warning. Automatic light-signals which show red as a stop-sign may be a source of danger by day as well as by night.

As colour-blindness is largely congenital, it will doubtless soon be practicable to eliminate it. In the meantime all 'bus drivers should be tested (on November 5 one did not see my brilliant red rear-light and charged into the tail of my car), and coroners might well inquire into the colour-vision of those who at night drive down inoffensive cyclists.

A. F. DUFTON.

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Dec. 1.

Systems of Four Immiscible Liquid Layers

THE mixture described by E. Lester Smith[1] gives a system which separates into four layers, as stated, but does not appear to be stable. A specimen made up as described at first separated into four layers, but after long standing these become two layers. One sample of the system made up in January 1931 has now formed two layers, coloured brown, and separates into these two layers on standing after agitation. The phase rule deals with systems in true equilibrium.

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[1] NATURE, 127, 91, Jan. 17, 1931.

Research Items

Ancient Civilisation in the Rift Valley.—Capt. G. E. H. Wilson discusses in *Man* for November the evidence for the existence of a forgotten civilisation in the Rift Valley, East Africa. The existence of ancient works, terracing, graded roads (the so-called elephant tracks) and irrigation works—canals and drainage—is now established not only in Tanganyika, but also in Abyssinia, Uganda, Kenya and Northern Rhodesia. The terraces, averaging in width at the top about one foot, but probably originally about three feet, follow the contours of the hills. The depth between terraces is about three feet. The roads, clearly not elephant tracks, point to a high state of civilisation. They are difficult to locate, though in places they are part of roads in use to-day. The points at present located suggest a system of communication running north and south on the eastern side of the Great Lakes, pointing to outlets by way of the Nile in the north and by Rhapta in the south, with possibly an intermediate route via Mombasa, the origin of which may prove very much more ancient than is thought. There are traces of an extensive system of irrigation at Uhehe, and in low-lying districts, such as the Mgeta River near Kisaki, there are river diversions which may be artificial. As to the authors of this civilisation, there are legends of an alien race dominating local peoples in both north and south Tanganyika. At present there is a great diversity of language and culture where these ancient works are found; but at some time the people may have been more homogeneous. If there has been an alien immigration, it is possible that it may have taken place so early as 1500 B.C., and that by the time of Solomon (970 B.C.) a flourishing trade already existed and the Sheban port of Rhapta had been established. It is suggested that this ancient civilisation may have originated in the north, spread through the Rift Valley over the highlands of the Great Lakes, and have reached Zimbabwe.

Sociological Value of Churches.—The problem of "The Churches and Social Well-being" is discussed by John Miner in *Human Biology*, September, 1932. An attempt is made to find some statistical evidence in the United States in support of the popular assumption that churches are not only the bulwarks of morality and social stability, but also promote social well-being in general. Correlations were calculated between the percentage of church members in each State and indices of wealth, education, health, and sexual morality. So far as his evidence goes, Miner finds no indication of any effective contribution of the churches to social well-being. States with large proportions of church members are on the average no healthier, no wealthier and no more literate than States in which the churches are weak, and show no lower illegitimate birth rates or death rates from venereal diseases. States with large proportions of Methodists and Baptists appear to be relatively poor and illiterate.

'Legislative Anthropology' in the United States.—Dr. Arthur Macdonald, who is well known for his advocacy of the study by anthropometric measurement of the members of legislatures as a body, as best representing the anthropological status of the population of their respective countries, has recently published in the *Congressional Record*, Washington, D.C. (Seventy-seventh Congress, First Session) an anthropological study of eighty-nine congressmen, representing various States, who may be taken as typical of the successful American in the prime of life. The great majority of them are of English or Scottish ancestry, while the remainder have a good sprinkling of English or Scottish blood. Their average age is fifty-three years. The average length of head is 196 mm., breadth, 156 mm. and height, 139 mm., cranial capacity, 1,625 c.c., and estimated weight of brain (Welcker's formula), 1,543 gm. Some interesting results emerge from a classification in State groups. The western south Central States (Arkansas, Louisiana, Oklahoma and Texas) give the greatest stature, 179 cm., greatest brain weight, 1,571 gm., and longest head, 198 cm.; the western north Central States coming next with brain weight 1,525 gm. and stature 177 cm. The lowest brain weight comes from the Pacific States (Washington, Oregon and California), of which the five members measured have a brain weight of 1,419 gm., head length, 191 mm. On the other hand, these five members have the greatest strength of hand-grasp—76 kgm.

Host-Parasite Relationship in *Olpidium*.—*Olpidium viciæ* and *O. trifolii*, which are found in the field only on *Vicia unijuga* and *Trifolium repens* respectively, are shown (S. Kusano, *J. Coll. Agric. Imp. Univ. Tokyo*, vol. 11, No. 4, 1932) by inoculation experiments to develop in sixty-three out of eighty-one species (sixteen out of twenty families) of phanerogams inoculated. The host plants react in two ways to the attack of the fungus. In one group the formation of a tumour results, while in the other no sign of infection is recognisable externally. The host of this second type may function as the fungus carrier, being susceptible to the parasite but immune from the disease. The hosts reacting in the first manner to *O. viciæ*, namely *Vicia unijuga*, *V. faba* and *Pisum sativum*, react to *O. trifolii* in the second manner; reciprocally the plant reacting in the first manner to *O. trifolii* exhibits the second type to *O. viciæ*. All parenchymatous tissues from the various plants liable to infection induce an apparent positive chemotaxis to the swarm cells of the fungus and the potassium ion is the active agent in this chemotaxis. Many susceptible plants remain unaffected in Nature because their anatomical characters, growth forms or habits prevent the parasite from approaching their susceptible cells. The morphological difference between the two forms of *Olpidium* is exceedingly slight and the range of their hosts exactly coincides. There is, however, a clear distinction between them as regards their effect upon certain plants.

Physiology of Ciliary Movement.—The first of a series of papers on this subject dealing with the effect of hydrogen ion concentration upon the ciliary movement of the gill of *Pecten* has recently been published by Dr. Shichiroku Nomura (*Sci. Rep. Tôhoku Imp. Univ.*, fourth ser., vol. 7, 1932). The most important conclusion reached, which appears to be based on sound experimental evidence, is that stoppage of the cilia in an enclosed chamber is not due to accumulation of carbon dioxide, as previously supposed, but to lack of oxygen. The supposed effect of carbon dioxide in regulating the rate of respiration in lamellibranchs by depressing ciliary activity is thus untenable, at any rate for the species examined.

