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Science and Humanism.

IT is sometimes instructive, sometimes amusing, but always interesting "to see ourselves as others see us," even when we think that their view is distorted. To the January issue of the *Nineteenth Century and After*, Mr. G. R. Stirling Taylor contributes an article entitled "The Age of Science," in which he advances criticisms of science and scientific men that are intended to represent the views of the intelligent man in the street. Starting with the assumption that science has dominated the world during the past 100-150 years (he really means the applications of science), he asks whether that domination has been good for man, or whether in harnessing Nature man has not also harnessed himself.

The steam-engine has led to the individual being subordinated to the machine; village life, with its sunshine and fresh air, has been largely replaced by industrial centres, with their slums, their polluted atmosphere, and their noise; and the electric telegraph has caused power to be concentrated in the hands of centralised groups of individuals. In a very real sense the late War was a war conducted by science—by the engineer, the chemist, and the physicist—and for the next war preparations are being made that "may blot out civilisation in a few months at longest." That much good has been done by science, and particularly by medicine, is not denied; but many of the ills that have been cured by it are the result of conditions which science itself has caused. Cold storage has increased our gastronomic temptations and made possible gross profiteering by the holding up of provisions.

Although the man of science may contend that such misapplications of science as chemical warfare are solely the responsibility of those who authorise their practice, the plain man, who cares nought for idealist intentions and is interested only in practical results, will saddle him with the blame: to turn loose a poison gas that may annihilate a city is, in its practical outcome, as immoral as to arm a crowd of drunken savages with knives and revolvers. May not a scientific man with an uncontrolled passion for truth (that is, discovery) be as dangerous as a man who has an unbalanced desire for alcohol?

Mr. Stirling Taylor then institutes a comparison of the man of science with the man of religion. Unlike the former, the priest has never made the amazing blunder of putting material truth in the centre of his altar, and he has never quite forgotten that human welfare is the chief end of life. The laws of both are dogmas, and the plain man will prefer such an unprovable dogma as that there is a God who

commands us to do right, to the logically water-tight dogma that a certain chemical procedure will split the atom and blow the world to pieces. "By their fruits ye shall know them," and the real test of the value of science is whether the men who work the machines and live round the factory are the better or the worse for its help and presence. Like the French revolutionists of the Reign of Terror, science has admirable intentions; it is the result which has been so disastrous.

Mr. Stirling Taylor's strictures on the evils accompanying industrial development, due mainly to the applications of science, are not novel; and although they are not entirely without a basis of fact, they certainly lack that very balance which he describes as the secret of life. On the material side he omits a host of directions in which the applications of science have proved beneficial, and he concentrates chiefly on certain unpleasant developments which first became prominent during the War. Throughout his article, he fails to discriminate between the discoverer and the inventor: the man who searches for new things and the man who applies them to human purposes.

In their ethical aspect, human acts can be classified as moral, immoral, or amoral, although the dividing line is not always easy to draw. "A good work of art," said Goethe, "may and will have moral results, but to require of the artist a moral aim is to spoil his work." Whatever view one may take as to the truth of this dictum in the sphere of art, we believe that the first part of it does not apply to science, and that a good piece of scientific work belongs strictly to the amoral category. On the other hand, the latter part of the dictum is certainly applicable: the searcher after truth of all kinds must go forward regardless of consequences, at any rate within the confines of his laboratory or study. The plain man, however, will argue that the social effect of an action cannot be overlooked, even if its morality is determined mainly by the intention behind it; and to this extent we think that Mr. Stirling Taylor is right in stating that a great responsibility falls upon those who discover potential weapons of inhuman warfare; although much greater responsibility must rest with those who use or sanction the use of these weapons. The intelligent man in the street must see that to abandon investigations on lethal weapons while other nations pursue them is to court disaster, if not extinction. However much we may detest these weapons, the calls of home, of country, and of Empire must come first. In these circumstances the responsibility of the scientific workers concerned appears to be confined to the observance of strict secrecy in their work. In almost every other sphere of scientific activity, freedom in publication is essential; but in this case both morality and national security demand that it should be taboo.

The best reply to Mr. Stirling Taylor's article, which deals exclusively with the material applications of science, is supplied by the presidential address, entitled "Science and the New Humanism," which was delivered by the Right Rev. C. W. Barnes, Bishop of Birmingham, to the Science Masters' Association (and will appear in the February issue of the *School Science Review*). In Dr. Barnes' opinion, science has changed the whole background of our thought by giving us a new knowledge of man's origin and place in the universe. Every branch of human thought feels the influence of the new knowledge. The outlook of our grandparents, the postulates of their thinking, have become incredibly remote. Despite certain ills following in the wake of industrial applications, science is ultimately beneficent and not brutal. As an instrument of education, modern science cannot replace what are traditionally called the humane studies; yet knowledge of scientific truth and appreciation of scientific method are indispensable to all, because they are the foundation of modern humanism, and without them human thought would progressively degenerate. Science has practically freed the civilised world from the thraldom of base superstition; it has banished irrational fear; and it has purified religious thought.

The intelligence of civilised man is the outcome of from one to two million years of human and sub-human growth. Not merely do animal instincts and passions survive in us, but the structure of our mind retains traces of an animal past. In times of emotional upset, such as during the War, primitive mental processes assert their vitality; and we go back to the second century of our era to find a parallel to the crazy necromancy, astrology, and magic that flourish to-day. The principle of evolution is now firmly established—as the world's laughter at Tennessee has amply demonstrated. Originally a biological theory, it is now the unifying factor in anthropology, and its influence on psychology is great and growing. Evolutionary psychology and anthropology have given us a more penetrating insight into human civilisation, and in due time they will enable mankind to strengthen his social fabric.

Although science cannot answer ultimate questions concerning matters outside the realm of physical and biological phenomena, it can lead us within that realm from error to truth, from phantasy to fact; and it is on the truth which science has revealed, and is revealing, that we are building the new humanism of our age.

Ideas of God in the Religions of the World.

The Attributes of God: the Gifford Lectures delivered in the University of St. Andrews in the Year 1924–25. By Lewis Richard Farnell. Pp. x+283. (Oxford: Clarendon Press; London: Oxford University Press, 1925.) 12*s.* 6*d.* net.

DR. FARNELL'S title is reminiscent of the lofty flights of Scholastic or Puritan divines, but his actual mode of procedure is at once more modest and more modern. It is, in fact, the historical and comparative method which he has already so successfully employed in his "Greece and Babylon" and "The Evolution of Religion." The aim and scope of these lectures, he tells us, is "not so much the problems of the philosophy of religion, but a review of the qualities and activities attributed to God in the religions that are living and have lived," the material for study being the religious literature of the world and to some extent religious art. He therefore proposes to deal "only with the philosophic thought that has borne fruit in real popular belief, not with that which may have only worked in the solitary brain of the eccentric thinker"; and as he several times records his conviction that "a religion without a personal god has not yet been found to be a living and enduring force," the survey is practically limited to beliefs of a theistic type. Buddhism, as a popular religion, he holds to be only an apparent exception to the dictum just quoted, but he does not draw upon it for his materials.

Within the limits indicated, Dr. Farnell offers us in this volume from the wealth of his knowledge a fascinating comparative survey of the main aspects in which men have conceived their deities. For belief in a personal god is by no means to be interpreted as equivalent to pure monotheism, and the chapter on "Polytheism and Monotheism" is one of the most interesting in the book. "The only monotheisms, pure, unmixed, and alive, are Judaism and Islamism," while in the past we have the creed of Ikhnaton, the reforming king of Egypt, and possibly the teaching of Zarathustra in its original form. As regards Christianity, Dr. Farnell says "the current popular religion of Europe should be rather described as a high spiritual polytheism tempered and restrained by the Athanasian Creed," while the cult of the Virgin and the saints reminds us that "Mediterranean polytheism was never permanently overthrown, and that many of its fibres survive in the soil of our orthodox Christianity." Similarly he notes that among the higher world-religions the only two that have remained consistently non-idolatrous are the Judaic and the Islamic. The early Christian church "upheld for a time the Judaic ideal, but the spirit of the Hellenic and Mediterranean idol-lover triumphed soon over the spirit of Moses; the resistance of the Byzantine iconoclastic emperors was futile; and the popular religion of Christendom, except within the shrinking borders of Puritan Protestantism, must to-day be called idolatrous." But, as might be expected from the author of "Cults of the Greek States," Dr. Farnell does full justice to the nobler side of "Hellenic idolatry" and its important contributions to religion as well as to art. He emphasises in another connexion the fact that, while wisdom in other religions is exalted as a divine attribute and God's highest gift to men, this is always understood in a moral-religious sense; only in Greek religion do we find the consecration of knowledge as such, the recognition of the life of the thinker and the man of science as divinely inspired and a reflection of the divine activity.

Nature-worship and tribal religion are dealt with in separate chapters, and the progress traced from tribal particularism to the conception of a universal God. A long chapter is devoted to "the moral attributes of God" and another to the attribute of power, while the concluding chapter, on "the metaphysical attributes," leads inevitably to some discussion of the problems of the philosophy of religion, which the author began by setting aside. Power is the earliest attribute of the divine: "the gods or the spirits are imagined as powerful before they are recognised as beneficent or just." With the development of monotheism the divine power is characterised as omnipotence, conceived at an early stage as the omnipotence of an arbitrary despot, but eventually as manifested in the law and order of the universe. The question of miracles and of the real validity and religious value of prayer is shortly discussed in this connexion, and Dr. Farnell recognises here, as elsewhere, "the wide cleavage that at present exists between the highest theistic thought and the popular religion."

In the concluding chapter Dr. Farnell dismisses as valueless for religion the philosophical conception of the absolute, if understood as "the All-in-All of the Universe." "Worship, the accompaniment of all active religion, and Love, the essence of the highest, seem both impossible and irrelevant to the impersonal All-in-All, besides which there is no other." He criticises the metaphysical attributes of eternity and immutability, commonly accepted in philosophical and religious thought as characteristic of the divine. Timelessness, he holds, is inconsistent with creation, and the changeful is not necessarily the imperfect. "If we could imagine an unending series of changes from one perfect state to another, we should not view it with regret; each succeeding state of being or phase of creation might be new but none the less perfect, and

the sense of change might become an added joy." The final riddle, how to reconcile the existence of the evil and pain in the world with the ideal of an omnipotent and beneficent God, Dr. Farnell pronounces to be insoluble. After quoting a sentence of Lotze to that effect, he adds: "'Though he slay me, yet will I trust in him' is the highest religious expression for this self-abnegation of the intellect. And this may well be the last word of wisdom." But although such a conclusion may be forced upon us, such self-abnegation is far from being, in his view, a thing to be gloried in; as he puts it on his last page, "a religion that makes intellectual assumptions incurs intellectual obligations, and cannot admit the claim, occasionally made in our pulpits, that incoherence and self-contradiction are proofs of the highest truth."

Steam Condensing Plants.

(1) *Modern Practice in Steam Condensing Plants: a Practical Treatise.* By Arthur R. Wright. Pp. xv + 309 + vi. (London: Crosby Lockwood and Son, 1925.) 45*s.* net.

(2) *Steam Condensing Plant in Theory and Practice.* By James Sim. Pp. xiii + 271. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1925.) 18*s.* 6*d.* net.

HITHERTO the subject of steam condensing plants has not received the attention to which its importance in the achievement of efficient power production entitles it. Difficulties have confronted the student of the subject. In the first place, research has yet much to accomplish in this direction, and further, such information as was available was not in the most accessible form, being principally confined to papers and articles which have appeared sporadically.

Now, almost simultaneously, two books appear, both making a commendable attempt to deal comprehensively with the whole field, and collect the available facts into a form which will be useful to those seeking information on the subject. Both have succeeded extremely well on different lines. One is principally useful for its descriptiveness and its collection of information and references, and the other for its analytical and mathematical treatment of the physics of the subject. Neither touches upon the considerable development which has recently been made in condensers for turbine-driven locomotives, but, presumably, it has been considered that that development, being almost exclusively Continental in origin, is not as yet of interest to the British engineer. Apart from that fact, comprehensiveness is a marked feature in each volume, and, unlike the majority of technical books, they fill a real gap in the library of technical literature.

(1) Mr. A. R. Wright commences his work at the root of the subject by stating in the opening chapter fundamental laws and the properties of steam, but it is unfortunate that the arithmetical errors in the examples given will tend to confuse the novitiate who finds this chapter necessary, and at the same time will create a bad first impression.

The various factors affecting the transmission of heat through condenser tubes are separately discussed and the work of accredited experimenters is effectively summarised. Analysis of their findings is not attempted, but the diagram showing collectively the results of the best known experimenters regarding the effect of cooling water velocity on the rate of heat transmission through tubes is useful. The merits of the various types of jet condenser, high and low level, counter and parallel flow and their adaptability to conditions, are well set out. Ejector, injector, exhaust steam induction and evaporative condensers are similarly dealt with and discussed, in all cases with good diagrams and illustrations. The principles of the operation of cooling ponds and towers are explained, and it is shown that the former will rarely be preferred to the latter. This is an excellent chapter and an exceedingly welcome contribution.

The functions and requirements of the surface condenser and the application of the laws of heat transmission thereto are next dealt with. A good selection of types are illustrated, but in their description, otherwise good, more attention might have been directed to the effect of baffles in maintaining the condensate temperature and to the features aiming at reducing resistance to steam flow across the tubes. Tube corrosion and its prevention are only briefly referred to, but, of course, this is a major problem in itself. The treatment of those important auxiliaries—the air and condensate extraction pumps—is appropriately thorough. Air pumps of every type, reciprocating, steam jet, water jet, rotating jet, and combinations of these, with and without intercoolers and after-coolers, are capably described. The circulating pump, not being exclusively a condenser auxiliary, receives less attention, but its functions and requirements are explained. Brief reference is made to de-aerators, oil separators, vacuum breakers, relief valves, etc. The note on commercial considerations in the choice of plant might have proved a valuable contribution, but the costs given are pre-War, and consequently have not much present-day value, even relatively to each other.

The mathematical treatment is perhaps purposely of an elementary nature, but it requires some revision, and the diagrams in the appendix also require a little attention, while a future edition could with advantage include statements of the performances of actual installations, properly correlated and compared. The

book is very well illustrated and is a splendid compendium of the various forms and functions of apparatus relating to the condensation of steam, while the copious references to further sources of information are of great value.

(2) Although the preface states that Mr. Sim's book is written for students, it will have a much wider field than that implies, for on this subject many engineers are much in need of sound information such as is contained in this volume. The book may be summarised as a thoroughly sound application of known physical facts to the design of steam condensing plant. It deals with surface, jet, ejector, and evaporative condensers, air pumps and air ejectors, centrifugal pumps for condensate extraction and for supplying cooling water, evaporators and feed water heaters, in regard to each of which a sound method of design and much valuable data are given, while feed water systems and de-aerators and details appertaining thereto are fully discussed. In all cases some useful examples of the products of well-known manufacturers are illustrated and described. Surface condensers are properly considered the most important, and in dealing with the factors affecting the rate of transmission of heat through the walls of the tubes, the method has wisely been adopted of regarding the resistance to heat flow as being composed of individual resistances which can be separately treated. Data for determining the values of these various resistances are given, and since these data are said to agree with the author's practical experience, which must be exceptionally wide, they should be of great utility. It is true that the figures given for the greatest resistance, that on the steam side of the tube, have a wide variation (in one case the maximum value is twice the minimum), but, in order to cover the great variety of practical conditions, this is unavoidable in a general treatment of this kind.

The selection of a proportion of the known total resistance to be allocated to each separate cause is probably of a somewhat arbitrary nature, unavoidable in the present state of knowledge, but it would appear that the arbitrariness is carried a little further than is necessary. For example, it is not clear why the resistance at the surface of separation of the tube wall and the cooling water should be different in a brass condenser tube and a copper feed heater tube of the same bore, or why this resistance should be different with a thin copper tube and a thick copper tube; again, in regard to the resistance across the tube wall itself, a brass condenser tube 0·048 in. thick has a value of 0·08 ascribed to it, while a copper feed water heater tube 0·064 in. thick has, in the same units, a value of 0·3—several times that estimated with regard to the respective conductivities and dimensions. If there are reasons for these apparent discrepancies, the student would prefer to know them. These comments are made rather in response to the prefatorial request for suggestions than in criticism or lack of appreciation of the general value of the work.

Useful data are given for determining the head necessary to overcome the resistance to flow of cooling water through condenser tubes, pipes, etc. The design of air coolers, their influence on the capacity of the associated air pumps, etc., and the conditions under which their adoption is justified, are lucidly explained. A useful coefficient of condenser performance is suggested involving the terminal temperatures of the steam and cooling water. Air pumps and air ejectors receive the attention their importance demands, and again good methods and useful data are given for determining their proportions to suit the service required.

The mathematical treatment is sound throughout and presented in such a form as to be readily assimilated, while numerous examples are worked out to show practical applications. Instructive examples are also given to indicate how data can be analysed to detect the functioning of an existing apparatus, but that in which the dryness of the engine exhaust is deduced from the condenser temperatures should have been accompanied by a note of warning. The corrosion of condenser tubes is a matter not touched upon, and although it is too wide a subject for full treatment in a general work of this kind, some reference to it, however brief, would be an improvement.

The general value of this publication may be gathered from the fact that in it there is the necessary matter to enable any one skilled in the art to undertake the rational design of condensers and their auxiliaries to meet the ordinary requirements of practice.

L. M. D.

The German Outwash Terraces and the Astronomical Theory of the Ice Age.

Die Gliederung und absolute Zeitrechnung des Eiszeitalters. Von Prof. Dr. W. Soergel. (Fortschritte der Geologie und Paläontologie, Heft 13.) Pp. vi+125-251+3 Tafeln. (Berlin: Gebrüder Borntraeger, 1925.) 8·25 gold marks.

THE revision of the astronomical theory of the Ice Age, usually associated with the names of Adhémar and Croll, and its recasting in a form which seems to show considerable correspondence with the observed facts of geology,[1] has led Prof. Soergel to attempt an interpretation, in terms of this theory, of the complex terrace system of certain German rivers.

[1] W. Köppen und A. Wegener, "Die Klimate der geologischen Vorzeit." Berlin, 1924.

The Köppen-Wegener curves for the secular variation in summer sunshine for latitudes 55°-65° show four well-marked double minima, corresponding to the four ice ages of the Alps, Günz, Mindel, Riss and Würm, and three intervening periods of variable but on the whole warmer conditions, supposed to be identical with the interglacial periods. The double character of the minima and the excessive length of the middle interglacial period give some grounds for confidence, for it will be remembered that Penck established on geological evidence a double maximum for the Würm Ice Age and proved that the Mindel-Riss Interglacial Period was several times as long as those which preceded and followed it.

Now the valleys stretching away from the Alps exhibit a fourfold terrace system, one terrace for each glaciation, but when we come to the river valleys containing the outwash terraces of the northern glaciation, we find a much more complex state of affairs. Here there are, according to Prof. Soergel's reading, ten

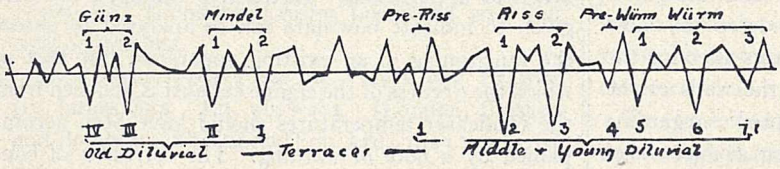

FIG. 1.—Comparison of the terraces of the Ilm with the astronomically calculated curve of summer sun-heat.

terraces, nine of which yield a cold fauna and one a temperate fauna. Eight of these terraces are accommodated by the four double minima corresponding to the Alpine Ice Ages. The curve of summer sun-heat shows, however, in addition to these, many other minima, four of which, though considerably less than those of the Ice Ages, are greater than the others (Fig. 1). They occupy positions as follows: (*a*) Pre-Günz, (*b*) Pre-Riss, (*c*) Pre-Würm, (*d*) Post-Würm (or Würm 3). The Pre-Günz minimum is supposed to be inoperative, the pole being at that time too distant. To the Pre-Riss and Pre-Würm are ascribed the two "supernumerary" terraces, that with the temperate fauna falling on the Pre-Riss. To the Post-Würm minimum are attributed the Bühl stadium of the Alps and the Baltic re-advance of the northern glaciation. There is no terrace in the German river valleys corresponding to this last minimum. An explanation of this failure is promised on p. 199 [75], but the reviewer has been unable to find it in the subsequent text.

A further test of the equivalence of the astronomical and geological records is applied by estimating the erosion which took place between the formation of the terraces, and comparing this with the lengths of the astronomically calculated interglacial periods. No direct relation is observable, and various factors are mentioned as likely to cause abnormalities in this respect. Of these, the most satisfactory is the occurrence of excessive maxima of sun-heat in certain periods in which the erosion is greater than the duration of the period might seem to justify. Crustal movements, changes of sea-level, and hardness of rock are also considered to have an effect, which is, however, less easy to assess.

It is difficult at the present moment to form any well-founded opinion on the merits of an attempt of this sort. One reads it with the fear that it is perhaps merely a renewal of the reckless "pigeon-holing" or fitting of facts into an artificially prepared scheme, which was carried to such extremes by James Geikie and his followers. On the other hand, the scheme on this occasion seems to be based on a securer foundation, and there is a fair amount of fitting between the facts and the theory. It is questionable, however, if this appearance of agreement is beyond the possibilities of coincidence, and the confidence of the reader is far from being reinforced by constantly recurring assertions regarding the conclusiveness of the argument.

The essential portion of the book is followed by a discussion of the importance for geology, palæontology, and archæology of an absolute time scale of this kind. Probable dates in years are assigned to the Palæolithic stages, the chronology of Penck being followed approximately, and the Chelléen being regarded as belonging to the Mindel Riss instead of to the Riss-Würm, where it is placed by Obermaier and the Abbé Breuil. This section is interesting, but the treatise as a whole seems quite unnecessarily prolix, and might with advantage be condensed into half the space. W. B. WRIGHT.

Fœtal Monkeys.

Angola et Rhodesia (1912–14). *Mission Rohan-Chabot sous les auspices du Ministère de l'Instruction publique et de la Société de Géographie.* Tome 4: *Histoire naturelle.* Fascicule 1: Mammifères (Anatomie comparée, embryologie); oiseaux, reptiles, poissons. Pp. viii+176+18 planches. (Paris: Paul Geuthner, 1923.) n.p.

THIS fascicule contains a systematic account of the birds, reptiles, and fishes collected in Angola and Rhodesia by M. de Rohan-Chabot in 1912–14. But the major portion of the volume is devoted to a report upon the anatomy of two fœtal baboons. The special value and significance of this investigation are due to the fact that it was carried out at the Laboratory

of Comparative Anatomy of the Natural History Museum in Paris by such competent and experienced anatomists as Profs. R. Anthony and F. Villemin.

The memoir represents a good deal more than the mere description of the two fœtuses of the Chacma baboon, and the bones of their respective mothers. The authors have collected all that is known of the anatomy of the viscera and skeleton in fœtal monkeys and apes, so that their report forms a very useful and important addition to our knowledge of the comparative anatomy and embryology of the Primates. Moreover, they have directed attention to several very suggestive and novel problems involving the correlation of function with morphology. It is not possible within the compass of this notice to summarise all the provocative hypotheses they put forward in a tentative way. Hence I must content myself with a reference to one of them.

While the fœtal kidney in man is lobulated, those of the tailed monkeys and lemurs are smooth, and the condition found in the anthropoid apes is intermediate between the catarrhine and the human. Discussing this curious phenomenon, the authors invoke the influences of climatic conditions and size of body as factors that play a part in causing lobulation. In 1922 Prof. Anthony discussed the reasons for the persistence into the adult stage of obvious lobulation of the kidney in such mammals as whales, elephants, bears, etc.; and he put forward the suggestion that the reduction of the relative extent of the skin (and of the ability to get rid of waste products by sweating) in proportion to the bulk of the body in large creatures was compensated by the increased activity of a kidney broken up into a large number of lobes. The fact that certain small mammals also have lobulated kidneys he explained by the fact that they live in cold climates, which reduces the sudorific activities of their skin.

In this memoir the authors attempt to apply these hypotheses to explain the conditions found in the Primates. In man and the giant anthropoids the great size of the body is a reason for lobulation of the kidney, which is less pronounced in the apes because they live exclusively in tropical climates. The authors state that in fœtal negroes from Africa the lobulation is less pronounced than it is in Europeans, and claim that this resemblance to the anthropoids is due to the fact that, like the latter, the kidneys of these tropical Africans have been influenced by the climatic conditions under which they live.

Such far-reaching conclusions obviously call for a wider basis of evidence than is yet available before they can be accepted as the true interpretation of the facts.

G. ELLIOT SMITH.

Our Bookshelf.

Structure des molécules. Par Prof. Victor Henri. 1: Polarité des molécules; 2: Structure des molécules déterminée par les rayons X; 3: Spectres d'absorption des vapeurs et structure des molécules; 4: Prédissociation des molécules; 5: Structure du benzène et de ses dérivés. Conférences faites au laboratoire de Ch. Moureu et à la Société de Chimie physique. (Publications de la Société de Chimie physique, 12.) Pp. ii+122+1 planche. (Paris: J. Hermann, 1925.) 20 francs.

Now that our knowledge of the structure of the atom is beginning to be very definite, it is natural to turn to the molecule. Here a much more complex problem presents itself, but, of recent years, several promising lines of investigation have been developed. As is to be expected, stress is laid on the interpretation of absorption spectra, a subject which Prof. Henri has made peculiarly his own. These spectra are exceedingly complicated, but it is now possible in many cases to identify the separate effects of the rotation of the molecule, the vibrations of the component atoms and the movements of the electrons. From these measurements it is possible to calculate the energy of the molecule in its various states of activation. Emphasis is laid on one important general result among others: that while in the normal state and the early states of activation the rotation movements of the molecule are subject to quantum restrictions, at a certain stage of activation this quantisation ceases. To this state Prof. Henri gives the name "predissociation" and claims that it is the necessary prelude to chemical action and combination

In a short chapter devoted to X-rays and molecular structure the author is clearly on less familiar ground. Here a few errors have crept in, notably in his discussion of the symmetry of the benzene ring, where he misquotes Bragg as suggesting a model with symmetry properties which are actually mathematically impossible. The first chapter gives a lucid account of the electrical moments of molecules, while the final chapter is devoted to the vexed question of the structure of the benzene ring. A new suggestion is made which the author claims is in better agreement with the facts that are at present known than any of the older models. The book contains a very useful summary of the recent methods of attack on the question of molecular structure, and the reader can scarcely fail to be interested in and impressed by the progress made on a problem which only a few years ago appeared almost impossibly complicated.

Public Health in Theory and Practice: an Historical Review. By Dr. William Henry Welch. Pp. viii+51. (New Haven: Yale University Press; London: Oxford University Press, 1925.) 4*s.* 6*d.* net.

THIS little book, which is the eighth work published by the Yale University Press on the Williams Memorial Publication Fund, is the second annual lecture in commemoration of William Thompson Sedgwick, the pioneer in American hygiene, a memorial volume to whom we noticed in our issue of March 14, 1925, p. 372. Dr. William Welch, who is Director of the School of Hygiene and Public Health at Johns Hopkins University,

Baltimore, shows that the justice of Sedgwick's claim that "the sanitarian needs a proper working theory" has been well illustrated in the history of preventive medicine, especially in the work of Fracastorius, Sydenham, Jenner, Sir George Baker, James Lind, Sir John Simon, and Pasteur. It is pointed out that inadequate and even erroneous theories which bear some relation to the state of contemporary knowledge may serve a useful purpose, as was exemplified by the doctrine of the so-called "filth theory" of the generation of epidemic diseases, especially typhus, typhoid, and dysentery, inasmuch as the acceptance of this theory led to a campaign for the supply of pure water, the proper disposal of sewage, the prevention of water pollution, the removal of nuisances, cleanliness of the streets, inspection of food, healthfulness of dwellings, ventilation, and proper disposal of the dead.

In conclusion, Dr. Welch deplores the lack of active participation on the part of the general medical profession in public health activities, the fault being partly due to encroachment on the field of the private practitioner and partly to a lack of sympathy and co-operation with health officials and with health programmes on the part of the practitioner.

General Zoölogy. By Prof. H. L. Wieman. (McGraw-Hill Publications in the Zoölogical Sciences.) Pp. ix+312. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1925.) 15*s*. net.

THIS book "is a rather condensed account of some of the outstanding facts and principles of zoology" prepared for use in conjunction with the author's course of practical teaching, and it is evident that a clear understanding of many of the subjects must depend largely on the work on structure and on histology done in the laboratory. The first eighteen chapters of the book deal with adaptation, the various systems of organs, metabolism, cell division, gametogenesis, ontogenesis, evolution and heredity, and a concluding chapter gives a "general survey of the animal kingdom" in fifty pages. The best chapters, in our opinion, are those on evolution and heredity; many of the other subjects are treated so briefly as to be largely ineffective, *e.g.* reproduction—agamic, hermaphroditic and bisexual—intrauterine development and certain general considerations are traversed in eight pages, more than two of which are occupied by illustrations. The author should have eliminated a number of loose statements, *e.g.* that the ilium of the frog "extends dorsally to the scapula," that the setæ of earthworms are arranged in clusters, and should revise his usage of the term nephridium. The illustrations are carefully chosen and well reproduced.

Manufacture, Design, and Laboratory Work. Compiled and collated by D. V. Onslow. (Electrical Engineers' Data Books, Vol. 2.) Pp. xvi+276+cxcv+9. (London: Ernest Benn, Ltd.; Radio Press, Ltd., 1925.) 15*s*. net.

ENGINEERING data of the manufacture and design of electrical machinery and also descriptions of tests which are useful in laboratories and testing rooms are given in this work. The book opens by discussing the electric strength of insulating materials, and we gather that electric strength has something to do with "average breakdown voltage." The impression left on the reader, however, is that possibly there is no such thing as "electric strength" after all. The scientific man will be appalled at the many trade names of insulating materials. The methods of testing devised by members of the various research committees have strictly practical ends in view, and a large "tolerance" has to be allowed for the results. We have a difficulty in understanding what is meant by saying that the power factor for clear micas is 0·003. The phrase "dielectric constant" is rather an unfortunate one, when we have to discuss how it varies with temperature, humidity, etc. In the appendix it is called specific inductive capacity. The type in which the mathematical tables is printed is difficult to read. In our opinion it is time that the so-called "international and B.O.T. units" were placed on the scrap-heap. The ampere, the volt, and the ohm have been determined with an accuracy far in excess of that required in commerce.

Abhandlungen zur Physiologie der Sinne aus dem physiologischen Institut zu Freiburg i. B. Herausgegeben von J. von Kries. Fünftes Heft. Pp. iv+120. (Leipzig: Johann Ambrosius Barth, 1925.) 4 gold marks.

IT is much to be regretted that in Great Britain there is a decay of interest in the physiology of the special senses. Among representative physiologists, there are extremely few who might be called special sense physiologists. The present volume bears witness, however, that this is not the case in Germany. The volume is a convenient fasciculus, the fifth of its kind, forming in reality a reprint of collected papers published from the school of von Kries in the *Zeitschrift für Sinnesphysiologie*. The papers describe congenital colour-blindness in one eye (J. von Kries), similarity of taste in mixed solutions (E. v. Skramlik), minimal luminosity in colour sense (E. Engelking and F. Poos), and the geometric representation of multiplicity of sensations (J. von Kries). Each contribution must be studied first-hand for its merits.

L'Hydrogène et les gaz nobles. Par Dr. J. J. Van Laar. Pp. ii+79. (Leyde: A. W. Sijthoff, n.d.) n.p.

THIS monograph is the first of a series on theoretical and practical chemistry to be issued in French or English under the auspices of the Société Chimique Néerlandaise. Devoted exclusively to consideration of numerical data relating to the physical properties of the gases specified in the title, it will be welcomed by all workers in this branch as a trustworthy, well-arranged, and reasonably up-to-date book of reference.

Exercises in Geometry. By V. Le Neve Foster. Part 1. Pp. viii+69. (London: G. Bell and Sons, Ltd., 1925.) 2*s*.

MR. FOSTER thinks it is not inconvenient to add to the number of riders given in the text-books. If he is right, it would be difficult to provide a better collection than this, which is intended to be used in Stage I. when the stress is laid upon the practical side of geometry.

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.*]

Hardness.

AMONGST the many properties of solids which are the subject of measurement, none are less satisfactorily specified than that of hardness. Two kinds of hardness may be distinguished, namely, surface hardness and body-hardness, though the distinction is often disregarded. Mineralogists deal with surface hardness, and of any two bodies call that the hardest which will scratch, but not be scratched by the other. On this system an arbitrary scale has been evolved having diamond (Hardness 10) at one end and talc (Hardness 1) at the other.