Interesting figures are also given of the critical *p*H values for the stoppage of cilia by carbonic, acetic, phosphoric and hydrochloric acids, which range from 5·5 to 3·8 in the order given. The longer the period for which the gill was exposed to acid sea-water, the longer it took to recover. This result is not in agreement with Gray's work on *Mytilus* but this animal, unlike *Pecten*, is a member of the littoral fauna and is normally uncovered daily and the gills exposed to a low hydrogen ion concentration in the mantle cavity. After the gill cilia had been stopped by lack of oxygen, motility was recovered by re-admittance of oxygen even after the gill had been left overnight.

Determination of Sex.—Max Hartmann discusses some very interesting work on the determination of sex in *Die Naturwissenschaften* for July 29, 1932. In the higher animals and plants, the two kinds of sexual cells are readily distinguished, but passing to the simpler organisms, such as the Algæ and Fungi, forms exist in which the differences in form may be very slight and the two gametes are practically only distinguished by their behaviour—the type regarded as male, or so-called − (when no form difference is recognisable), usually being more active than the female or +. In the extreme case, even this physiological difference disappears. The school of workers under Hartmann at Berlin, working mainly on Algæ, have devised a good method by which they have shown that even in the extreme isogamous forms, a sharp distinction of the gametes into two kinds exists, which is expressed by the liberation into the culture solution of an actual sex-specific substance. If the filtrate from a + culture which contains bacteria, is added to a culture of the − type, a grouping of the gametes is induced, as when gametes of the + and − types are mixed, though actual fusion does not occur in the present case. The explanation given is that the bacteria in the one culture have absorbed a substance, which affects the behaviour of the gametes in the other culture in the same way as the presence of the actual gametes would have done. The gametes, though morphologically and physiologically similar, yet exude distinct substances according to whether they are + or − and only gametes of these opposite kinds will copulate.

Meteorological Observations in Southern India.—In a paper on the extreme dryness observed at Kodaikanal during the winter months, by S. L. Malurkar (*Scientific Notes, Ind. Meteorol. Dept.*, vol. 4, No. 43), an attempt is made to explain the occurrence at Kodaikanal of dry spells during which the relative humidity frequently falls below 10 per cent and attains at times values so low as probably to be far outside the range of accuracy of ordinary wet-bulb hygrometry. Kodaikanal is one of the hill-stations in southern India; it lies in lat. 10° 14′ N. and long. 77° 28′ E., at an elevation of 2,343 metres. Two common causes of exceptional dryness are the advection of air from high to low latitudes accompanied by a rise of temperature due to powerful solar radiation, and the gradual descent of air from high to low levels, such as takes place in many anticyclones, with consequent rise of temperature due to compression of the air as it comes under the higher pressure of the lower levels. In this paper the alternative explanations are critically examined in the case of Kodaikanal. An anticyclone is almost always to be found over southern India in winter, and incursions of dry cold air from northern India often take place round it, but on examining the observed humidities and temperatures over India at these times, no support is found for an explanation based on these. With the idea of descent of air from above, on the other hand, the observed course of events at Kodaikanal and other places fits well. There is often an inversion of temperature with a dry layer, and on plotting the relative humidity at Kodaikanal against the height of this layer as measured by registering balloons at Poona, it was found that the two were positively correlated; further, the occurrence of exceptional dryness was generally simultaneous at all stations with an elevation of 2,000 metres or more, and was apt to be absent from the stations at lower levels. These facts seem to leave little doubt that the exceptional state of the atmosphere is observed on those occasions when the inversion layer of the nearly permanent anticyclone is to be found at a lower level than usual.

Luminous Phenomena accompanying Earthquakes.—Shortly after the Idu earthquake of November 26, 1930, Mr. K. Musya collected many records of luminous phenomena observed at or about the time of the earthquake (NATURE, 128, 155; 1931). Since then, he has studied the phenomena attending four other earthquakes (*Earthq. Res. Inst. Bull.*, 10, 649–673; 1932). The most important of these is the South Hyuga earthquake, which occurred at 7.3 P.M. on November 2, 1931, the number of observations collected being 355. They were observed most frequently at the time of the earthquake and over a tract of country about 130 miles from north to south. The directions in which the lights appeared are varied, but most observers on the coast saw them towards the district in which the submarine epicentre lies. The luminescence usually seemed to radiate from the horizon or to be like a search-light turned to the sky, in colour most often blue or bluish. The phenomena were clearly not due to houses on fire, or to lightning or landslides, though some may be assigned to electric sparking or to meteors. But the author is convinced of the reality of the phenomena and of their connexion, in some way not at present understood, with the earthquake.

Charge of Thunder Clouds.—In the *Revue Scientifique* of September 10, C. Dauzère, director of the observatory at the Pic du Midi, discusses at some length the present position of our knowledge concerning the transfer of electricity from the clouds to the earth by rain drops and by lightning of the ordinary type. He gives summaries of the theories of Simpson and Wilson in regard to the polarity of thunder clouds, and of the two appears rather to favour Simpson's theory that the positive pole is in the lower parts of the front of the cloud and the negative pole in the rear and at the top of the cloud. According to a theory of his own, however, introduced in a number of papers published within the past five years, the ice particles of the cirrus clouds play a part in the distribution of electricity in the thunder cloud. This theory supposes that positive electrification of the ice particles caused by ultra-violet light leads to the condensation upon them of super-cooled water droplets carried upwards by the vertical currents in the cloud, and that the resulting hailstones have generally not had their positive charges neutralised by the time that they have become heavy enough to fall into the lower

forward parts of the cloud. M. Dauzère's view, therefore, is that the large positively charged drops normally found there, which are explained by Simpson as due to the mechanical break-up of drops exceeding a critical size, are partly derived from the cirrus level, and he regards the top of the cloud—or at least the overlying cirrus—as positively charged. But he considers all this part of the subject, and also the question as to whether positive or negative electricity is discharged by a lightning flash, as very speculative, that in fact there is only one point about which definite knowledge has been acquired since the time of Franklin, and that is in regard to the sign of the charge normally carried by raindrops; this charge has been found to be positive in widely separated parts of the world.