Engineers are chiefly concerned with body-hardness, which (in the most usual test) is measured by the depth or diameter of the impression left on the surface of the material tested, when a hard steel ball is pressed against it by a known force. Other forms of test are also in use, but in all cases the hardness is given by a number and not in mechanical units. Body-hardness, however, may be simply defined as the greatest normal pressure which a surface will bear without rupture. More than twenty years ago I tried to get the Ordnance Committee to have its hardness tests stated in this way, but nothing came of it.

In scratching tests the conditions are more complex. The harder of the two bodies exerts a tangential drag on the surface of the softer, and a scratch is produced when this drag exceeds the limit of distortion at a free surface. The coefficient of friction between the pair is, therefore, involved; and it is probable also that the distortion limit at the surface may differ from the corresponding limit for the interior from causes analogous to those which produce surface tension in a fluid. Even for body-hardness the same cause may operate to a small extent.

It may happen, therefore, that the scratching and indentation tests indicate different degrees of hardness in the same material.

As regards indentation tests, it must be noted that

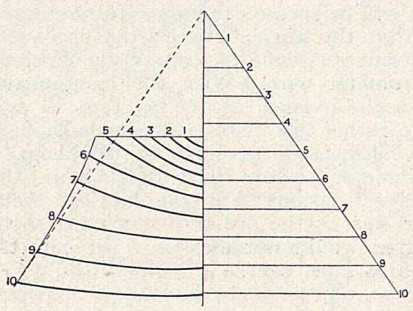

FIG. 1.—Showing the deformation which occurs when the apex of a cone is flattened. The curves are copied from an axial section of a cone built up of coloured strata of plastic material.

they are of use only when the indenting body is much harder than the indented, and also when the limits of elastic deformation of the latter are small. The ball test, for example, applied to a sheet of india-rubber would indicate infinite hardness, since no permanent impression could be made.

In the course of some experiments made during the year 1925 on the properties of various steels, I have had occasion to make many measures of their hardness, and for this purpose have employed a method which is free from some of the above objections.

A small piece of the material to be tested is shaped into a circular cone which is placed point downwards in a loaded vertical holder, provided with a means of

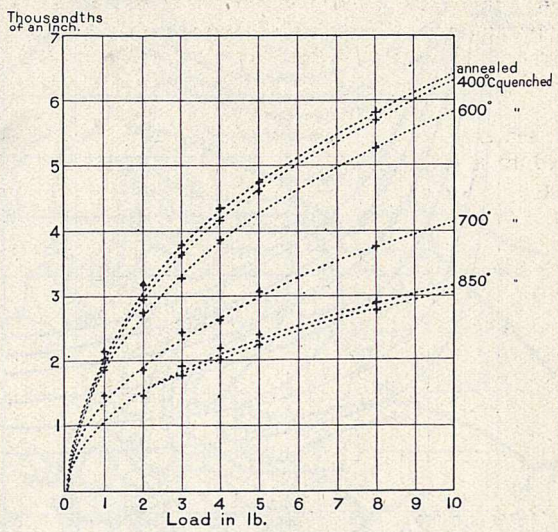

FIG. 2.—The ordinates are the diameter of the flats formed by pressure on the apex of cones of carbon-steel (Stubbs's steel rod) when hardened by quenching at different temperatures. The abscissæ are the applied loads.

slowly lowering the point until it rests on, and is entirely supported by, a hard flat surface. The pressure flattens the point of the cone until the area of contact is sufficient to carry the load, and the diameter of the flat is then measured with a microscope and micrometer.

In these experiments the hard surface was a piece of polished sapphire. Diamond no doubt would be preferable, but a suitable stone would have cost as many pounds as the sapphire did pence, and sapphire is so much harder than any of the metals that in this case the results would be identical.

The nature of the deformation set up in the flattened cone is shown in Fig. 1.

If the coefficient of friction between the surfaces over the area in contact is known, the deformation curves can be calculated, and it can be shown that the pressure is nearly uniform over the whole surface, but in the figure they are copied from an experimental model. Sheets of a plastic substance of uniform thickness and quality, but differently coloured, were placed on one another, and from the stratified block thus formed, a cone was cut by means of a properly guided and tightly stretched fine steel wire. The cone was then pressed against a flat plate by a motion parallel to the axis, and an axial section cut showing the distortion of the strata.

For any given angle of cone the curves are similar, whether the flattening is large or small; and supposing that the material is isotropic, that is, neglecting any peculiarity belonging strictly to the surface layer, hardness may be estimated by the pressure between the two plane surfaces involved.

If D is the diameter of the flat, this pressure is Load $\times 4/\pi D^2$, and for any particular material D should be proportional to the square root of the load. The experimental results illustrated in Fig. 2 (and in the many similar diagrams which have been plotted) show that this is actually the case. In this figure the ordinates of the dotted curves are proportional to

the square root of the abscissæ which represent the loads, while the crosses are the measured diameter of the plate. If the diameter of the flat is n thousandths of an inch and the load on the cone is m pounds, the pressure on the flat is $565m/n^2$ tons per square inch (nearly).

A series of curves for various values of m (see Fig. 3)

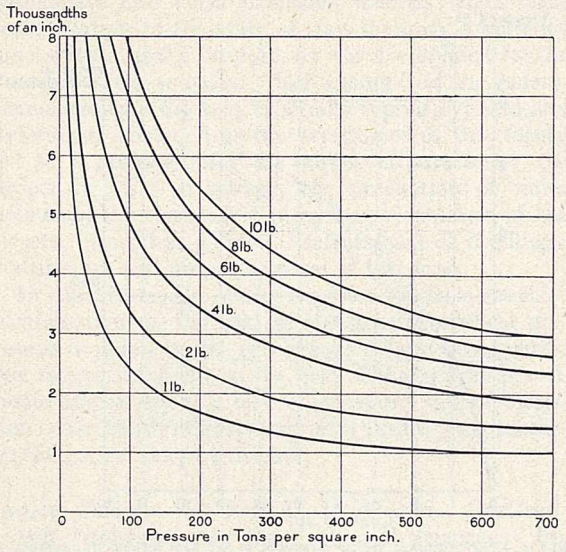

FIG. 3.—Diagram to enable the hardness of a material to be determined by inspection for any load and diameter of flat. The ordinates are the diameter in thousandths of an inch, and the abscissæ the hardness in tons per square inch.

(in which the ordinates refer to n and the abscissæ pressure) may be drawn so that the hardness for any values of n and m may be found by inspection. Fig. 2 relates to Stubbs's steel rod hardened by quenching in water from different temperatures. When softened by slow cooling the hardness is less than 100 tons per square inch.

The maximum hardness is attained when the quenching temperature is rather lower than 900° C. and is then well above 600 tons per square inch. It was a surprise to me that any metal could withstand such a pressure without crushing.

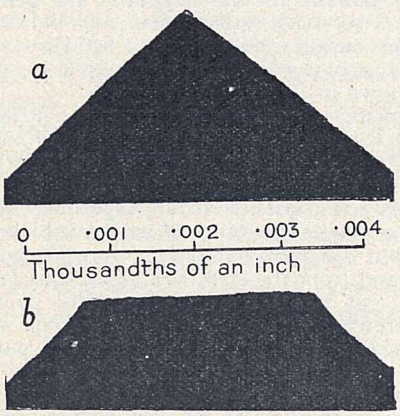

FIG. 4.—Photographs of a hard steel cone. (*a* Untoucned; (*b*) after the application of a pressure of 610 tons per square inch.

In Fig. 4 two photographs are given of the same steel cone before and after this pressure was applied. A few measures of the effect of tempering have been made, and these are included in the subjoined table, but they will be repeated in greater detail.

In the case of alloy steels the effects of quenching are very complex, sometimes increasing and sometimes diminishing the hardness, and the differences in their behaviour seem to have no simple relation to the proportions of the alloying metals (manganese, chromium, and nickel), but none of them under any conditions which I have tried approaches the hardness of carbon steel.

For the softest of my specimens (36 per cent. nickel) the hardness was about 70 tons, and for the hardest (13·5 per cent. chromium) 300 tons.

HARDNESS OF VARIOUS MATERIALS.

The hardness is stated as the maximum pressure which the surface of the material will withstand.

Soft Iron.	Hardness. Tons per sq. inch.	Remarks.
1	68	Nearly pure iron about 0·04 per cent. carbon.
Carbon steel		Stubbs's steel rod.
1	150	,, ,, as sold.
2	155	Annealed by slow cooling from dull red heat.
3	158	Quenched at 400° C.
4	164	,, 600°.
5	265	,, 700°.
6	540	,, 850°.
7	610	,, 900°.
8	500	,, 800°, tempered at 100°.
9	350	,, ,, Straw yellow.
10	290	,, ,, Blue.

Alloy Steels.	As from the Rolls.	After Quenching at 900°.	Composition of Alloys per cent.				
			C.	Si.	Mn.	Cu.	Ni.
1	190	165	0·15		5·4		
2	197	220	0·15		15·3		
3	230	330	0·35	0·22	0·13	13·6	
4	112	265	0·43	0·32	0·25	3·3	
5	114	210	0·19	0·20	0·65		4·0
6	94	75	0·16	0·03	0·86		36·0
7	145	135	0·6		5·0		15·0
8	93	Sample of Invar. Analysis not known.					

Miscellaneous.		
Brass	70	Hard drawn commercial rod.
Copper	39	16 B.W.G. wire.
Aluminium	24	Commercial drawn rod.
Tin	7·25	Commercial.
Lead	3·3	Commercial.
Beeswax	0·14	At 14° C. The hardness varies rapidly with the temperature.

As bearing on the accuracy of the measures here given, it will be seen on reference to photograph *b*, of Fig. 4, that the angle between the flat and conical surface forms very definite positions on which to adjust the micrometer wire. With the magnification employed, each division of the micrometer was equivalent to rather less than one sixteen-thousandth of an inch. Repeated readings of the length of the same diameter seldom varied by more than one micrometer division. For the hardest metals this diameter was of the order of 0·003 in., so that the linear error would not exceed 2 per cent. and the error of area 4 per cent.

It was found, as might have been expected, that near the apex of the cone the cross section was generally somewhat oval, and for this reason two diameters at right angles to one another were always measured and their mean used in computing the area.

Taking all sources of error into account, I believe the results to be generally correct within 5 per cent.

A. MALLOCK.

9 Baring Crescent,
Exeter,
December 15.

Phenological Observations and Results in Russia.

PHENOLOGICAL studies are not a new branch of scientific research in Russia; they have, indeed, a long history.

After the first efforts to make and to publish phenological observations, the attempts of N. Annenkoff in Moscow (1844–49), of A. Doërgingk in Kishinev (1845–60), and of Prof. A. Voeikoff (1885–95), phenological observations were established on a real scientific basis and were carried on during the long period from 1888 to 1923 by the Russian pioneer of this branch, the late professor of the Institute of Forestry, D. N. Kaigorodoff. He not only made very careful personal phenological observations every spring and autumn in the Lessnoi Park, near Petrograd, but organised them also over all Russia by many correspondents, whom he had recruited.

After Prof. Kaigorodoff's death in 1923, at the age of seventy-seven years, his work was taken in hand by the Russian Society of Amateurs of the Study of the Universe ("Obstchestvo Mirovedenja"), an entirely private society of amateur astronomers and meteorologists.

This Society elected a special Phenological Committee, which undertook the organisation of a large network of phenological observation points and also the compilation, study, and publication of the results. Through appeals to its correspondents and through propaganda in newspapers, the committee has greatly developed this during the last two years.

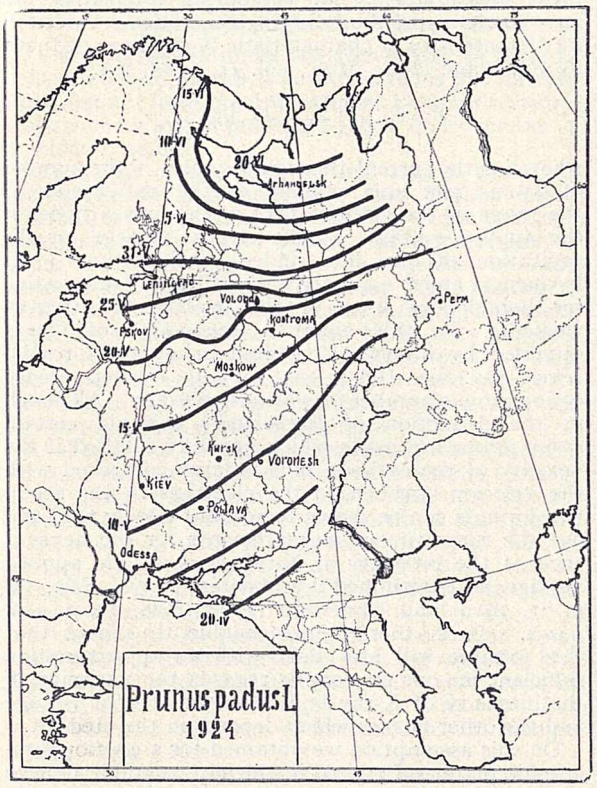

FIG. 1.—Curves showing the date of flowering of the wild bird cherry (*Prunus padus*).

In the year 1924 there were 258 observers, corresponding with the committee, in 223 different stations in the U.S.S.R., and in the spring of 1925 the number of observers increased to 608 at 512 points. At nearly 75 points in European Russia phenological observations had been made for periods of 10-20 or more years.

Besides these points of observation of the committee there is a network of 58 points organised by the Meteorological Bureau of the Ukraine (South Russia).

The study of the large series of observations made at different points and during a long series of years permitted the Phenological Committee to draw up a

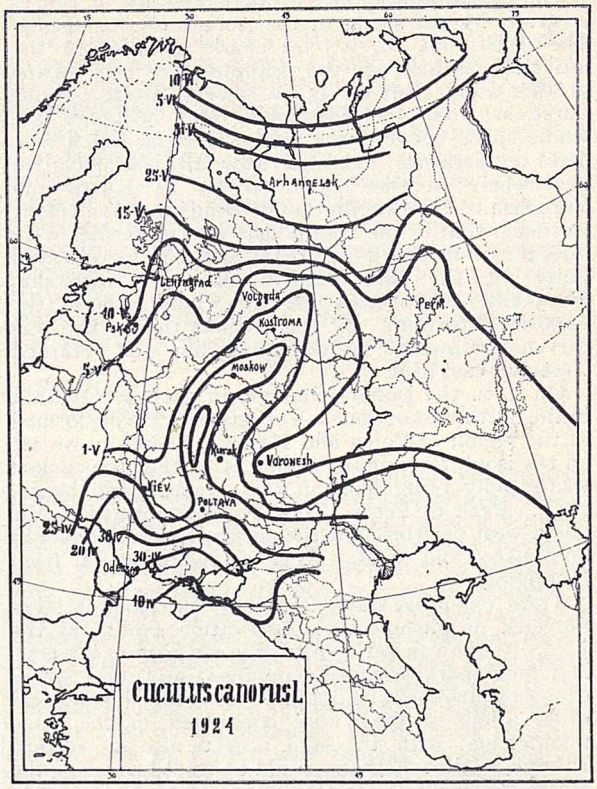

FIG. 2.—Curves showing dates when the cuckoo was first heard.

table of the mean times of different natural phenomena at 17 typical centres distributed over all European U.S.S.R.

This table affords the possibility of comparing the natural phenomena of every spring and autumn with the mean times, and of deciding how far either event is too early or too late in the present year.

Such observations compared with results of the meteorological observations show generally a coincidence with weather conditions. A more precise idea of the gradual procession of the natural phenomena and of their dependence on meteorology can, however, be obtained also in another manner. Having a dense network of observation points, we can easily draw curves of isochronous events—*isopipteses* in the case of the arrival of birds, and *isoanthes* for the flowering of plants.

The Phenological Committee has tried to draw some curves for the spring of 1924, and also for the spring of 1925, and has obtained very interesting results.

The isoanthes in 1924 of the earlier plants (Fig. 1), as, for example, of the flowering of the wild bird cherry (*Prunus padus*)—a tree very common and widely distributed in Russia—in the south and middle part of U.S.S.R. lie in a N.E.-S.W. direction, showing that in the east part the flowering began earlier than in the west part of the country, where it was retarded by some unfavourable conditions. But in the north part they lie quite regularly in a later period, 25, v.-20, vi. (Roman numerals refer to months of the year). The flowering of the lilac (*Syringa vulgaris*) shows nearly the same conditions.