Nature of Martensite.—An interesting contribution to our knowledge of the nature of martensite is contained in a paper by Honda and Nishiyama (*Sci. Rep. Univ. Tôhoku*, series I, vol. 21, No. 3, 299). It has been known for some time that when a hardened steel is tempered, several physical properties show a sudden discontinuity at a temperature just above 100° C., as well as a more gradual change between 250° and 300° C. The meaning of the two sets of changes has hitherto been somewhat obscure, but it is now suggested that the first represents a transformation from the tetragonal form of martensite, which results directly from the quenching, to a cubic modification, whilst the latter is due to the breakdown of the cubic martensite to troostite. Since for both forms of martensite the size of the unit cube changes continuously with the carbon content of the steel, it is held that proof has been obtained that they are both solid solutions and not structures in which the carbide is present as particles of colloidal size out of solution. From measurements of the density it is shown in each case that the carbon atoms are arranged in the lattices interstitially and that the replacement theory is untenable.

Astronomical Topics

A Recent Sunspot and Magnetic Disturbance.—A large, single sunspot that was recently visible to the naked eye for a few days crossed the sun's disc between December 6 and 19. It was the return of the leader spot of a large group which had developed rapidly between November 16 and 21 and was then lost to observation around the sun's west limb. The position of the spot was, longitude 325°, latitude 10° north, and its area 600 millionths of the sun's hemisphere on December 7 and 450 millionths on December 14. The spot was most nearly in line with the earth on December 13·0, and on December 14 at 16^h a considerable magnetic disturbance began (in which the range in declination at Greenwich was nearly ½°), thus strongly suggesting a connexion between the activity of this region of the sun and the earth's magnetism. Although the spot was observed with the spectrohelioscope at Greenwich, whenever the sky permitted, no activity in the nature of an eruption was seen in the light of Hα. The longest possible watch was limited, however, to two hours on December 12, so that combined observations from observatories abroad may be more decisive. It may be added that a sunspot of this size is rare but by no means unique during the epoch of minimum phase of the eleven-year cycle upon which the sun's activity has now entered.

New Comet, 1932*n*.—Mr. G. F. Dodwell, the Government Astronomer at Adelaide, has telegraphed to the Astronomer Royal announcing his discovery of a comet of magnitude 11. On December 17 at 1^h (probably local time, but telegraphed as U.T.), its R.A. was $23^h2^m23^s$, South Declination 28° 43′; the R.A. was increasing 3^m18^s daily, the declination diminishing 47′ daily, motion northward. Mr. Dodwell suggested identity with Tempel's comet, but this does not appear to be possible. The comet is on the meridian about 5 P.M.

The Leonid Meteors.—*Popular Astronomy* for December and Science Service, Washington, November 25, report that a fairly active shower was seen in the United States in the early hours of November 16. At Dubuque, Iowa, the rate reached 240 per hour, and two bright meteors were seen after sunrise. At Yale Observatory it was noted that the proportion of bright meteors was large. Half of them were brighter than Procyon and one-fifth of them brighter than Sirius. At East Radford, Virginia, 734 were recorded in 3 hours; at Catskill Mountains, New York, 901 were recorded. The last two numbers, however, include many duplicates. At Harvard, Dr. P. H. Millman photographed the spectra of the trains of two bright meteors; the photographs had not been fully examined when the report went to press.

The above results suggest that the predicted time of maximum, Greenwich noon on November 16, was not greatly in error. Probably if the moon had been absent, this shower would have been considered a fairly good one.

Mass of the Galactic System.—Dr. J. H. Oort has investigated (*Bull. Astron. Instit. Netherlands*, vol. 6, No. 238) the force exerted by the galactic system in a direction perpendicular to its plane. His methods involve so many steps that they cannot be summarised within the limits of a note, which is therefore limited to his conclusions. The acceleration perpendicular to the plane increases proportionally to the distance from the plane up to a distance of 200 parsecs, and then remains nearly constant to a distance of 500 parsecs. The mass per cubic parsec in the sun's neighbourhood is 0·092 sun, but in the larger region including stars to 13·5 visual absolute magnitude it is only 0·038 sun; this would, however, be increased if still fainter stars were included. The mass of interstellar dust and gas is concluded to be only a small fraction of that of the stars. The mass per cubic parsec is shown to be of the same order as that deduced by Dr. Hubble for the Andromeda nebula. The nebula N.G.C. 4594 indicated greater mass in proportion to its light; but the light of this nebula is dimmed by a belt of absorbing matter.

A note at the end of the article gives reasons for believing that van Maanen's star has a mass 3 times the sun's, with a radius of 5,000 km.; the resulting Einstein shift to the red is 240 km./sec.; it is pointed out that it will be possible to distinguish this from true recession by measuring the change of proper motion in forty or fifty years.

Durban Meeting of the South African Association for the Advancement of Science

THE thirtieth annual meeting of the South African Association for the Advancement of Science was held in Durban on July 4–9, under the presidency of Prof. P. J. du Toit. The meeting was very well attended and 117 papers were read. The South African medal and grant were presented to Prof. J. W. Bews and the first British Association medal to Dr. Nellie F. Paterson at the close of the presidential address. Popular evening lectures were given by General J. C. Smuts on "Climate and Man in South Africa" and by Prof. B. de St. J. van der Riet on "Essential Oils". There was a reception by the mayor and councillors and numerous excursions to places of scientific interest in the neighbourhood. [The papers presented at the meeting are now available as vol. 29 of the *South African Journal of Science* (Johannesburg: South African Association for the Advancement of Science, 1932. 30*s*. net).]

The presidential address on "Africa's Debt to Science" was delivered by Prof. P. J. du Toit. To illustrate what science has done for Africa, advances in preventive medicine and in veterinary science were considered in detail. Progress in the science of nutrition, including the rôle of vitamins and minerals for man and stock, was summarised and the interrelation of botanical and veterinary science indicated. Improvements in refrigeration and in communication were noted. What science can do for Africa in the future was indicated as increase in health, reduction of infantile mortality, eradication of diseases such as malaria and East Coast fever, organisation of native races and the development of large white dominions in Africa. According to Prof. du Toit, Africa should do much more to further research. The best use is not being made of either the money or the men available. Economy in brain power is necessary and men of great research capacity should not be wasted doing the work of junior clerks. Research should not be sacrificed for economy. Organisation of research is necessary and also the creation of conditions such that outstanding men can devote themselves to research.

Prof. R. W. Varder gave an account of recent work on "Particles and Waves" as his presidential address to Section A. The quantum theory in relation to light and waves was discussed and the photo-electric and Compton effects were contrasted with de Broglie's views. The interference experiments of Thomson and their mathematical solutions, leading to the uncertainty principle of Heisenberg, were discussed. Quantum mechanics, radioactive decay and the structure of the atom in relation to modern spectral theory were also considered.

The presidential address to Section B, delivered by Dr. L. J. Krige, dealt with "The Geological History of Durban". After the deposition of the oldest existing South African rocks, included in the Swaziland and Pongola systems, intrusions of granite occurred. The earlier formations were afterwards denuded, and granite is the most ancient rock near Durban. Succeeding formations are not represented in Natal. Each of the old systems has a bed of tillite, indicative of arctic conditions, and the Dwyka ice age was the severest known. At the break-up of Gondwanaland the Cretaceous beds of Durban Bay were deposited. In the Pleistocene the Bluff Peninsula was built up and the sea level oscillated to 500 ft. In post-Pleistocene times, sea level did not rise so high as in previous inter-glacials, but at its greatest height a spit was built from the Bluff to the mouth of the Umgeni River, which opened into the original Durban Bay. Its silting up formed the Durban flat and resulted in its present course to the sea. Sea level subsidence left the old alluvial flats above sea level and several rivers formed new flats. Remains of marine wave-cut terraces occur between the Bluff and the Umbogintwini River and mark its former position.

Prof. E. M. Robinson considered "The Development of Veterinary Bacteriology in South Africa" in his presidential address to Section C. The early work on bacteriology here was noted, then special diseases were considered. The work on anthrax, including immunisation, attenuation and methods of administration were described. The gas gangrene group includes the organisms of blackquarter and the various methods of treatment were described. The usefulness of formolised vaccines against *B. welchii* and *B. œdematiens* was noted. The work on contagious abortion due to *B. abortus* and *Vibrio fœtus*, and the salmonelloses, of importance to the poultry industry, were discussed. Bovine tuberculosis is receiving attention; avian tuberculosis does not seem widespread. *C. parabotulinum bovis*, responsible for lamsiekte of cattle, was discussed and miscellaneous bacteriological conditions in domestic animals noted.

Dr. R. Broom spoke on "Evolution as the Palæontologist Sees It" in his presidential address to Section D. The hypotheses of Darwin and Lamarck were considered palæontologically. Evolution, said Dr. Broom, is not by large mutations but by almost imperceptibly slight modifications along definite lines, from small generalised forms to large highly specialised types, as is shown by a wealth of examples. The evolution of horns in fossil and modern forms was considered. Many structures that were useless developed in the past, and their owners were failures. Evolution is continuous, not backwards and forwards. About 99 per cent of all known fossil forms became specialised in some direction so that they could not adapt themselves and so perished. The Therocephalia remained small and generalised. By the middle of the Eocene all known mammalian orders were established, all small generalised types had specialised and hence no new orders of mammals could afterwards appear. The belief was expressed that a psychic and a cosmic force had been at work and that some force had restrained the specialisation of the primates, evolving a higher type of brain, and causing man to appear. As evolution has practically finished and cannot be repeated unless all higher life is wiped off the earth and a new start made, man may be the end to which some power has guided evolution.

The presidential address to Section E, by Miss D. F. Bleek, was entitled "A Survey of our Present Knowledge of Rockpaintings in South Africa". Four areas in southern Africa were delimited. The first comprises the western Cape Province, Cape Midlands and southern part of the eastern Cape Province. There are three subdivisions: the western, with pictures showing poor work, little grouping, few superpositions; the midland, with many group scenes, more superpositions and bichromes in the

latest layer; the south-eastern, less developed and mostly monochromes. The second area comprises the north-east Cape Province and foothills of the Drakensberg in Basutoland, the Free State and Natal. Caves are crowded with pictures, there are numerous superpositions, group scenes are frequent and monochromes, bichromes and polychromes are numerous. Towards the north, rock engravings replace paintings, the best being in the Transvaal. The third area, between the Kalahari and the Atlantic, has polychromes and dressed human figures of a curious type not found in areas 1 and 2. The fourth area, Southern Rhodesia, has granite as rock background, monochrome animals standing quietly, trees and plants and two types of human bodies; the workers seem to have been some branch of Bushmen. Southward migrations of different branches of the race seem to have occurred, one degenerating in art as it went, the other developing a high state of perfection.

The Rev. Prof. J. du Plessis dealt with "Missions as a Sociological Factor" in his presidential address to Section F. The influence of early missions, before the colonial era began in 1884, on the black races of Africa was considered. Before 1884, the influence of missions on the general social life of the African was in part destructive; witchcraft, poison ordeal, human sacrifice, etc., being banned. Hygiene, sanitation, clothing and housing, industry and agriculture were introduced. The educational methods of early days were open to criticism, since the English public school system was imposed on people to whom it was not applicable. Adoption of European methods of life and the social status given them by the missionaries alienated them from their people. The introduction of better food products and teaching of trades in the early days were commended. The missionary carried the gospel, but in his wake came the traders and the Government. These contacts meant change of the old social order, and the value of missions was that they enabled the native to make the transition from old to new without moral and social disaster. New culture must be grafted on the old stock of native life. Missions are still necessary as a permanent and not merely permissive factor in the evolution and uplift of the native races.

In Section A a paper was given on the determinantal properties of oblong matrices; astronomical papers dealt with the pulsation theory of Cepheid variation, Tempel's comet 1866 (1) of the Leonid meteors, and the parallax of Nova Persei, 1901. The definitions of mechanical quantities were discussed. A new type of continuously variable inductance of fixed resistance was described. A series of papers dealt with the Electricity Supply Commission, the cost of generating and distributing electricity and electrostatic capacity. Recent investigations on cosmic rays and on Wilson chamber experiments on δ-rays were described, and a note on polarised light-stress apparatus was presented. Mechanical strength of aggregates, soil erosion and its prevention, and veld reclamation were subjects of discussion.

In Section B there were several joint meetings with other sections. Papers of geological interest dealt with the problem of past climates and peculiar little rock basins at Isipingo, Natal. The essential oils of *Empleurum serratulum* and of certain veld bushes in the Cape Western Province were described, as was the chemistry of the roots of *Arctopus echinatus*, and a further contribution to knowledge of the medicinal springs of South Africa was made.