The first cry of the cuckoo (Fig. 2) gives greater complications: the curves make a large tongue-like

projection to the north, showing that the arrival of this bird was retarded in the east as in the west, but that it succeeded in progressing on the nearly meridional line Poltava — Moscow — Kostroma — Vologda in the central part of U.S.S.R.

The explanation of this strange direction of curves is given by the study of the isobars of this spring. The isobars of 20, iv. are nearly parallel to the latitudes, as also are the isopipteses of the cuckoo at this time. But on 23, iv. a very strong cyclone burst in from the north-west and occupied the whole space between the Baltic and the Black Sea. The temperature fell and snowfall was recorded everywhere in this region so far as Kursk and Voronesh. The distribution of winds in this cyclone was such that in the middle part of Russia they were directed from south to north, and this is observed quite on the line Poltava—Moscow—Kostroma. West and east of this line the winds blew in the opposite direction. By these winds the cuckoo was driven northwards on the given line and retarded west and east of it.

On 5, v. the isobars changed in such a way that in the north-east of Russia a strong anticyclone formed in the region of Volga and Kama. Therefore we see on the isopipteses of 10, v. and 15, v. that the cuckoo was rapidly progressing in this direction and heard, 10, v., north of Perm. New cyclones formed in the north-west part brought the cuckoo also to Novgorod and Pskov, and on May 10 it was heard not far from Leningrad.

These examples show us that by the existing large network of phenological observation points in the U.S.S.R. one can get results of great general interest. But incomparably more generalised and more interesting results could be obtained from the phenological observations if they were conducted in the same manner and with the same objects also in western Europe, so that diagrams could be traced covering the whole continent. For this purpose the programmes of phenological observations in the various countries, as also the methods of observations, must agree in general characters.

It seems to us that the best way for establishing such an agreement between the observations of different countries would be the organisation of an International Congress of Phenology, or of a special Section of Phenology at the next International Meteorological Congress. Such a gathering of specialists could discuss and fix the most appropriate list of objects for observation in every country, and it could elaborate also the best methods of observation, study, and publication of phenological phenomena.

Only by international agreement and co-operation can phenology—this link connecting biology and meteorology—be promoted to further development.

P. J. SCHMIDT.
(Curator of the Zoological Museum,
Russian Academy of Sciences.)
Leningrad.

Relative Intensity of X-ray Lines.

THE development of the theory of atomic constitution has made measurements of the intensity of lines in X-ray spectra very important. Estimates of relative intensities of X-ray lines have hitherto been attempted by means either of the ionisation chamber or the photographic plate. Owing, however, to the lack of precise knowledge of the relative sensitiveness of these methods for different wave-lengths, the comparison of intensities of lines which differ in wave-length has involved a considerable uncertainty. To overcome this difficulty, absolute measurements of the energy of X-ray lines based on the bolometric method have been attempted by several workers. Since the wave-lengths used lie on the short wave-length side of the bromine K-absorption edge, the sensitivity curve for the photographic plate obtained in this way cannot be applied to measurements of the relative intensities of the L- and M-series of most elements. To obtain the sensitivity curve in this region, we have exposed plates to X-rays from different metals excited under conditions which can be discussed on the basis of the theory of X-ray production.

In a vacuum spectrograph of the Siegbahn type the four faces of an anticathode, which were covered with sheets of iron, cobalt, nickel, and copper, were exposed in succession by turning the anticathode from outside. The X-ray tube was run off a high tension transformer with a rectifier under constant working conditions, the effective value of the applied voltage being about 20 kv. The vacuum was maintained by a mercury vapour pump working continuously. To make our result as free as possible from accidental errors, especially those which might arise from a variation of the electron emission of the filament or of the vacuum in the tube, a large number of photographs was taken on the same plate, the sequence of exposure of the faces of the anticathode being varied. The blackening of the plate was measured by means of a Moll microphotometer, and relative values of the maximum blackening for the K_α and K_β lines of the four elements were obtained.

In order to utilise the information contained in these measurements for comparing intensities, we have made use of the following theoretical expression for the intensity of characteristic X-ray lines deduced by Rosseland (*Phil. Mag.*, vol. 45, p. 65, 1923):

$$F = Ci\frac{Nl}{V^2}\left(\frac{V - V_0}{V_0} - \log\frac{V}{V_0}\right)_\nu,$$

where i is the current through the tube, N the number of atoms per unit volume of the anticathode, l the range of the cathode rays in the anticathode, V the applied voltage, V_0 the critical voltage for the excitation of the line under consideration, ν its frequency, and C a quantity which has the same value for homologous lines of the spectra of different elements. In this equation the value of l was obtained by interpolation from Schonland's results (*Proc. Roy. Soc.*, 108, p. 187, 1925) on the dependence of l on atomic number for various voltages. Although in the deduction of Rosseland's formula certain assumptions are made which are only fulfilled if the velocity of the cathode rays is large compared with the velocity ascribed to the electrons in the atom, this formula can be shown to account closely throughout the range of our measurements for the dependence of the intensity of X-ray lines on the applied voltage as determined by Wooten (*Phys. Rev.*, 13, p. 71, 1919) and Unnewehr (*Phys. Rev.*, 22, p. 529, 1923). It is therefore reasonable to expect that this formula will also hold with an approximation sufficient for our purpose as regards the variation of the intensity of X-ray lines with the critical voltage and the other factors which depend on the element.

On this assumption we obtained for a given photographic plate and crystal in the spectrograph a curve of the relative blackening as a function of wave-length. We were thus able to compare the intensities of the lines in the L-series of tungsten. For example, we found

$$L_{\alpha_1} : L_{\alpha_2} : L_{\beta_1} = 100 : 10 : 33$$

as the relative intensities corresponding to our experimental conditions. Since the critical excitation potentials for these lines are not quite the same, the relative intensities will depend on the applied voltage.

Correcting for the difference in the critical potentials by means of Rosseland's formula we obtain

$$L_{\alpha_1} : L_{\alpha_2} : L_{\beta_1} = 100 : 10 : 43$$

as the intensity ratio to be expected for an applied voltage very large compared with the difference of the critical potentials.

It is of interest to compare this result with the intensity relations of optical spectra. For the lines *np-md* of the alkalies, which have a formal analogy with the above X-ray lines, one would expect $9 : 1 : 5$ [1] (100 : 11 : 55). Here the measurements in Utrecht have given results agreeing with the theory. Although there is a close resemblance, it seems that our values differ from this ratio by more than the experimental error which we estimate at 5 per cent. Such a deviation is, however, not unexpected, since the theoretical result is only strictly valid so long as the frequency difference of the lines is very small compared with their frequencies. While this condition is fulfilled in the case of the doublets *np-md* of the alkalies, we meet in our case with a frequency difference of 15 per cent. which can scarcely be considered to be small.

We hope later to publish an account of the experimental details and of further measurements.

Y. NISHINA.
B. B. RAY.
Universitetets Institut for teoretisk Fysik,
Copenhagen.

The Convection of Light by Moving Matter.

IN the paragraph under the above title, in NATURE of December 26, p. 948, a new question is put forward quite distinct from the discussion of Einstein's theory, dealt with in my unpublished letter of November 5, to which it refers.

The writer of the note, having noticed that I do not belong to that multitude who blindly follow Einstein, seems to conclude that I am of the Einstein-antagonist party, all of whom aim more or less to return to older ideas. Even a scientist of well-deserved universal repute, such as Prof. Lenard in Berlin, in his polemic and anti-Einstein pamphlets, which have been reprinted many times, only proposes older theories in a somewhat modified form. But is that generally existing conformity a valid excuse to attribute to me what as a matter of fact is only the impression of the writer of the note ?

It obliges me to state emphatically that there is not the least essential connexion between the writings of all those Einstein-antagonists and my papers. I challenge the writer to point out in my papers (*C.R.*, vol. 175, 1922, p. 574, and *Phil. Mag.*, Ser. 6, vol. 49, 1925, p. 579) a single word which may be interpreted as my advocating a return to older electromagnetic theory.

According to the paragraph, my " deduction is not entirely free from ambiguity, in so far as equation (11) in his earlier and more fundamental paper leads at once to the expression $\mu'_w = \mu + A(n' - n)$. . . . For A, which is a constant of integration, M. Menges puts $(\mu - 1)/n + d\mu/dn'$."

As to this, I can only say that neither the reasoning nor the formulæ is to be found in my papers.

My equation is :

$$\frac{d\mu'_w}{dn'} = \frac{\mu'_w - \mu}{n' - n}.$$

This is not given in NATURE. It is immediately obvious that the expression presented in NATURE as the solution of my equation is incorrect. For it may be written :

$$A = \frac{\mu'_w - \mu}{n' - n},$$

which, as a solution of my differential equation, is absurd.

Within the scope of a letter, it is quite impossible to explain my new formulæ fully. I must refer the reader to my books " Nouvelles vues Faraday-Maxwelliennes " and its " Supplément " (Gauthier-Villars and Co., Paris, 1924). There he may see that my mathematical deduction is quite free from ambiguity and undoubtedly correct, and that it leads to the true solution of the question. He will find also that it is by no means by returning to, but, on the contrary, by radical departing from older electromagnetic theory, that my new results are obtained. My new formulæ and new insight in electromagnetism, confirmed by experiment, then leads to the result that Einstein's theory is inadmissible.

CHARLES L. R. E. MENGES.
The Hague,
December 30.

M. MENGES seems to have misunderstood the drift of my notice, which was intended as a *critical review*, not an *abstract*, of his two published papers, without any direct reference to his unpublished covering letter at all. I am not conscious of having attributed any views respecting Einstein's theories, either for or against, to M. Menges, whilst the references to Newtonian principles and the older electromagnetic theory followed naturally from the *Phil. Mag.* paper and its references to the books of Jeans and H. A. Lorentz. I added the reference to v. Laue's paper for the sake of completeness, for it shows that the experiments of Fizeau and Zeeman do not lead to the result that Einstein's theory is inadmissible, as M. Menges states in his letter.

The paragraph of which M. Menges complains is a criticism of his solution (12), not a reproduction of his method of deriving it from his equation (11), for he gives no details in his papers. If we write $n' - n = x$, $\mu'_w - \mu = y$, n and μ being constant parameters, (11) reduces to $dy/dx = y/x$, which is the familiar differential equation of a plane pencil of straight lines through the origin. Its *general* integral is $y = Ax$, where A is the constant of integration ; I fail to see the absurdity of this well-known solution, for its verification is immediate. The point of my criticism is that M. Menges' solution (12) is only a *particular* integral, obtainable of course by choosing a particular value of A ; in the papers specifically referred to, M. Menges gives no sufficient reason why this particular integral should be selected rather than any other. It may well be that good reasons are given in his book, but I have not had access to it. My wording no doubt is liable to misconstruction : it would have been better to write : " We can obtain M. Menges' solution (12) by putting for A the particular value $(\mu - 1)/n + d\mu/dn'$."

THE WRITER OF THE NOTE.

Mullet as an Enemy of the Oyster.

DURING the past summer large numbers of oysters carrying larvæ were examined in the Plymouth laboratory, and in order not to waste the larvæ, batches were thrown as food into an aquarium tank containing anemones, sea-cucumbers, small fishes, and other smaller marine animals. After throwing the larvæ into the tank, the animals being fed were

[1] D. Coster and S. Goudsmit, *Naturwiss.*, 13, p. 11, 1925; A. Sommerfeld, *Ann. d. Phys.*, 76, p. 284, 1925.

watched, and it was found that a small school of small grey mullet (*Mugil chelo*) in the tank came rapidly towards the clouds of larvæ and greedily ate them up. These mullet soon became accustomed to being fed on larval oysters, and quickly appeared from remote portions of the tank when larvæ were thrown in.

The manner in which the mullet obtained the larval oysters from the water is remarkable for a fish. The fishes entered the cloud of oysters and while remaining poised or practically still, very rapidly drew water in at the O-shaped mouth and expelled it out through the gill-slits, by using the walls of the oral cavity as a pump. The action is an accentuation of the ordinary breathing mechanism. Obviously also the water passing into the mouth was sieved, as the cloud of larvæ in the water soon cleared on the advent of a number of the little fishes.

Cunningham ("Marketable Marine Fishes," p. 335) records the presence of minute molluscs in the stomachs of mullet, and Day ("British Fishes," i. 229 and 234) points out that there is "a filtering apparatus in the pharynx which prevents large and hard substances from passing into the stomach, or sand from obtaining access to the gills."

The mechanism which prevents sand from passing the gills is not unlikely used for filtering off plankton organisms, such as oyster larvæ, as food. It is the more probable that young mullet and to some extent older fishes are partially general plankton feeders, since Day also records the occurrence of minute Crustacea in the stomachs of mullet.

Since mullet abound in some of our estuaries where oyster beds occur, it is practically certain that those and also other small fishes take a toll on oyster larvæ, as Lebour (*J.M.B.A.*, 12, 3, p. 464) has shown that young sprats may do. In a recent publication ("The Story of the Oyster," *Australian Museum Magazine*, ii., 1925) T. C. Roughley states, without, however, giving any details, that Australian mullet destroy oyster larvæ; thus it would appear that the mullet family in different parts of the world feed in a similar way.

Although there can remain little doubt that young mullet are enemies of oyster larvæ, the critical test would be derived from the examination of stomachs of fishes taken over or near an oyster bed in summer, and especially in the period preceding new moon. Such material will, however, not be easy to obtain.

J. H. ORTON.

The Laboratory,
The Hoe, Plymouth,
December 24.

Absorption and Resonance Radiation of Excited Helium.

PASCHEN in 1914 published results of experiments on absorption and resonance radiation in weakly excited helium. A more extensive investigation is being made of absorption in excited helium, and results have been obtained indicating absorption of the following lines:

5875	3889	5016	6676
4471	3187	3964	4921
4026		3614	

It was observed that 3889 was very strongly absorbed, and it was decided to attempt to detect resonance radiation. Light from an intense capillary was focussed by means of a cylindrical lens along the axis of the resonance tube. This served as a strong source of monochromatic radiation of wave-length 3889 Å.U. The resonance tube was focussed, end on, on the slit of a quartz spectrograph adjusted with a wide slit. A series of three photographs was then taken, namely:

1. With the weakly excited resonance tube alone and the light from the capillary screened off.
2. With the resonance tube as in the first exposure and the light from the capillary incident on the resonance tube.
3. With the resonance tube off but the light from the capillary still focussed as in the second exposure.

Examination of the plate showed a barely detectable trace of scattered light. Under the influence of the monochromatic radiation from the capillary, a great increase of the intensity of the radiation of wave-length 3889 Å.U. from the central portion of the resonance tube, on which the light from the capillary was focussed, was observed. Since this was not due to scattered light, as was proved by the third exposure, it must have been due to resonance radiation from the weakly excited helium.

This result appears to prove beyond doubt the possibility of obtaining resonance of the 3889 line in weakly excited helium. A more detailed account of the work will appear shortly. W. H. MCCURDY.

Johns Hopkins University,
Baltimore, Maryland,
December 12.

Allotropy of Chromium.

CHROMIUM prepared by a special method was found to have certain peculiar properties. This fact has led us to make an X-ray examination of the structure of this material, which has revealed the fact that this specimen of chromium was a mixture of two allotropes. Besides a much smaller quantity of the normal body-centred cubic modification, the predominating structure consisted of a form not previously described.

The atoms are arranged on two hexagonal lattices, and form a structure which is almost hexagonal close-packed, the axial ratio c/a being 1·625 instead of 1·633, the ideal ratio for the close-packing of spheres. The distance between neighbouring atomic centres is 2·714 and 2·705 Å.U. Below are tabulated the readings obtained from the film and those calculated for a structure of the above type:

Radiation.	Interplanar Spacings in Ångströms.		Reflecting Planes.	Intensity of Lines.
	Observed.	Calc.		
β	2·204	...	0002	Very weak.
α	2·346	2·331	$10\bar{1}0$	Weak.
β	2·064	...	$10\bar{1}1$	Weak.
α	2·202	2·203	0002	Medium.
α	2·068	2·074	$10\bar{1}1$	Very strong.
α	2·034	...	(110) [1]	Medium.
α	1·608	1·608	$10\bar{1}2$	Very weak.
α	1·358	1·357	$11\bar{2}0$	Weak.
α	1·248	1·246	$10\bar{1}3$	Medium.
α	1·177	1·175	$20\bar{2}0$	Strong.

[1] This corresponds with the (110) spacing of the body-centred variety of chromium.

Further work on this subject is in hand to determine the conditions under which the two allotropes are formed.