In Section C a number of papers of mycological interest dealt with *Helminthosporium* parasites of cereals and wild grasses, the genus *Hemileia*, of importance to coffee growers, aster wilt, South African Clavariæ, various new South African fungi, die-back in *Pinus insignis* and a fungal infection on a tsetse fly. Bacteriological papers were concerned with the Weil-Felix reaction in heartwater, the serological diagnosis of horse sickness and the distribution of *Azotobacter* in Transvaal soils. An ecological study of the wattle bagworm, involving the possibility of controlling the insect by salting the soil, was presented, while another paper dealt with the physico-chemical changes produced in soils by the addition of salt. A series of papers of much interest to agriculturists related to work on intensive grazing on veld, experiments with improved pastures in the coastal belt, the relation of fertiliser treatment to soil reaction under turf, a pasture study of grazing conditions on a Potgietersrust farm, and a regrouping of cultivated barleys, with suggestions on the classification of cultivated plants. A revision of the genus *Lopholœna* was given. Other papers dealt with the cytology of the pollen mother-cells of certain plants, the aims and requirements of the International Committee on plant sociology and phytopathological notes.

In Section D papers of much entomological interest dealt with the embryological development of *Euryope terminalis*, the early stages of some South African hesperids, the biocœnosis of the plant *Gnidia laxa*, the possibilities of combating wattle bagworm with insecticidal dusts, and the control of *Glossina pallidipes*. Embryological papers dealt with developmental stages in the skulls of geckos and the morphology of the skull of *Hyperolius*. Papers on the morphology and phylogenesis of the Pareiasauridæ were of interest to palæontologists. Protozoological papers dealt with new parasitic Protozoa, including new species of *Isospora* and *Eimeria* from snakes and fish, with the freshwater Rhizopoda from the Worcester District of the Cape, with new species of *Nebela* found in South Africa and with the rate of growth of gregarines. *Testudo verreauxi* was discussed as a study in variation. The ultra-violet content of South African sunlight and the effect of underground work on the erythrocyte count of miners were considered. The validity of the Polypedatidæ as an autonomous family of the Anura was considered from the detailed anatomy of a number of genera. The significance of seasonal egg production in predicting the yearly total was of much interest to farmers. Baboon crania from Cathkin Peak district were described. South African Ancylidæ and the occurrence of schistosomiasis at river mouths were discussed. Two papers of much interest and causing much discussion were given in joint meetings with other sections and dealt with biology in relation to modern civilisation and with glands in relation to personality.

Section E had papers mainly centring round prehistory and social anthropology. The prehistory of South Africa and western Europe, the Smithfield and Wilton industries, and the archæology of the Cathkin Peak district were discussed. Rock shelters and archæological sites at Isipofu near Durban and at Salisbury Commonage were described, and papers were given on prehistoric South African defences and the ancient forts at Penhalonga, Southern Rhodesia. Strandlooper middens and implements in Natal were described, the occurrence of true burins in the Cape Province was notified, and an account given of the South African cleaver or biseau. The origin and

phallic character of conical and perforated stones were discussed. Some South African Bushman paintings and rock engravings were described, and the weathering of granite in relation to such paintings was considered. The Bantu potting industry and its impact on other native potting industries in South Africa were described. Of much interest were papers dealing with the history and distribution of the bow and arrow in South Africa, the name 'Hottentot' in the records of early travellers, and the drums of the Zulu. An extraordinary Nyasaland dance mask was described. Skeletal remains from a gold prospecting trench in the Matopos were, on the whole, considered to be of Bushman origin. The results of culture contacts on the Xosa and Pondo families were reviewed.

In Section F, economists discussed the relations of currency and capital, the economics of the hire-purchase system and the scope and method of business economics. Historical papers dealt with the influence of the tsetse fly on South African history, early South African rock inscriptions, early road administration in the Cape and mining in South Africa, and a defence of Sir Benjamin D'Urban was presented. Educationists discussed the present system of vocational training, an experimental scale for measuring the attitude of the white to the native, Freudian classification of the instincts and its application to some problems of civilisation. Basic English was recommended as a foundation for bilingualism. An interesting analysis of what becomes of boys after they have left school was given. A paper of outstanding social importance dealt with education and economic condition in relation to size of family, the results embodying analysis of such in connexion with nearly 50,000 families.

The next annual meeting of the Association will be held at Barberton, under the presidency of Dr. H. Spencer Jones, in July, 1933.

H. B. FANTHAM.

The 'Butterfly' Map Projection

IN NATURE of October 22 an account was given of the "'Butterfly' Map Projection" devised by Mr. B. J. S. Cahill, of Oakland, California. To save space and to use *one* instead of *three* world maps, Mr. Cahill combined his three variants in one drawing which he referred to as a *diagram*. We regret, however, that the writer of the article in NATURE misconceived the diagram, so that his comments upon it misrepresent the character and value of the projection. In justice to Mr. Cahill we print below a condensed statement sent by him referring to the completion of the theory, tabulated computations and diagrams of his decentralised octahedral system of projection begun thirty years ago.

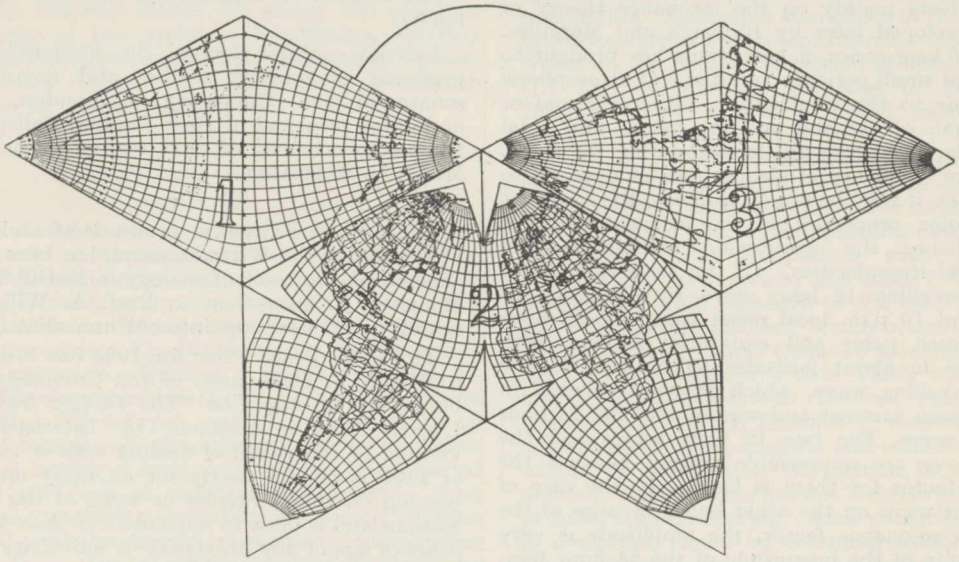

FIG. 1. Butterfly map of the world. The three variants are condensed to one diagram.