The X-ray examination was undertaken by us at the Physical Laboratories of the University of Manchester, by the kindness of Prof. W. L. Bragg.

A. J. BRADLEY.
E. F. OLLARD.

Research Department,
Metropolitan-Vickers Electrical Co., Ltd.,
Trafford Park, Manchester, December 18.

X-rays in Industry.[1]

By Dr. G. W. C. KAYE, O.B.E.

THERE are few more stimulating pages in the history of scientific endeavour than those which record progress in the field of X-ray investigation and application.

Physical research has spread itself over 60 octaves or more of electromagnetic waves which are now known to stretch without break from wireless waves 25 miles or more in length through heat waves, visible light waves, ultra-violet waves, and X-rays to gamma-rays of wave-lengths of the order of a ten-thousand-millionth of an inch. In this gigantic gamut of natural activity that group of radiations encroaching into and extending some thirteen octaves beyond the ultra-violet, and possessing wave-lengths ranging from about 5×10^{-6} to 5×10^{-10} cm., is now generally styled X-rays. Of these thirteen octaves, ten are extremely absorbable, but the remaining three possess those remarkable powers of penetrating matter which made Röntgen's discovery so arresting and monumental when it was announced exactly thirty years ago. If we include the gamma-rays of radium, this gives us a total of nearly six octaves of radiation with which the science of medical and technical radiology of the present day does its work.

The differential absorption of X-rays by matter of different densities (which makes the work of the medical radiologist possible), and the diffraction of X-rays, are phenomena which have been turned to account in the industries and arts in a diversity of directions. At the outset mention should be made of the dangers arising from X-rays. These are well known and have caused many casualties in the past. They can, however, be wholly avoided by common-sense protective measures which consist in the main of interposing lead sheet or the like, properly disposed and sufficiently thick, between the X-ray tube and the operator. The reports of the X-ray and Radium Protection Committee should be consulted for details by which complete safeguards can be secured.

RADIOGRAPHY.

One other practical precaution arises in industrial radiography, and that is the necessity for taking account of the scattering of the X-rays. Three things may happen to a beam of X-rays when it passes through a material. Part of it emerges undisturbed and undeviated, and outlines the shadow picture on the photographic plate. Part of it is absorbed with the liberation of characteristic X-rays and electrons. The rest is scattered or dispersed, which is equivalent to stating that, while the rays are not altered in quality or but slightly so, a considerable proportion of them have their direction altered to a greater or less extent. In some cases it is estimated that, of the energy received at a point well within or beyond a mass of material, the fraction arriving by devious routes may be equal to or several times greater than that by the direct route. This proportion may be lessened by narrowing the width of the beam of incident rays, but the size of the aperture is usually prescribed by the size of the object and, in general, the X-ray beam does not approximate to a pencil. Scattering thus produces a sort of halation or fogging of the main image on the photographic plate. The effect may be troublesome enough, even with lesser thicknesses, to impair definition in the absence of suitable precautions, but increases to such an extent with greater thicknesses as to render the method nugatory or nearly so.

Many of the various applications of radiography to industry have come about owing to the fact that the method does not injure the specimen in any way. Further, it provides in many cases the only means, independent of human judgment, of detecting concealed defects in a material or of scrutinising in a structure or sealed enclosure the disposition of component parts which are hidden from view. Incidentally, the mere existence of the method is not without its moral value as regards workmanship. Radiography is, of course, inoperable in those cases where the shape of the object prevents the right disposition of X-ray tube and film.

The X-rays found little effective scope in industry until the invention of the Coolidge tube, which permitted the utilisation of high voltages with standardised procedure. Experience differs as to the sensitiveness of the method, but, depending on the area of the inclusion, probably a variation in density equivalent to 2 to 5 per cent. of the thickness is necessary to be detected on the photographic plate. These figures require to be increased for fluoroscopy, but much depends on the luminosity and on the visual acuity of the observer. Definition is, of course, dependent, among other things, on the size of the focal spot in the X-ray tube. If a body has tapering edges, this will normally result in a nebulous radiographic outline. Exposures naturally depend on the conditions, and may vary from a few seconds to an hour or more. Stereoscopic radiography is sometimes useful in estimating depth.

If the intrinsic value of a specimen is low, or if "mass inspection" is contemplated, then visual inspection with a fluorescent screen is the only practical policy. It is not always satisfactory, but the more expensive and protracted process of photography has to be justified by the value of the specimen, or the importance of the job for which it is intended, or the desirability of confirming the fluoroscopic diagnosis by a permanent record. For some industrial purposes Dauvillier employs an exploring ionisation chamber filled with xenon, the ionisation currents being readily measured by a galvanometer.

The shape of the specimen may be such as to emphasise the evils of scattered radiation. If the object is continuous, with one side flat, there is no difficulty; for the flat side can be brought into close contact with the photographic plate. The same end can be achieved with bodies of regular shape, such as cylinders or spheres, by resting them in closely fitting solid metal "cradles" with flat bases. If the body is irregular in contour, something may be done by filling up pockets or hollows with wax or plasticene and placing a "mask" of lead or lead powder round the specimen. With hollow bodies a film may sometimes be placed inside and sprung against the interior face, though parallax is often exaggerated. In all cases the

[1] From a public lecture delivered at the University of Leeds, November 30.

photographic plate or film should be backed and framed with lead foil.

It should be realised that, while X-rays have proved of considerable value in many directions, their use in radiographing steel is limited at present. While both in Great Britain and America X-rays have been detected photographically after passing through 4 inches of steel, the result has little or no practical value. The present practicable limit is more nearly 2 inches for photography and less than half an inch for fluoroscopy. Incidentally, the corresponding limit for solid masonry is about a foot.

The quality or mean wave-length of the X-rays used depends on the requirements. For very transparent objects X-rays excited by fifty thousand volts or less may suffice. For the more opaque materials we require rays excited by up to 200,000 volts, which is as near to the present upper limit as any present-day X-ray tube will stand. Approximately double this voltage will be required to test so much as 6 inches of steel. The electrical engineer can, of course, generate such voltages, but an X-ray tube has yet to be designed which is capable of turning them to account. The task is not proving easy of solution, and the fact has a bearing on the possible extension of radiometallography to heavy engineering. With such high voltages the scattering effect may be somewhat reduced, and the attendant dangers could doubtless be countered if the results warranted the expense.

Within its limitations, however, radiography is very sensitive; for example, fine tool or mould marks and similar surface irregularities are frequently displayed in radiographs. Blowholes in castings show up as light spots. Cracks are occasionally revealed, though, if they are filled with material of density not very different from its surroundings, or if the cracks are fine or tortuous (hair cracks), the method normally fails. A negative result does not, in fact, afford a positive answer. Inclusions of sand, etc., are registered as cloudy, indefinite areas. The method has been proved to be of value in suitable cases for checking up steel castings and so preventing the machining of defective castings.

If the specimen is of large area, such as a turbine disc, to radiograph the whole disc is a costly and protracted operation which has, however, on occasion been carried out in its entirety in Great Britain. But normally in such cases the X-ray method would be used only when the material is already under suspicion by the use of other tests.

X-ray photography of steel welds has been used successfully for thicknesses up to about 1 inch. Welding is discredited for some purposes, for it is easy to scamp such work, but the X-rays are a somewhat severe critic in displaying blisters, blowholes, and lack of bonding. Skilled experience can usually say whether any imperfections indicated in the radiograph are sufficiently serious to disqualify a weld for its purpose. The method will not, however, indicate a common defect of welding—the burning of the adjacent metal.

The X-rays have become a useful adjunct in the photography of a variety of subjects in the laboratory and in the industries. The manufacturers of electrical insulators—ebonite, built-up mica, fibre, paper—find the X-rays useful for detecting the presence of metallic particles, particularly if a high-grade product is desired. Fibre is frequently made from pulped rags and so may contain foreign metallic matter. Feminine labour has been occasionally responsible for the presence of hairpins in the finished product.

The centrality of the core of a heavily insulated electric cable can be tested by this means. In such a case as this, to secure both a sharp outline of the opaque core as well as clear detail of the more transparent insulation, a good plan is to make the exposure partly at a high exciting voltage and partly at a low voltage. The soundness of steel balls intended for ball bearings; the differentiation of lead-glass from soda-glass stems of clinical thermometers—now a routine test at the National Physical Laboratory—the centrality of the cores of golf balls; the test of the fit of a new shoe on the foot as now met with in many shoe shops; the nature of certain defects in artificial teeth; the proportion of ash in samples of coal, are among recent examples of the use of the method.

Aircraft materials afford scope for the X-rays as a testing agent. Aluminium alloys are very transparent, and so lend themselves to radiography, while if steel is used, its greater trustworthiness is offset by the necessity of keeping the weight down. The main difficulty, in fact, with aircraft components is usually their shape rather than their thickness. Timber offers no difficulty, of course, and the use of X-rays in this connexion, more particularly as regards aeroplane parts, was demonstrated during the War.

If a material is very transparent, its opacity may sometimes be increased much as a medical radiologist uses bismuth meals to watch processes in the alimentary canal. For example, the Dunlop Research Laboratory, by previously impregnating selected canvas threads with lead chromate, was able to test whether the stretch during the successive processes of manufacture of a tyre was within the limits tolerated by the yarn. Similarly, if it is desired to watch the behaviour of glued joints or splices while under stress, the radiography is facilitated if a little lead salt is added to the glue.

X-ray photography is at times particularly useful for displaying the construction of apparatus, the interior of which is hidden from view by thin metal or other opaque container. Among examples which may be cited are the counting of the turns of wire in a coil heavily covered with insulation; the details of the design of opaque vacuum pumps and radio valves; the interior detail of opal-glass electric lamps; the construction of selenium cells; the internal diameter of metallic tubing; and the interior construction and accuracy of assembly of explosive devices—this last by the Research Department at Woolwich Arsenal.

In quite another direction radiographs recently taken in Chicago of Egyptian and Peruvian mummies showed that rickets, bony tumours, pyorrhœa, caries of the teeth, were common conditions of disease, as nowadays. It was further found possible to gather something definite about the age and sex, and the nature of any injuries received. A recent attempt to X-ray the mummy of Tutankhamen was nullified mainly by the heavy gold "armouring" of the body.

Finally, one other application of radiography may be

referred to. As is well known, the forging of valuable pictures and antiques has always been a flourishing industry. One estimate puts the number of Rembrandts in existence at four to five thousand, yet, so far as is known, Rembrandt painted about 700 in his lifetime. We know that Sheraton had a little shop and did most of his work himself with only occasional help from a few expert artisans, but the amount of Sheraton furniture in existence belies the truth of this.

The X-rays have shown that they can sometimes usefully supplement the tests which are commonly resorted to for detecting fraud in old Masters and antiques. A radiograph will sometimes reveal constructional or other detail sadly out of tune with the reputed period. In the case of pictures or panels, the X-rays may give instructive information on the pigments which, in general, are more opaque in old pictures than in new, on the priming, which is commonly more opaque in new pictures than in old, and on the canvas, wood, or other surface painted on. Thus it happens that in the case of an old painting the X-rays can sometimes be employed as a means of detecting alterations or restorations or of identifying a modern fake.

Radiography could similarly be used to establish the identity of originals of modern pictures or panels, forgers of which are therefore not prevented from simulating closely the canvas, wood, and pigments. But in a radiograph the fine details of the canvas, or of grain and knots in the case of wood, are so characteristic as to be impossible of exact copying. If such records were normally taken, the method would also be of service in differentiating between the original and the copies painted by the artist himself. Furthermore, tentative detail ultimately painted out is sometimes revealed in the original painting which naturally is not repeated in the copies.

X-ray Diffraction

From Laue's momentous discovery in 1912 of the diffraction of X-rays, the science of X-ray spectrometry has grown to great proportions. The main developments deal with emission and absorption spectra, with crystal analysis and with the structure of atoms. Naturally, with the growth of the subject, special apparatus and technique have been developed.

In optical spectra the number of lines peculiar to an element are frequently numerous and their numerical relations complicated. X-ray spectra, on the contrary, are noteworthy for their simplicity, the number of lines characterising an element being relatively few, readily recognisable, and measurable with a precision not inferior to that which obtains in optical spectra. Moseley's great discovery in 1913 established a simple proportionality between the atomic number of an element and the square root of the frequency of a characteristic radiation or of an absorption limit. Moseley's law holds for all the known elements, and so it is possible to interpret new spectral lines with ease. It was by X-ray spectrometry that the element hafnium was discovered in 1923; and only recently Nonnack and Tacke announced the discovery by X-ray analysis of two new elements which they called masurium and rhenium. Thus 89 out of 92 elements are now known, and the spectral lines of the missing three elements (Nos. 61, 85, 87) are predictable with certainty.

X-ray absorption spectra are very simply obtained by passing a pencil of X-rays through a sample of the matter and examining the transmitted beam by a crystal spectrometer. The X-rays should be excited by a suitably high voltage. It is best to have the substance in finely powdered form deposited on, say, paper. Very little material will suffice if the absorbing screen is placed at the slit of the "collimator." Solutions can also be tested, though not so readily. The method is specially applicable to all elements with a strong *K* absorption band, *i.e.* the iron group and heavier elements. For the elements of high atomic number the *L* band is also convenient. In the case of mixtures of adjacent elements the several absorption bands may tend to obscure one another, and for this reason the method excels in detecting traces of heavy elements in light elements.

Emission spectra are conveniently excited by mounting the material on the face of the target of an X-ray bulb and applying a suitably high voltage. In such spectra every element present is recorded with an intensity which depends only on its concentration and is independent of the presence of any other elements with which it may be mixed or combined. Such intensities are measured with a microphotometer. The method thus enjoys great advantages over optical spectroscopy. The test is a very sensitive one and, although not suitable for the very light elements, has found commercial application in analysis of the platinum group of metals and the rare earths. An alternative method, though not so effective, is to bombard the test material with X-rays, as in Barkla's original method of exciting characteristic X-rays. This can be readily made the basis of a method for analysing mineral salts.

The aim of X-ray crystal analysis is to determine the grouping of the atoms and molecules in the crystal unit, and so to account for the properties of the crystal. There are three main experimental methods:

(*a*) Laue's method, in which a narrow pencil of heterogeneous rays is passed through a single crystal.

(*b*) The Hull-Debye-Scherrer method, where homogeneous rays are passed through a thin rod of crystalline powder.

(*c*) The Bragg spectrometer method, in which a "slit" of homogeneous rays is reflected from a single crystal.

Many variations in the technique of these methods have been developed, some of which are becoming of industrial importance. For example, the Laue method may be arranged to test the general orientation or symmetry of crystal aggregates, in which case homogeneous rays are advantageous. The Bragg method is also applicable to a conglomeration of minute crystals. In many of these methods the specimen is kept in continual rotation or oscillation (de Broglie).

Our knowledge of the atomic structure of the solid state of matter owes more to X-ray analysis than to any other means. For example, most chemical elements, including solidified gases, have been shown to crystallise in the cubic or hexagonal system. Already nearly half the elements have been examined, including those allotropes which can arrange themselves in more than one kind of space lattice. As regards alloys—solid solutions and intermetallic compounds—the

X-rays have thrown light on and tested the truth of the existence of the several phases of steel and other alloys which metallurgists had differentiated by other means. The method has also indicated the atomic features which go hand in hand with ductility, hardness, etc. It has also been shown that in a solid solution of two elements the replacement of one atom by another is effected by substitution in and distortion of the lattice and not by interstitial insertion (Owen and Preston at the National Physical Laboratory). Other points which have been worked on are the effect of annealing, tempering, rolling, or other working; the mechanism of deformation and slip in metals; and the general shapes and sizes of atomic domains.

By the use of X-rays Sir William Bragg has shown that a diamond has an atomic bonding perfect in its symmetry and so possessing intense hardness. On the other hand, graphite (another variety of carbon) with unsymmetrical atomic linking, with weak linking and greatest separation between cleavage planes, is a good lubricant. So-called amorphous carbon is found to consist of minute graphite crystals. The fragility of annealed tungsten lamp filaments is explained by the gradual transformation to a number of single crystals of large dimensions.