Earlier accounts published in Edinburgh 1909, Boston 1912, Gotha 1914, etc., describe a single 'maid-of-all-work' map now superseded by The Three Variants here condensed to one diagram (Fig. 1) and severally defined as to scientific quality and specific application as follows:

(1) The Orthogonal, Conformal or Orthomorphic Variant, a three-way continuum, rhombic type, for use mainly as an international meteorological base map from which local synoptic charts are cut, to be reassembled after isometrical data is added to form daily single weather maps in the interest of long range forecasting.

(2) The Authalic, Equivalent or Orthometric Variant, a land map for anthropogeographical, statistical, economic, educational and general geosophical purposes.

(3) The Gnomonic, Central or Orthodromic Variant, with double tetrahedral extensions, for geodesic, navigational and geophysical problems of sea, land, air or 'ether'. The practically undistorted eight charts of this variant are to have full topographical details. Alternate sets of four of these charts are also enlarged by encroaching on one-third of the adjacent ones to cover the facets of right and left enveloping tetrahedrons, thus yielding two sets of reciprocally overlapping expansions of

the original octants, since any octahedron can, by adding small tetrahedrons to alternate faces, be extended to positive and negative large tetrahedrons. By means of this fortunate geometrical fact the orthodromic service of this double set of tangent planes exceeds by far the service of any single plane possible.

Supplementing this variant are simple graphic diagrams for (*a*) continuing any line from chart to chart around the world, (*b*) joining any two points anywhere in one great circle, (*c*) measuring with precision all distances whether across any one, four or six charts, (*d*) converting all forward and retro-azimuths to true compass directions or vice versa to or from any point on the entire globe.

The 'Butterfly Map' is deliberately designed and mathematically detailed to meet the needs of ever growing world-wide problems and to help mankind above all things "to learn to think planetarily".

Atmospheric Tides

IN a paper entitled "Tides in the Atmosphere", in *Scientific Monthly* for August, J. Bartels gives a simple summary of our present knowledge concerning phenomena that would interest many people but for the intricate mathematics involved. He states that these tides have been studied lately by magneticians rather than by meteorologists because they assist the interpretation of terrestrial magnetic data. The main facts deserve, however, to be noted by meteorologists and others for whom this summary should, therefore, be of value.

It appears that our understanding of atmospheric tides still rests mainly on the resonance theory of Kelvin, developed later by Rayleigh and Margules. Analysis of long series of barograms has brought to light several small periodic variations of atmospheric pressure due to the tidal action, either thermal or gravitational, of the sun and the moon, and tidal theory is largely successful in accounting for them. The relative simplicity of atmospheric as opposed to oceanic tides, it may be noted, is due to the fact that the resonance properties of the atmosphere as a whole enhance the world-wide oscillations and repress local irregularities. Of the solar tides there are the travelling 12 hour wave with maxima at 10 a.m. and 10 p.m. local mean time, the 12 hour wave between polar and equatorial regions, with fixed nodes in about latitudes 35° N. and S., the 8 hour travelling wave, which shows a reversal of phase between summer and winter, and the 24 hour travelling wave. The two 12 hour waves and the 8 hour wave are appreciable mainly because the resonance factor for them is large. In the case of the 24 hour wave on the other hand, because of the very small resonance factor, the amplitude is very small in spite of the magnitude of the 24 hour temperature wave that causes it. The demonstration of the existence of the small lunar 12·4 hour and of the much smaller 24·8 hour wave is a recent success, Airy having failed to find even the 12·4 hour wave from an analysis of no fewer than 160,000 hourly observations at Greenwich. These lunar waves are simple gravitational waves owing little to resonance.

An interesting point is that the favourable resonance properties of the atmosphere for the 12 hour and 8 hour waves is apparently fortuitous. If the earth were to lose about thirty per cent of its atmosphere, none of the world-wide oscillations of pressure would be observed.

University and Educational Intelligence

BIRMINGHAM.—At a degree congregation held on December 16, the degree of D.Sc. was conferred on William Leach for numerous published papers on plant ecology and on plant physiology, especially on respiration.

Fourteen candidates also received the degree of Ph.D., namely: two each in physics, civil engineering, mining, metallurgy, and zoology, and one each in botany, chemistry, electrical engineering, and mechanical engineering.

CAMBRIDGE.—Dr. T. C. Phemister, of St. John's College, has been appointed University demonstrator in mineralogy and petrology in succession to Dr. A. G. Hutchinson, who has resigned.

Mr. C. F. A. Pantin, of Trinity College, has been nominated to use the University's table at the Zoological Station at Naples.

Dr. R. McG. Carslaw, of St. John's College, has been appointed advisory economist and head of the Farm Economics Branch.

It has been decided that in the regulations for the John Humphrey Plummer professor of inorganic chemistry, the word 'inorganic' should be replaced by 'theoretical'.

EDINBURGH.—The University Court has received with great regret intimation from Sir Edward Sharpey Schafer of his intention to retire from the chair of physiology at the end of the current academical year. He was appointed to the chair in 1899.

On the recommendation of the Senatus, Dr. J. B. Todd, lecturer in engineering, has been appointed a reader.

LONDON.—Major-General Sir Frederick Maurice, professor of military studies and member of the senate of the University of London, has been appointed principal of East London College as from the commencement of next session in succession to Mr. J. L. S. Hatton.

PROF. H. B. FANTHAM, professor of zoology in the University of the Witwatersrand, has been appointed Strathcona professor of zoology in McGill University, Montreal, in succession to Prof. A. Willey, and is taking up his new appointment immediately.

THE Cecil Peace Prize for 1932 has been awarded to Mr. A. J. Mackenzie, of the University of Edinburgh, for an essay on "The Danger from the Air. Discuss Possible Methods, by International Convention or otherwise, of dealing with it". This prize of £100 is offered yearly for an essay on a subject bearing on the principles or work of the League of Nations and is open to students less than twenty-five years of age of any university or university college in Great Britain or Northern Ireland.