The X-rays have demonstrated that almost every solid substance in Nature shows crystalline form, including such apparently amorphous materials as rubber, cellulose, soap, leather, bamboo, and talc. Müller and Shearer have shown that the fatty acids give characteristic spectra which enable them to be identified in mixtures. This work was done at the Davy Faraday Laboratory where, under Sir William Bragg's guidance, the structures of many organic and inorganic crystals have been elucidated. Colloidal metals are shown to be made up of minute yet perfect crystals so small that they contain only a few score atoms. The molecular arrangements in thin metal and liquid films have been ascertained. In gold leaf, for example, the cubic crystals are found to have their cube faces parallel to the sheet. The Laue method has been used at the National Physical Laboratory to ascertain the crystal axes of jewel bearings. Within the last few months Dauvillier and Shaxby have ascertained the structure of pearls and shown that the Laue method, using homogeneous rays, affords a trustworthy and valuable criterion between the true natural pearl and the cultivated Japanese pearl, consisting of a thin pearly covering on a sphere of mother-of-pearl as a nucleus.

These are but a few of many examples which indicate that the several processes of X-ray spectroscopy are not only a valuable scientific tool for the physicist, but also that they are destined to play an important rôle in many industrial processes of the future. There are grounds for hoping that light may be thrown on the mechanism of such properties as magnetism, electrical and thermal conductivity, contact and thermal electromotive forces, dielectric capacity, fluorescence, the various types of elasticity, cohesion, diffusion, adsorption, etc.

Mineral Industries of the United States during the War.

THE mineral resources of the United States are of primary importance, for in 1915 that country produced 40 per cent. of the world's output of coal, 40 per cent. of its iron ore, 32 per cent. of its lead and zinc, 60 per cent. of its copper, and 66 per cent. of its petroleum. Since then, some of these proportions have increased. The data for the history of the mineral development of the United States during the War have now been issued in seven thick volumes,[1] which contain for each year the full record of the United States output of all important economic minerals, with shorter accounts of the contributions of other countries. The volumes consist mainly of compilations of mineral statistics accompanied by the statement of such geological and economic facts as are necessary to their interpretation. In each volume some chapters, in addition to the annual statistics and record of the year's development, contain a general review of the subject with reference to the current literature and geological descriptions of the chief mining fields. These monographic chapters include those on chromite by J. S. Diller, on graphite, with interesting accounts of its mining in Ceylon and Madagascar, by H. G. Ferguson, on molybdenum by F. L. Hess, on potash by W. B. Hicks, on American utilisation of peat by C. C. Osbon, and on quicksilver by F. L. Ransome. In view of the importance and variety of the American yields, the especially important sections are those dealing with coal, petroleum, and the five metals which are so closely associated that they are recorded together—gold, silver, lead, copper, and zinc.

We find in these volumes, in addition to the record of the normal development of the mining industry, an account of the more sensational temporary effects of the War, which were often bewilderingly unexpected and contrary. Prices rose and fell in a manner that was at the time inexplicable, and in some cases is still obscure. The answer may be simple, though not obvious at the time; thus, although cadmium is more expensive than tin it was used in solders as a substitute, so that tin might be reserved for purposes for which it was indispensable. Some of the uses to which cadmium was put are still unrevealed, and Mr. Siebenthal, the author of the chapters on that metal, reports that a German firm in 1913 advertised for the purchase of unlimited supplies, and refused to answer inquiries as to the purpose for which it was wanted. It was certainly used in Germany during the War as a substitute for tin, but other uses by the belligerents on both sides have not yet been revealed.

The War, by its increased demands for metals, helped some branches of mining, but hampered others; thus the unlucky antimony miners of China, who produce the bulk of the world's supply, suffered both from the fall in price of their product and from the rise in the price of silver, which added to their working costs. In the case of some metals a fall in prices appeared to

[1] Dept. of the Interior, United States Geol. Survey. Mineral Resources of the United States:
1915. Part I., Metals, 1917, iv, 99a, 1000+3 pl.
1916. Part I., Metals, 1919, v, 73a, 871+3 pl.
1916. Part II., Non-Metals, 1919, v, 1115+4 pl.
1917. Part I., Metals, 1921, v, 79a, 980+8 pl.
1917. Part II., Non-metals, 1920, vi, 1293+1 pl.
1918. Part I., Metals, 1921, iv, 149a, 1096+9 pl.
1918. Part II., Non-metals, 1921, viii, 1557+16 pl.
Washington: Government Printing Office.

encourage production. This anomaly is now explained by the feverish prospecting in consequence of the sudden increase in the demand. Thus in the zinc fields of Oklahoma it is estimated that ten years prospecting work was done in two years; and ore had to be produced and sold at any cost to repay the expensive development work, and thus the mines had to empty their reserves during the subsequent slump in prices. The anxiety as to the shortage of molybdenum in the early part of the War was easily allayed by the United States, where it was known to occur in many districts; the chief producer had been Arizona, but the demand was satisfied by the output from the colossal deposits of fractured granite yielding about 0·8 per cent. of molybdenite at Bartlett Mountain near Leadville, Colorado.

In spite of the War troubles, many of the American mining fields continued their normal progress. Thus the goldfields of California, in spite of seventy years of production, still have mines working in five of the counties along the great Mother Lode; in 1918 they yielded no less than 1,015,509 short tons of gold ore of a value of 4,334,061 dollars, or an average of 4·268 dollars per ton. The total yield was smaller owing to the War conditions and not to the exhaustion of the ore, and some of the mines that closed down are expected to reopen when costs become normal. The placer mines of California are worked successfully both by hydraulic sluicing and dredging, and it would be of interest if the yield per cubic yard and costs of working were stated. For Alaska these figures are given, showing that the dredges are working there at the high cost of about *2s. 6d.* per cubic-yard; the amount fell owing to the higher costs. Of the Alaskan placers 574 of them were at work during the summer and 153 in the winter; but the lode mining is increasing and in 1918 yielded 29 per cent. of the output. The great Homestake Lode of South Dakota, famous for the large scale of its operations, has still vast reserves of ore. Between 1875 and 1918 it has yielded 160 million dollars of gold with a profit of 41 million dollars. The output of ore in 1918 was 1,628,000 tons, but the dividends, owing to higher costs, fell one and a half million dollars.

The United States still maintains its supremacy in copper production, and on opening these volumes it is natural to turn at once to the sections which show the conditions at the Calumet and Hecla Mines of Lake Superior. They work three "lodes," as they are called to satisfy American mining law. The famous conglomerate which was the most remarkable ore from this field is nearly exhausted; the working of the amygdaloids is increasing, and the mines obtained 67 million pounds of copper during the year 1918, at a total cost of 21·65 cents per lb. The prolific field of Butte, which, mainly from one mine, the Anaconda, for years supplied 60 per cent. of the world's output of copper, has had in recent years a less prosperous time owing to the competition of large bodies of low-grade ore in the south-western States; but the yield from Butte in 1918 was still more than 313 million lb. of copper ore worth nearly 80 million dollars, in spite of the fall in price of the metal from the previous year. An especially interesting development announced is the reopening of the lower levels of the famous Comstock Lode in Nevada. Their closing thirty years ago by floods of superheated water is one of the best known and most instructive tragedies in the history of mining. The water has now been lowered by electric pumps through the Sutro Tunnel, world famous for its evidence as to the geology of the Comstock Lode; and good ore has been worked at 2900 ft., and some ore found at the depth of 3100 ft.

Tin remains the one metal in which the United States output is practically negligible. In 1918, in spite of the search for tin stimulated by its high price, the output amounted only to 69 short tons, mostly yielded by the gravels of Alaska with a little from South Dakota and Carolina. The report on tin is illustrated by one of the many interesting maps showing the distribution of mining through the world; but this map appears to suggest that the Australian output of tin is in New South Wales, and the figure should have been over Tasmania.

Amongst the non-metallic materials, the normal development has continued the remarkable increase in American cement production, which is now nearly all of Portland cement. A peat industry has been established in recent years; its delay was no doubt due to the abundance of coal. The peat deposits of the United States are widespread through the north-eastern and north-central States from Minnesota to Maine, and the oft-expressed belief that peat cannot be formed in the tropics is contradicted by the large supplies known in Florida and beside the Gulf of Mexico. The bulk of the peat in the United States would appear to be a result of glacial conditions, and it is attributed to accumulation in the lakes, pools, and marshes left by the last glaciation. Peat is used mainly in the States for the manufacture of bacterial fertilisers, and as litter owing to its power of absorbing stable fluids; but in 1918, owing to the higher price of coal and difficulties of transport, it was used as fuel for the first time on an important scale in parts of the United States.

One of the most interesting developments of the non-metallic minerals during the War was that of potash. The agriculture of the eastern States of America was largely dependent on German supplies, and on their complete stoppage desperate efforts were made to utilise the local sources. It was found, however, that potash is not so indispensable as had been thought, and the view has since been expressed that the American farmers' faith in potash was a delusion inspired by the persuasive salesmen of the German Potash Syndicate. The urgent supplies of American potash were yielded by the Salt Lakes of western Nebraska; but it is recognised that they cannot be worked at post-War prices. The development of Searles Lake in California has been watched in Great Britain with especial interest; but the reports up to 1918 are of continued disappointments owing to technical and legal difficulties, which, it is said, are at length overcome and ultimate success there is anticipated. Some American igneous rocks contain huge quantities of potash silicates, but it seems doubtful whether they can be worked profitably in competition with the German supplies. The volume for 1918 enumerates many patents for the extraction of potassium from silicates; but these are not now regarded as hopeful, as the fall in price after the renewal of supplies from Germany led to a collapse

in American production, and the closing of most of the potash mines.

Coal is dealt with at great length for each year, and the report condemns what it describes as the utterly wasteful methods of American coal mining. The chapters on petroleum record the intense activity of the period under review, which afterwards had a disastrous effect on the American industry. The efforts of 1918 are now ancient history in the swiftly changing conditions of the mineral oil industry, and it is interesting to read the predictions of 1918 with the information of six years later. It is remarked with satisfaction that the oil yield had been maintained in spite of the inherent difficulty of finding new pools, and it is suggested that California, after six years production at its peak, must be prepared for a decline. The great success of the year 1918, in consequence of the active drilling, was in Texas; but that achievement was soon surpassed by the enormous increase from California, which produced a revolution in the American oil trade. In the report on 1915–16, confidence was expressed in the quick development of the oil shale of Colorado, but apparently nothing is said about that material in the later volumes, and the American output of shale oil was only begun in subsequent years.

By their wealth of compressed information and by the varied interest of the problems elucidated, these reports maintain the high standard which has made the series one of the chief works of reference in the history of the mineral industries of the world. J. W. G.

Solar Eclipses and the Eclipse of January 14, 1926.

THE rarity and striking character of total eclipses of the sun naturally predisposes astronomers to their study. Eclipses have revealed a remarkable feature in the movement of the moon, and successive observations are year by year increasing our knowledge of the sun's surface and surroundings. In the eighteenth century Halley, from the study of records of early eclipses, inferred a secular acceleration in the moon's motion. Twenty years ago Cowell confirmed this, and discovered a small secular acceleration of the sun's motion. His results have been further verified and amplified by Fotheringham. It has been shown by Taylor and Jeffreys that these results can be quantitatively explained by a slowing of the earth's rotation caused by the friction of the tides in certain shallow and constricted seas.

The observations of eclipses in the earlier part of the nineteenth century showed that the corona as well as the prominences belonged to the sun itself, and that it was not a halo produced in some way by the earth's atmosphere. The eclipse of 1868 led to the simultaneous discovery by Janssen and Lockyer of a method of observing prominences without an eclipse, and was a first stage towards the development of the spectro-heliograph. At the eclipse of 1870 Young, watching the diminishing crescent of the sun through his spectroscope, observed the reversal of the dark lines of the spectrum at the moment the eclipse became total. The existence of a green line in the spectrum of the corona near the iron line 1474*K* was also discovered. In course of time it was found that this line could not be attributed to any known element, and the name coronium was given to the substance from which it emanated.

Since this time the most important observations at eclipses have been made by photography. They have confirmed the fact, already shown by drawings, that the form of the corona changes in sympathy with the well-known cycle of the sun's activity shown by spots and prominences. But the main purpose of modern eclipse observations has been the elucidation by means of the spectroscope of the nature of the sun's surface and of the corona. One important exception is the verification of the bending of a star's light in passing through the sun's gravitational field, predicted by Einstein. British observers, taking advantage of the neighbourhood of seven bright stars in the eclipse of 1919, found that these stars showed, severally, displacements in accordance with the generalised theory of relativity. The result was confirmed in a more statistical manner by the American astronomers at the eclipse of 1922.

A great advance in the study of the constitution of the sun's surface as revealed at the instant at which the eclipse becomes total was made by Lockyer and Fowler in 1893. They found that the "flash" spectrum, as it is called, was not a mere reversal of the solar spectrum, but that many lines were "enhanced" in brightness, corresponding to differences found in the laboratory between spectra of the same substance obtained from an arc and from a spark. They amplified this by observations at the eclipse of 1898, and the striking differences between the "flash" spectrum and the permanent spectrum have been verified over a greater range of spectrum and in more detail at subsequent eclipses. These differences are now known to arise from ionisation of the elements, and Saha has shown what light they throw on the pressure and temperature at different levels above the sun's photosphere. In this connexion, the accurate determination of the heights above the photosphere which different elements attain is of importance. These heights have been determined from the lengths of the arcs of the "flash" spectra obtained by the use of an objective prism, but further research is needed.

These partially solved problems, combined with the desire to witness a very striking phenomenon, attracted a large number of astronomers from different countries to observe the eclipse of January 14, 1926. The track ran from the east coast of Africa across Sumatra to the Philippines (Fig. 1), and the maximum duration of the total phase was a little more than four minutes. An Italian expedition, under Dr. Horn d'Arturo, went to Somaliland. The British, French, German, Dutch, Australian, and several American expeditions chose sites in Sumatra, generally near Benkulen on the west coast, or the more readily accessible Palembang on the east coast. The telegraphic reports show different degrees of good fortune in the weather. The distribution of observers ensured good photographs of the corona. This is satisfactory, as in view of the relation-

ship between the form of the corona and the phase of the solar cycle it is desirable that such photographs should be secured at all the rare opportunities furnished by eclipses. It would seem that cirrus cloud has probably interfered with the further verification of the Einstein deflexion of light. To some this observation may appear a work of supererogation, but as an experimental problem it is very attractive, as by the photography of a field of stars a few degrees from the sun as well as that of the eclipsed sun, the agreement with theory can be more closely verified.

The British expedition near Benkulen was fortunate in weather and carried out its programme completely, but it is impossible as yet to say what results were obtained. The observers attempted to obtain spectra of the "flash" and the corona so far as possible in the infra-red and ultra-violet parts of the spectrum, where further exploration is required. One of their aims was to obtain the relative intensity of different lines of the spectrum of the chromosphere. In particular they wished to compare the intensities of two calcium lines in the extreme infra-red with *H* and *K*, as Prof. E. A. Milne had pointed out the special value of this observation in the determination of the degree of ionisation near the sun's surface. Photographs of the corona and of its spectrum, and the precise determination of the beginning and end of totality from the appearance of the "flash" lines, were also included in their programme.

To show what is involved in the observation of an eclipse, a more detailed account may be given of the British Expedition. In 1914 the Joint Permanent Eclipse Committee of the Royal and Royal Astronomical Societies decided that an expedition should if possible be sent to observe the eclipse of January 14 last, and it also prescribed the general lines of the research to be carried out. The Committee invited two of its number, Col. Stratton and Mr. Davidson, to undertake the task. These gentlemen had then to frame provisional estimates of the cost, so that a grant could be applied for from the Government Grant Committee of the Royal Society. When this was assured they had to decide upon the most suitable site in consultation with the Meteorological Office and the Admiralty. Their next task was to settle in detail the programme of observations, and to set about securing the best available instruments. They obtained a number of cœlostats from the Eclipse Committee, and borrowed other instruments from all sources. The Edinburgh Observatory lent a 4-inch lens of 40-ft. focus, formerly used by Dr. Copeland with a long iron trellis-work tube which could be taken to pieces and put together on the spot. The Royal Irish Academy lent a 4-inch lens of 20-ft. focus, and for a tube they adapted one made in sections and used by Greenwich observers in 1919. The Solar Physics Observatory at Cambridge lent two spectroscopes (one flint and one quartz) given to the Observatory by Col. Hills and used in several previous eclipses. In addition several prisms and speculum mirrors were collected. Other instruments, including a cinematograph, were bought by Mr. Barton, who arranged to go with the expedition as a volunteer to determine the precise instants of the commencements and end of totality. A wireless installation was kindly lent by Messrs. Burndept, Ltd., for the reception of time signals, and a recording chronometer by M. Dittisheim. The various instruments were then set up and got into approximate adjustment. Clocks were cleaned and repaired, mirrors silvered, and photographic plates and chemicals obtained. Observing huts of light wooden frames covered by waterproof canvas were constructed, the instruments and baggage were carefully packed and despatched to Liverpool for conveyance to Sumatra, the Blue Funnel Line kindly accepting this four tons as passengers luggage without extra charge.