THE annual meeting of the Mathematical Association will be held at the Institute of Education, Southampton Row, London, W.C.1, on January 5–6, under the presidency of Prof. G. N. Watson. Several papers will be read and a discussion on "The Study of Statistics in a School Course" will be opened by Mr. F. Sandon. The presidential address, to be delivered on January 5 at 3.45, will be entitled "The Marquis and the Land Agent: a Tale of the Eighteenth Century". Further particulars can be obtained from the Hon. Secretary, Mr. C. Pendlebury, 39 Burlington Road, Chiswick, W.4.

Calendar of Geographical Exploration

Dec. 25, 1539.—Discovery of the Amazon

Gonzalo Pizarro, brother of the conqueror of Peru, set out from Quito to find if there was truth in the rumour that beyond Quito was a land where cinnamon grew. His party crossed the snowy Cordilleras and in the valley of the Napo experienced two months of steady rain. Forest impeded their progress, so Pizarro built a ship in which Orellana was sent ahead to find food to bring back to the starving party. Orellana found none and instead of returning sailed down the Amazon to the sea. Pizarro, with the remnant of his party, returned to Quito in June, 1542. The discovery of the Amazon was dearly bought, for of Pizarro's party, 4000 Indians and 210 Spaniards perished.

Dec. 27, 1831.—Voyage of the *Beagle*

H.M.S. *Beagle* sailed from Devonport under Capt. FitzRoy to carry out surveys in South America and some islands of the Pacific and also to make chronometrical observations. The voyage became memorable because Charles Darwin was invited to accompany the expedition, which lasted nearly five years. He afterwards published his famous journal, and undoubtedly much of his subsequent work was inspired by this journey and especially by what he saw in the Galapagos Islands. (See NATURE, 128, 1065, Dec. 26, 1931.) The *Beagle* supplemented the surveys begun by King and FitzRoy in 1826–30 on the coasts between the Plate River and Chiloé; it completed the coast survey as far as Guayaquil. The Santa Cruz River was followed inland for about 250 miles to within sight of the Andes. In addition, FitzRoy visited the Paumotu Archipelago, the Society Islands, New Zealand, Australia and the Keeling Islands, in the course of his circumnavigation of the globe.

Societies and Academies

LONDON

Society of Public Analysts, Dec. 7.—J. Cecil Maby: Further notes on the identification of woods and charcoals. The characteristic structures of the charcoals of hazel, horsechestnut, hawthorn and apple were described and the difference between the 'sycomore' wood of the ancient Egyptians and English sycamore was demonstrated.—Winifred E. Smith and Edith K. Waller: The characteristics of millet oil. Whole millet seed yielded 3·9–4·7 per cent of a semi-drying oil consisting mainly of glycerides of linolic and oleic acids, and having a high acid value. It contained nearly 5 per cent of unsaponifiable matter, from which was separated a crystalline compound, melting at 285° C. and having an elementary composition differing from the 'panicol' described in 1888 by Kassner.—H. N. Griffiths, T. P. Hilditch and J. Rae: The stability of vitamin A in cod liver oil emulsions. The vitamin A potency of cod liver oil emulsions as measured by the antimony trichloride test and spectrographic examination, showed no appreciable decrease (as compared with the original oil) for at least four months. At six months there was evidence of some change, but chiefly in the original oil. If kept in well-stoppered amber glass bottles in the dark, cod liver oil emulsions could probably be kept without appreciable alteration for seven or eight months. Development of acidity in emulsified oils is attributed to the presence in minute quantity of a lipoclastic anærobic organism.—E. Lester Smith: The validity of the Lovibond tintometer method in the assay of vitamin A. A suitable technique for making accurate measurements of the blue coloration in the antimony trichloride test by means of the Lovibond tintometer was described; the results thus obtained agree closely with the vitamin A potency of an oil, as measured by the spectrographic method.—A. L. Bacharach, E. Lester Smith and S. G. Stevenson: Some physical and chemical properties of ergosterol and calciferol. An outline was given of the probable constitution of ergosterol and its derivative calciferol, and the melting points, optical rotation and other physical and chemical properties of the two compounds were tabulated.

EDINBURGH

Royal Society, Dec. 5.—A. G. Hutchison: The metamorphism of the Deeside Limestone, Aberdeenshire. This limestone, which Prof. Read has correlated with the Loch Tay limestone of the Central Highland Dalradian succession, is in the sillimanite grade of regional metamorphism. The occurrence of plagioclase felspars more basic than oligoclase distinguishes it from the Loch Tay diopside limestones of the almandine zone. Contact metamorphism by newer granites produces hornfelses referable to Goldschmidt's classes 7–10, and unstable types. Subsequent pneumatolytic and hydrothermal action accounts for pegmatites and limestone with scapolite, prehnite, zeolites, etc. The order of formation of minerals in the hydrothermal phase with falling temperature is grossular (doubly-refracting), zoisite-epidote, albite, prehnite, analcite, thomsonite and apophyllite. Successive alterations of the interbedded greenstone series are also considered.—Mary G. Calder: Notes on the Kidston collection of fossil plant slides, (1.) The anatomy of the axis of *Lepidodendron Brownii* Unger sp., with special reference to the relationship between this stem and *Lepidostrobus Brownii* Unger sp. A previous description by Prof. Chodat in 1911, having been made from a single transverse section, does not mention certain important features of the pith, xylem, phloem, outer cortex and leaf-traces. The comparison with *Lepidostrobus Brownii* has been revised and more fully discussed, particularly with reference to the cone pedicels, not known to Prof. Chodat, which were described by Zeiller in 1911. Prof. Chodat's identification of the stem as the vegetative axis which bore the cones known as *Lepidostrobus Brownii* receives further confirmation.—W. J. Hamilton: Restoration and regeneration of the epithelium and endometrium of the uterus of *Cavia* after parturition in non-pregnant animals. This process has not hitherto been described in detail in the guinea pig. After parturition the uterus is completely lined by columnar epithelium except where the placental pedicle was attached. This site becomes a cleft filled with organised blood-clot over which new epithelium grows. The old epithelium is shed from the rest of the uterus and new epithelium formed from gland mouths, consisting first of flattened cells which become cuboidal and ultimately columnar. Below the union of the uterine horns restoration is by the superficial endometrial mesodermic cells becoming epithelial. *Pari passu* the endometrium is restored from a fibrous to a cellular structure.—H. Briggs and R. P. Sinha: Expansion and contraction of coal caused respectively by the sorption and discharge of gas. Small but definite linear expansions in eight varieties of coal, in consequence of their