The three observers sailed from Liverpool on November 7, and reached Benkulen, *via* Singapore and Palembang, safely with their instruments on

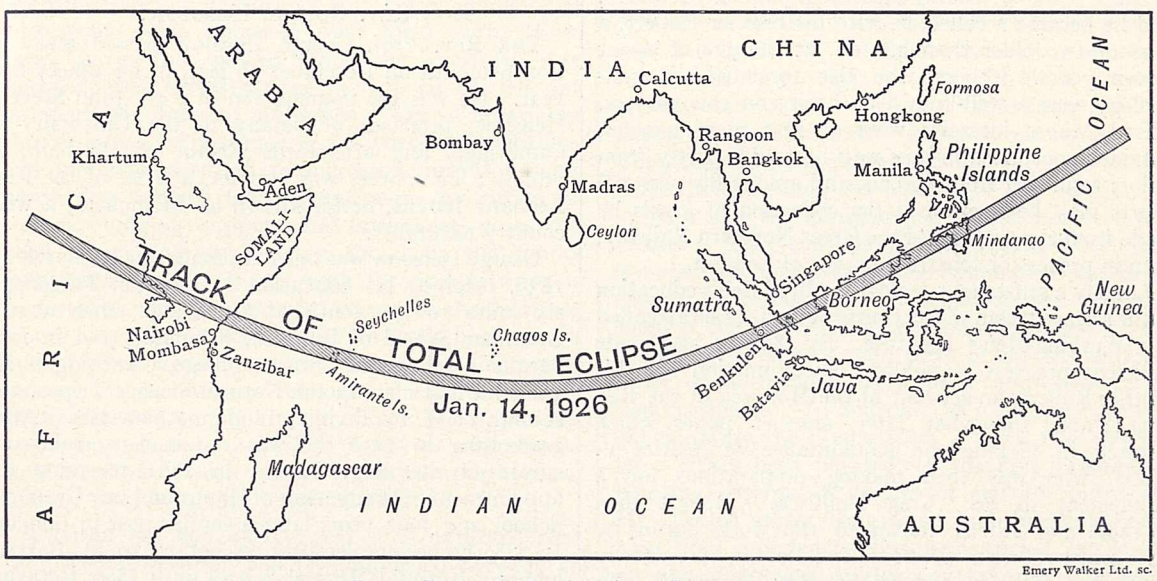

FIG. 1.—The track of the solar eclipse of January 14, 1926.

December 14, just a month before the eclipse. They thus had sufficient, but not too much, time to get their instruments erected and adjusted. They were joined later by Dr. Aston and Col. J. Waley Cohen, who combined a view of the eclipse with service to the party in the manipulation of their half-dozen instruments during the four minutes of totality. After the eclipse the plates must be developed, brought home and measured before the value of the results of half a year's work can be assessed. The observation of eclipses is expensive in time and money. The return on the outlay has been hitherto highly satisfactory, and we may expect that equal success will attend the latest expedition. F. W. D.

Obituary.

Mr. Alfred Bell.

MR. ALFRED BELL, who died at Ipswich on December 7, 1925, was born in the parish of St. Marylebone on June 28, 1835. During his long life of more than ninety years, he had been brought into contact with a long succession of geologists, and he was personally known to Murchison, Sedgwick, Lyell, Owen and many others. His interest in science was awakened in early years by reading illustrated popular literature, and he became a collector, with his brother Robert, a year or two older than himself, at the age of about eleven years. Robert, who also specialised in conchology, was a well-known authority on this subject. Alfred, whose interests were at first more general, obtained specimens in any way he could, partly from sailors returning from abroad, and among his personal efforts may be mentioned the collection of fossils he made from the cuttings of the Great Northern Railway, then in process of construction out of London.

Largely a self-taught geologist, Alfred Bell's education in the science began with a course of lectures he attended at a Working Men's Institute. By 1868 he had made sufficient progress to publish, in conjunction with his brother Robert, an account of the Mollusca of the Red Crag; and, somewhat later, another paper which resulted in making the acquaintance of Searles V. Wood, who was then making preparations for a supplement to his "Crag Mollusca." Robert died in 1888, and Alfred continued the work begun by his brother, with Prof. Kendall, on the newly discovered Pliocene beds of St. Erth, Cornwall. To the end of his life he worked specially at the East Anglian Crag, of which he had a remarkable knowledge. He visited all the important Pliocene deposits of Great Britain, Ireland and the Isle of Man, and he had some personal knowledge of those of Holland, Belgium and the Rhine Valley. His judgment on the specific differences of molluscan shells was regarded as particularly good, and a long list of papers on this group stands to his credit.

Alfred Bell was not one of the favourites of fortune, and he was obliged to make his living in commercial life, partly in the employment of others, but for a time as a professional collector and dealer. In the later years of his life he became the friend of Mr. F. W. Harmer, to whom he made prolonged visits, taking the greatest interest in Harmer's monograph on Pliocene Mollusca, the preparation of which was facilitated by the opportunities given by the visits for discussion and criticism. After Harmer's death, in April 1923, Bell retired to Ipswich, where he worked indefatigably until a few days before his death. His last paper, referring to the shells of the Isle of Man, was in the press when he died.

Without any special educational advantages, Bell acquired a wide knowledge, not only of his own subject, but also of others, such as archæology and history. He was of a genial temperament, possessing a considerable fund of quiet humour, and his characteristic optimism did not desert him even in his closing years, when the disabilities of old age fell heavily on him. His friends speak of him with affectionate regard.

G. Maynard.

Rev. George Henslow.

The Rev. Prof. George Henslow passed away at Bournemouth on December 30 last, in his ninety-first year. He was the younger son of Rev. John Stevens Henslow, professor of botany in the University of Cambridge, and afterwards Rector of Hitcham, in Suffolk; his mother was Harriet, a sister of the Rev. Leonard Jenyns, better known as Blomefield, a west country naturalist.

George Henslow was born at Cambridge on March 23, 1835, received his education at Sawston Parsonage, six miles to the south of Cambridge, then at the Grammar School of Bury St. Edmunds, and in 1854 became a scholar of Christ's College, Cambridge. He gained a first class in the Natural Science Tripos, and second class in divinity and mathematics. After graduating in 1858, he was ordained, and became curate of Steyning, Sussex, in 1861 receiving the appointment of headmaster of Hampton Lucy Grammar School, and four years later a similar post in London. In 1886 he became lecturer on botany to St. Bartholomew's Hospital Medical School until 1890, lecturing at other institutions also. He was a popular lecturer at the Royal Horticultural Society for many years; he had a good resonant voice, his method was attractive, his delivery clear and plain, and in the days before lantern-slides were common, at the right moment he would display a specimen or a drawing to his audience.

Henslow's pen was busy upon botanical subjects, largely in a popular sense, on evolution, the fertilisation of plants, Bible plants, the origin of flowers, and the like. Some years before his death, he gave to the Linnean Society eleven volumes of reprinted papers and three volumes on Darwinian subjects. He was elected a fellow of this Society on March 17, 1864, and at the time of his death was the senior fellow but two. He was twice married, his second wife surviving, but left no family.

We regret to announce the following deaths:

Mr. R. A. F. Murray, a pioneer of the Geological Survey of Australia and Government Geologist from 1881 until 1897, aged seventy-nine years.

Prof. W. H. Warren, Challis professor of engineering and president of the Professorial Board in the University of Sydney, and twice president of the Royal Society of New South Wales, aged seventy-three years.

News and Views.

THE National Institute of Industrial Psychology announced last week that in response to its appeal for funds, issued by Earl Balfour, an anonymous gift of 10,000*l.* had been received. Although the first list of donations has not yet been published, it is known that a thousand guineas have been contributed by Messrs. Debenham's and a hundred guineas by the National Union of Railwaymen. The Institute was established for promoting the study of the human factor in industry and commerce, and applying the results of such study in practice. Its investigations include the study of the best methods of work, especially the elimination of unnecessary movement, the most advantageous distribution of periods of rest and work, and the reduction of monotony. Suitable methods are devised for securing more efficient and scientific selection of workers, and better guidance of adolescents when choosing their life's work. Five years have now passed since the Institute was founded, and investigations have been carried out in twenty-six different industries. Almost invariably the resulting improvements in working conditions and methods have led to increased output accompanied by reduced fatigue, and some indication of the encouraging support and assistance given by both labour and employers is shown by the donors mentioned above. When work for private firms is undertaken, they are required to pay to the Institute a sum covering the expenses of the work, but, as with every other application of science, an enormous amount of preliminary research is essential before the results can be put into practice. The appeal for 100,000*l.* has been issued to form an endowment fund to allow of such research, and to equip a satisfactory laboratory and technical library.

BEFORE the end of the year it is expected that radio communication will be established between all the principal dominions of the British Empire. The stations at Bodmin in Cornwall and at Bridgwater in Somerset, which are on the Marconi short-wave beam system, are practically completed, all the masts being erected and nearly all the radio apparatus is installed. The engineers are only waiting for the conclusion of the tests at Chelmsford on the transmitters and receivers before starting operation. The Bodmin station is the transmitting station with Canada and South Africa, and the Bridgwater station is the receiving station for these services. Each station has ten masts, five for each dominion. The design of the masts is identical at each station. A row of five is erected at right angles to the direction at which signals are received or emitted. The masts are 277 feet high and 650 feet apart. Each mast has a cross arm at the top measuring 90 feet. There are two parallel steel cables, separated by a distance dependent on the wave-length used and running on each side of the masts from the first to the last, a distance of about 3000 feet. Internal combustion engines are used to drive the alternators, and the various requisite voltages are obtained by motor generators. The valves are of the oil cooled type and are mounted in a separate room adjacent to the power house. Owing to the high frequencies employed, the feeders to the aerials are made of copper tubes. Both stations are connected with the London General Post Office, and the transmitting station is operated from London by "distant control." The incoming messages are automatically relayed to London. Both outgoing and incoming messages will be received at the same table in the telegraph office, thus giving true duplex working and complete central control over the traffic. Similar stations are being erected at Grimsby and Skegness for communication with Poona in India and Melbourne in Australia. At the present time Marconi's Wireless Telegraph Co., Ltd., has in hand seventeen short-wave transmitting stations.

A PAPER entitled "Recent Forestry Development" was read by Mr. W. L. Taylor before the Surveyors' Institution on January 11. Mr. Taylor is a member of the staff of the Forestry Commission and his paper, perhaps naturally, presents the views of that Department of the progress made in afforestation in Great Britain since the passing of the Forestry Bill in 1919 and the inauguration of the Forestry Commission. That considerable progress has been made is undeniable, but professional opinion in Great Britain cannot be termed unanimous as to the wisdom of some of the activities of the Commissioners. During the six years some 52,279 acres of conifers and 2254 acres of hardwoods have been afforested by the Commissioners. In addition, as a result of grants in aid made by the Commission, a further 49,695 acres have either been planted, or the area prepared for planting, by public bodies or private individuals. Mr. Taylor states that some bad planting seasons have been experienced during the period, but is silent on the important subject of failures experienced. The remarkable afforestation work proceeding on the catchment areas of some of the big city water schemes such as Thirlmere, Derwent Valley, Vyrnwy, etc., is rightly highly commended. Up to date, the Commissioners have acquired 243,280 acres of land, of which 165,400 acres are considered to be plantable. The land appears to have been acquired at reasonable rates. One or two notable gifts of land have been made by private individuals, and the Crown Woods, Forest of Dean, New Forest, etc., have now been placed under the Commission. The scheme for the establishment of forest workers' holdings, inaugurated in 1924, should have great possibilities before it if correctly worked.

FOR some time past, the monthly journal *Roads and Road Construction* has been urging the necessity for organised research on road-construction, and in the January issue the question is returned to and it is pointed out, among other things, that research conducted under government auspices need in no way clash with that undertaken in private laboratories. The great problem is stated to be that of making a road capable of carrying the ever-increasing

bulk of traffic and axle-weight, without having to lay down a road-crust so massive that the expense would be prohibitive. Although rural roads in Great Britain are not above suspicion, those in the United States appear to be worse; no less than 85 per cent. of them, it is stated, are nothing more than tracks and are impassable for several months in the year. Very satisfactory results have recently been obtained in North Carolina, where the sands extend for hundreds of miles along the coast, by mixing 93 per cent. of sand with 7 per cent. of bitumen, and the view is expressed that much more sand should be used for road-construction in Great Britain. To the same issue Dr. P. E. Spielmann contributes an article in which he deplores the paucity of research-work on road-construction. Apart from the routine-testing of materials, the National Physical Laboratory has shelved its research work on behalf of the Ministry of Transport, and the various incorporated bodies having interests in this direction appear to be equally passive. Attention is directed to the plan of the Worshipful Company of Paviors to create a Maybury chair of highway engineering, tenable in the University of London, and the hope is expressed that research problems of basic importance will be undertaken by some government organisation appointed for the purpose.

THE report of the accountants appointed by the Board of Trade to inquire into the costs of production and financial results of the shale industry (as carried on by the undertakings associated with Scottish Oils, Ltd.) for the six months ending September 30, 1925, has recently appeared, and it makes very gloomy reading. The inquiry was held at a time when the industry was not only suffering severe economic depression, but also was harassed by acute labour troubles, the culmination of a long and critical period of commercial stress. As a result of the audit, the accountants find that there has been a net loss on the shale oil operations of the companies concerned of 77,822*l.* (for the six months in question), without allowing for plant and works depreciation; if the latter are included, the figure reaches 177,519*l.* The accounts for the same period, after allowing for income and expenditure apart from shale oil operations, and before making any provision for depreciation, show a loss of 57,776*l.* Thus the position of the industry is really quite as critical as has been evident from reports in the daily press, and it is not surprising, therefore, to find that the accountants propose that those works showing the heaviest loss per unit of output should be closed down. If this policy is carried out, it will result in the cessation of operations in the Tarbrax Crude Oil Works and Mines, the Dalmeny Crude Oil Works and Ingliston Mine, the Broxburn Crude Oil Works with the Broxburn and Newliston Mines, and the Broxburn Refinery. This would mean that the remaining mines would presumably supply shale to be treated principally at the well-known Oakbank and Pumpherston refineries. There are many contributing factors to this decline of the Scottish shale industry, chief of which is undoubtedly the competition which has to be faced with regard to products from natural petroleum, and so long as the markets are swamped with such products at existing prices, so long will the oil shale industry remain at a disadvantage, both from the point of view of contemporary economics and of future development

THE Russian Society for the Study of the Urals, Siberia and the Far East is publishing, in conjunction with the All-Russian Central Executive Committee for Assistance to Northern Tribes, a new periodical, *North Asia*, devoted to the study of the northern Asiatic territories of Russia. The journal has the support of the Chief Department of Scientific Institutions (Glavnauka) and is edited by V. Vilensky-Siberiakov. The editorial staff includes a number of well-known authorities in various departments of science, economics and history. The main object of the new journal is the investigation of the economic problems of Siberia and the amelioration of the position of its native tribes. The four numbers of *North Asia* already issued contain a series of articles dealing with the natural resources of the country, its trade and industries, and a prominent place is given to sociological and ethnographical questions. There are also a number of papers on the geography, geology and history of various parts of the country. Apart from the original articles, the journal contains reviews of reports presented to the Society, bibliographical notices, and the texts of administrative and legislative Acts concerning northern Asia. All the articles are written in Russian and are not provided with summaries in a foreign language, only the title of the journal and the table of contents being translated into English.

SINCE the Belgian physicist Plateau, nearly a hundred years ago, devised a stroboscopic apparatus for the study of the vibrations of plates, many modifications of his type of apparatus have been used in practice. They can be divided into two classes. In one class the moving object is only seen when it is passing through one phase of its motion. In the other, it is only illuminated when passing through one phase. In *La Nature* for December 19, a description is given of an apparatus of the latter class called the "stroborama," invented by L. and A. Séguin. The great advantage of this apparatus is that it can be used in broad daylight, and so it should prove useful in studying the working of the various parts of the machines running in a factory. In a textile workshop, for example, the tension of the threads as well as the running of the reels can be examined. The electric power taken by the device is about 1·5 kilowatts. Neon tubes of great illuminating power are used. By means of a rectifier, a transformer and condensers, the tubes flash with great brilliance at periodic intervals adjusted to the period of the rotating or vibrating apparatus which is being examined. The accuracy with which the running of machines can be studied by the stroborama was demonstrated by the following experiment. Two scratches at a distance of 1 mm. apart were made on a disc. It was then rotated

rapidly so that the scratches moved at a speed of 100 metres a second. When examined by the stroborama the scratches moving at this speed were plainly visible.