contact with methane or carbon dioxide under pressure, were measured by the authors and shown graphically. Pressures ranged from zero to 300 lb. per sq. in. The coal specimens were prepared in prisms about 75 mm. long, and the specimens included two of anthracite, two of durain, three of clarain (mixed durain and vitrain) and one of impure cannel. The physical reaction in most cases took a long time to reach completion; though small, it is definite and apparently reversible. The effect of adsorbed moisture was briefly discussed. The corresponding changes due to dry coal adsorbing moisture had yet to be investigated.—W. O. Kermack, W. H. McCrea, and E. T. Whittaker: On properties of null geodesics, and their application to the theory of radiation. The conception of a transport vector along a null geodesic is employed first to derive a new general definition of spatial distance, and secondly to derive a new invariant depending on two neighbouring null geodesics. The latter is used to obtain a general formula for the Doppler effect in general relativity. The same result holds for propagation by waves and by light quanta. The Doppler effect vanishes for two systems at relative rest, with a very general definition of relative rest. Some special cases are worked out in detail.—L. T. Hogben: A matrix notation for Mendelian populations. By the use of a matrix notation the unwieldiness of expressions encountered in the theory of consanguineous unions, systems of inbreeding and correlation of relatives when transmission is sex-linked can be avoided. The appropriate operations are defined and illustrated by application to known theorems of inbreeding and a series of new theorems concerning consanguineous matings are given.—A. C. Aitken: Graduation of data by the orthogonal polynomials of least squares. In the fitting of polynomial curves to equidistant data the use of the orthogonal polynomials of Tchebychef is known to possess great advantages. The author develops the properties of these polynomials, gives new forms for them, and introduces new arithmetical methods depending on repeated central summation.

CRACOW

Polish Academy of Science and Letters, Oct. 10.—W. Swietoslawski: A universal boiling point apparatus and its application. By means of this apparatus the following three temperatures may be determined: the boiling point of the liquid (solution), the condensation temperature of the first bulb of the fractionating column, and that of the condensation after the vapours have been fractionated.—W. Swietoslawski, Mlles. A. Dorabialska and E. Turska: The spontaneous emission of neutrons by certain non-radioactive elements. The analysis of the table of the known elements shews that the α-, β- and H-transformations cannot explain the production of the existing isotopes, without admitting the possibility of the emission of neutrons. Attempts at proving the decomposition of elements with production of neutrons have resulted in the proof of neutron emission in the cases of sodium fluoride and metallic arsenic.—J. Biborski: The histological structure of the veins of the frog, *Rana esculenta*.—S. Sekutowicz: Studies on the development and the biology of *Caryophyllaeus laticeps*.—Z. Raabe: Researches on certain species of the genus *Conchophthirus* Stein.—J. Jakobiec and T. Marchlewski: The influence of repeated connexion between closely related animals on the biological characters and the commercial value of the domestic pig.

SYDNEY

Linnean Society of New South Wales, Sept. 28.—J. McLuckie and A. Burgess: Mycotrophism in the Rutaceae. (1) The mycorrhiza of *Eriostemon Crowei* F.v.M. Two fungi are recorded as occurring in the young roots. One is a phycomycetous form giving rise to arbuscules and vesicles, the other, a moniloid type resembling *Rhizoctonia*. This affords confirmation of Peyronel's double infection theory. From a physiological point of view the former is more important. Large quantities of fatty substances accumulate in its hyphae and are afterwards transferred to the host, thus augmenting its carbonaceous supplies. In addition 'vesicles' are formed. These contain numerous nuclei and are packed with fat. Later the contents are withdrawn and the structures collapse. It is suggested that these are reproductive bodies the functions of which have been interrupted.—G. H. Hardy: Two new Australian species of *Pollenia*. One Victorian and one Queensland species of the genus are described and their genitalia figured.—G. H. Cunningham: The Gasteromycetes of Australasia. (15) The genera *Mesophellia* and *Castoreum*. Both genera are members of the Lycoperdaceae, though differing sufficiently from other genera placed therein to warrant the erection of a third tribe to contain them. *Mesophellia* contains two or possibly three species, namely *M. arenaria*, *M. pachythrix* and *M. castanea*, which are confined to Australia and Tasmania. *Castoreum* likewise contains three species, *C. radicatum*, *C. avellaneum* and *C. cretaceum*, also endemic to Australia and Tasmania.

Royal Society of New South Wales, Oct. 5.—F. W. Booker: Note on the internal structure of *Barrandella* and *Sieberella*. The descriptions of *Barrandella linguifer*, Sowerby, and *Sieberella galeata*, Dalman are amended and a comparison with *Barrandina Wilkinson* and *B. minor*, is made.

Forthcoming Events

TUESDAY, DEC. 27

ROYAL INSTITUTION, at 3.—(Christmas Lectures). Prof. A. O. Rankine: "The Round of the Waters" (succeeding lectures on Dec. 29, 31 and Jan. 3, 5 and 7).

Official Publications Received

GREAT BRITAIN AND IRELAND

Department of Scientific and Industrial Research. Report of the Radio Research Board for the Year 1931. Pp. iv+123. (London: H. M. Stationery Office.) 2*s*. net.

The Quarterly Journal of the Geological Society of London. No. 352, Vol. 88, Part 4. Pp. 515–711+plates 31–46. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

List of Geological Literature added to the Geological Society's Library during the Year ended December 31st, 1931. Pp. iv+303. (London: Geological Society.) 10*s*.

The Journal of the Board of Greenkeeping Research. Vol. 2, No. 7, Autumn 1932. Pp. 223–302+viii+4 plates. (Bingley: St. Ives Research Station.) 2*s*. 6*d*.

OTHER COUNTRIES

Field Museum of Natural History. Geology Leaflet 13: The Geological History and Evolution of the Horse. By Elmer S. Riggs. Pp. 54+19 plates. (Chicago.) 40 cents.

U.S. Department of Commerce: Bureau of Standards. Miscellaneous Publication No. 138: Annual Report of the Director of the Bureau of Standards to the Secretary of Commerce for the Fiscal Year ended June 30, 1932. Pp. ii+40. 10 cents. Bureau of Standards Journal of Research, Vol. 9, No. 5, November, Research Papers Nos. 493–500. Pp. 583–709. 25 cents. (Washington, D.C.: Government Printing Office.)

Smithsonian Institution: United States National Museum. Bulletin 158: The Copepods of the Woods Hole Region, Massachusetts. By Charles Branch Wilson. Pp. xix+635+41 plates. (Washington D.C.: Government Printing Office.) 75 cents.