PROF. P. F. KENDALL, emeritus professor of geology in the University of Leeds, and Mr. T. Sheppard, of the Municipal Museums, Hull, have been elected honorary life members of the Yorkshire Conchological Society.

IT is announced in *Science* that Dr. Harris J. Ryan, professor of electrical engineering at Stanford University, California, has been awarded the Edison medal for the year 1925 by the Edison medal committee of the American Institute of Electrical Engineers "for his contributions to the science and the art of high-tension transmission of power."

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. Albert Einstein, for his relativity theory of gravitation. Prof. Einstein's name is widely known, even beyond scientific circles, through the theory of relativity originated by him in 1905 and generalised ten years later. Last year he was the recipient of the Copley Medal of the Royal Society.

THE New York correspondent of the *Times* states that Mr. Daniel Guggenheim is establishing a fund of 500,000*l.* to assist aeronautics until the freight and passenger carrying services of the United States are self-supporting. The fund is for the promotion of teaching and research in aeronautics and for the development of commercial aircraft, and the trustees are empowered to expend the whole in ten years.

THE Dominion Museum, Wellington, N.Z., has long been dangerously crowded. From the latest reports of the Director we learn that a large part of the Maori collections has been provisionally removed for exhibition to another building, and that the Government has decided to allocate the sum of 75,000*l.* towards the cost of a new building, provided that an equal sum is contributed by the public.

AT the meeting of the London Mathematical Society on Thursday, March 11, at 5 P.M., in the rooms of the Royal Astronomical Society in Burlington House, Mr. R. H. Fowler will give a lecture on "Atom-Mechanics." Members of other societies will be welcome as guests. It is hoped that Prof. A. Sommerfeld, of Munich, honorary member of the Society, will be present and speak after the lecture.

ACCORDING to a recent issue of *The Publishers' Circular*, a total of 13,202 new books and editions were issued in Great Britain during the year 1925. The number of new books was 9977. The corresponding totals for 1914 were 11,537 and 8863. Grouping the publications according to subject, the totals for the past year appear in the following order: (1) Fiction, (2) juvenile, (3) religion, (4) sociology, (5) poetry, (6) biography, (7) science, (8) technology. The order for 1914 was: (1) Fiction, (2) religion, (3) science, (4) sociology, (5) technology.

IT is stated in *Bull. No. 20 of the U.S.S.R. Society of Cultural Relations* that Prof. Elie Ivanov, well known for his numerous investigations on hybridisation by means of artificial insemination, is proceeding to French Guinea with the object of carrying out a series of experiments on the crossing of the human species with anthropoid apes at the station of the Pasteur Institute. Cross-breeding will first be attempted between the chimpanzee and orang-outang, and the baboon and gorilla. The human experiments will be conducted on representatives of some of the primitive African tribes.

THE Society for the Provision of Birth Control Clinics has issued its annual report for 1924–25. The major part of the Society's work is conducted through the Walworth Women's Welfare Centre, where 2069 new cases were dealt with during the year. From some of the cases quoted it can scarcely be doubted that such clinics under wise control serve a useful purpose. An important principle laid down by the Society is that every patient must be seen by a member of the medical staff, which is composed of medical women. We think that wherever practicable the staff should be married women. The Society depends entirely upon voluntary contributions, apart from a small nominal fee paid by patients.

A CONFERENCE was held by the Society for Experimental Biology at University College on January 7 and 8. At the morning session a general discussion was held upon respiratory pigments found in both plant and animal tissues, which was closed by Prof. J. Barcroft, who summed up the present position of the problem. In the afternoon papers were presented on the nature of protoplasmic surfaces on amœboid movement, on the hydrogen ion concentration and oxidation potential within cells, and on the occurrence of nuclear materials in certain plants devoid of differentiated nucleus. A large number of exhibits were shown during the tea interval. The final session included papers on the physiological adaptation of abyssal Cephalopoda; on inheritance in *Limnæa stagnalis*; on structural growth in *Gammarus chevreuxi*, and on the relation of the effect of temperature on movement of the tail in tadpoles to its effect upon chemical reactions. At the end of the conference members of the society expressed their thanks to their hosts, particularly to Prof. D. M. S. Watson and Prof. J. P. Hill.

COMMENTS by O. Hahn and L. Meitner on the experiments described by Dr. A. Gaschler on increasing the yield of uranium X from uranium by artificial means were referred to in NATURE of December 5, 1925, p. 827. Dr. Gaschler now writes to say that it is incorrect to state that he undertook experiments at the A.E.G. on the transmutation of uranium into uranium X with high-tension currents. He also states that accurate experiments could not be carried out at the Kaiser Wilhelm Institut für Chemie in Berlin-Dahlem on account of lack of facilities. Most of Dr. Gaschler's work has been carried out in private laboratories.

WE have received from Messrs. Negretti and Zambra the "Easy Setter" Thermometer Case. It consists of a clinical thermometer case of the usual type with a screw-on cap and provided with two short arms placed at right angles to the main part of the stem just below the cap. One arm is fixed to the stem, while the other is covered by a loose cylinder, so that by holding this arm between the thumb and forefinger the whole case can be made to rotate on this arm as axis. The fixed arm is milled to give purchase to the thumb and forefinger of the opposite hand in spinning the case. The principle is that of the centrifuge. The thermometer is placed in its case with the bulb downwards, the cap screwed on, and the instrument spun, when the mercury falls towards the bulb. The necessity of shaking the thermometer is thus obviated.

AN article appears in the *Fortnightly Review* for December, by J. B. C. Kershaw, on the domestic smoke problem. Data are available which show that the burning of coal in open grates contributes very largely to the haze of smoke which hangs over large towns. The use of gas coke and anthracite in closed stoves and of coal gas for heating has solved part of the domestic smoke problem, but the use of smokeless fuels in the open grate is essential before houses can be run without the production of any smoke whatever. We have also received a copy of the sixth report of the Smoke Abatement League of Great Britain, containing accounts of the annual meeting, smoke abatement exhibition, "smoke weeks," exhibits, lectures, literature, etc. The work of the League is fostered by local authorities, but the report indicates that it is hampered by lack of means.

AMONG the announcements by the Cambridge University Press of forthcoming books are "Clouds and Weather Phenomena," by C. J. P. Cave, the aim of which is the explanation of clouds, rainbows, mirages, the colours of the sky, and other atmospheric phenomena, and part 4 of "Ticks," which work is by Prof. G. H. F. Nuttall and others. The new part is by Dr. L. E. Robinson and deals with the genus Amblyomma.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A junior assistant in the physics department of the National Physical Laboratory, Teddington—The Director (February 1). Three technical assistants in the Torpedoes and Mining Department of the Admiralty—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (February 5). A junior scientific assistant in the Ignition and Electrical Department of the Royal Aircraft Establishment to assist in research in connexion with aircraft appliances—The Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (February 13, quoting A. 78). The Wilson Philological lectureship for 1926–27 in the University of Bombay—The Registrar, the University, Bombay (March 10). An assistant physicist to the Linen Industry Research Association, Lambeg, Co. Antrim—The Secretary.

Our Astronomical Column.

THE NEW COSMOGONY.—An interesting article by Dr. J. H. Jeans on "The New Outlook in Cosmogony" appears in the December number of *The Nineteenth Century*. "We now get the best picture of the universe," he says, "by thinking of it as consisting of a number of sub-universes, detached from one another like islands in an ocean." Our own star-system is one such universe—"a very big island indeed, with the sun not far from its centre."

Space is not infinite, so that there are a finite number of sub-universes. As a guess we may suppose that the most remote bodies of all in our universe are at four million light-years from us. The Andromeda nebula and the star cluster N.G.C. 6822, the most remote bodies the distances of which are yet known, appear to be about one million light-years away. The history of this universe is investigated in terms of the energy changes which we deduce must occur from the fact that the stars radiate more energy than they receive. All possible sources of their energy so far suggested have proved to be altogether inadequate except that arising from the annihilation of mass. According to the theory of relativity, loss of energy must entail loss of mass, and if we suppose the mass lost to be the actual "material" mass of the atoms—the so-called "rest-mass"—then there is a sufficient store to account for stellar radiation over the periods indicated by geological and other evidence.

The life of a star on this hypothesis can be calculated, and comes out to about 200 million million years. The sun has at present lived about seven million million years, so that the greater part of its life has yet to come, although as regards magnificence it has been and will be continuously on the wane. The great length of stellar life now contemplated makes it possible that many solar systems such as ours have been formed in the past by the close approach of two stars, although, even now, "a small proportion only of the stars in the sky are likely to be surrounded by families of planets and so to form possible abodes of life." Dr. Jeans sees no prospect of a utilitarian application of the conversion of mass into energy. "So far as can at present be seen, this dream is not destined to be fulfilled."

THE BRIGHTNESS OF SATURN'S RING.—B. Fessenkoff of the Astrophysical Institution, Moscow, describes in *Astr. Nachr.*, No. 5408, some interesting comparisons of the brightness of Saturn's ring as compared with the centre of the disc; the observations were made by him and Mr. Vsechsviatsky, using a Rosenberg-surface-photometer on the 7-inch refractor of the Koutchino Observatory.

A square 5″ in the side at the centre of the disc was compared with an equal square at each ansa of the ring. The result of comparisons on five nights in June last is that the centre is brighter than the western ansa by $0{\cdot}414 \pm 0{\cdot}0104$ magnitudes, and than the eastern ansa by $0{\cdot}317 \pm 0{\cdot}0057$ magnitudes. The difference of 0·1 mag. between west and east was clearly shown, but can scarcely be permanent. The above differences do not directly apply to albedo, since the centre of the disc is vertically illuminated by the sun, while the illumination of the ring is very oblique. Moreover, the measures were apparently made on the outer ring A, which is well known to be considerably less bright than the outer part of ring B. Thus the albedo of the latter probably exceeds that of the disc, a result that has been obtained from earlier measures.

Research Items.

IDENTIFICATION BY RECOGNITION.—In a pamphlet called "Mistaken Identity" (London: Longmans, Green and Co., 1925, 6*d*. net), Mr. Clifford Sully discusses the psychology of recognition. A recent famous case has demonstrated only too clearly that to identify a person as a particular person is neither an easy nor a trustworthy process. Because we so frequently in ordinary life see people in their usual setting, we fail to realise how little we actually observe at the moment, as against the amount we bring to bear from memories of previous occasions. Perception and accurate observation are not the simple processes they are rashly assumed to be, nor can honesty of purpose guarantee accuracy of observation. Reference to any text-book of psychology will give the reader evidence of the complicated and personal nature of ordinary perceptions, and this can be easily demonstrated by studying some of the well-known illusions. If errors are frequently made when the mind is critical and unperturbed, how much more likely are they to be made when emotion forms the background, which would naturally be the case in connexion with police trials. Complicate the problem still further with the effect of the newspapers on witnesses, and we have a state of affairs when the probability of unbiassed judgment is exceedingly low. No experimental psychologist would accept evidence given under such conditions, and yet it forms no insignificant part of police court evidence. Nor is a feeling of certainty any proof of the truth of the judgment. The author pleads that more attention should be paid to the psychology of human testimony.

THE "ARCHAIC CULTURE" OF MEXICO.—The sensational claims made for the antiquity of the relics of human occupation discovered beneath the lava flow in Mexico Valley give an added importance to the very careful investigations which were carried out there by Mr. A. L. Kroeber in the spring of 1924. A descriptive analysis of his results have now been published in Pt. 7 of vol. 17 of the *California University Publications in American Archæology and Ethnology*. The archaic culture first began to be recognised as such in 1911 or 1912. A particular phase of it is the so-called sub-Pedregalense—a culture found beneath the lava flow or pedregal of San Angel. This is a sheet of lava of about twenty sq. km. or more in Mexico Valley which issued from the peak of Ixtle, covering earlier Pliocene or Miocene andesitic flows. In parts excavated on this occasion, the cultural deposits extended to a depth of so much as 3 metres below the lava flow. Careful comparison of material from this and other archaic sites, based chiefly on the pottery, have made it possible to work out a culture sequence which falls into four periods; but the absolute age cannot yet be fixed. In the geological sense the lava flow is quite recent. Culturally the archaic period is characterised by maize agriculture; but cotton may not have been in use, as spinning appears to have been undeveloped. All the important traits of the culture are found in more developed form in the Teotihuacan culture. While it includes the general objective features of Mexican religion, it precedes the individualisation of specific deities, symbols and acts of this religion. It has no specific features characteristic of any other area, such as the Pueblo, from which indeed it is definitely marked off by the occurrence of pyramid and step structures as well as other features.

MARQUESAN MUSIC.—Mr. E. S. Craighill Handy and Miss Jane Lathrop Winne have published in *Bull. 17, Bernice P. Bishop Museum of Honolulu* a study of the native music of the Marquesas Islands based upon material acquired by the former when a member of the Bayard Dominick Expedition of 1920–21. In the olden days, chanting accompanied practically every activity of life among the Marquesans and formed the central feature in most rites and festivities. Twenty-five different types of chants for use on different occasions were collected on Hivaoa alone. Although solo singing was in use it was choral singing that was distinctive of their music. When a song was required for a particular occasion, the head of a family hired an adept who composed words and music. A chorus was then assembled and instructed, a special house being built for the accommodation of the singers while instruction was proceeding if the song was a tapu chant. The type of chant determined the nature of the chorus, *i.e.* whether of young girls, mixed voices, men or old men. Three types of voices in each sex were recognised, and each song had an established voice or register. For instrumental accompaniment, drums of wood and shark skin, bamboo mouth flutes and small resonant sticks were employed. The songs themselves were recreational, eulogistic or religious, while the natives themselves divided them into tapu (those with a serious purpose in view) and non-tapu (old songs which had served their purpose and were chanted for amusement, or those which were purely recreational).

IRRIGATION IN INDIA.—The Public Works Branch of the Department of Industries and Labour of the Government of India has published the Triennial Review of Irrigation in India for the period 1921–1924, from which it is to be gathered that the average area irrigated annually in British India by Government works of all classes during the triennium was 27½ million acres, as compared with 26¾ million acres, the average of the previous triennium. In general, the results obtained have been as good as, or better than, those of the previous period, the notable exception being the United Provinces. The decrease in the area irrigated in this territory (rather more than a million acres) is attributable mainly to the favourable seasons experienced during the triennium. The total capital outlay, direct and indirect, on irrigation and navigation works, including works under construction, amounted at the end of the year 1923–24 to Rs. 89,25 lakhs. The gross revenue for the year was Rs. 10,65 lakhs, and the working expenses, Rs. 3,77 lakhs; the net return on capital was, therefore, 7·71 per cent. It is pointed out that the capital invested includes considerable expenditure upon three projects of the first magnitude, namely, the Sarda-Oudh canals, the Sutlej Valley and the Lloyd (Sukkur) Barrage projects, which are under construction and contribute nothing at present by way of revenue. The last named is the greatest irrigation scheme ever undertaken, and, when completed, it is expected to inaugurate an era of unprecedented prosperity for the Province of Sind in which it is situated. The Secretary of State for India sanctioned the project in April 1923, and the total expenditure on works, mainly of a preliminary character, including special tools and plant, during the year 1923–24 was nearly Rs. 23½ lakhs. The Sutlej Valley project in the Punjab, sanctioned in the year 1921–22, has made good progress, and the Sarda-Oudh canals are well advanced.

SALMON AND RIVER POLLUTION.—An interesting and important report on pollution of the River Tyne Estuary, 1922–1924, by Miss Edith M. Meek, produced by the Tyne Pollution Sub-Committee, is published

in the Dove Marine Laboratory Report for the year ending June 30, 1925. Pollution from various sources has resulted in a serious deterioration of the salmon industry in tidal and non-tidal waters; the ascending and descending fish both being involved, although it is specially the smolts which suffer. The smolts, about seven inches long and usually just under two years old, migrate down the river in large shoals at certain periods, and, unlike the older ascending fish, are not able to take advantage of specially favourable conditions occurring irregularly; they thus frequently enter polluted areas and are destroyed in numbers. The chief causes of pollution are sewage and effluents from works, the former causing suffocation through lack of oxygen, the latter direct poisoning. Of these, however, the sewage problem is by far the more dangerous, and crude sewage is the dominant factor in the pollution of the Tyne Estuary. The report of the sub-committee is of the opinion that sewage is by far the worst enemy of the industry. Two natural counteractions are the water temperature and the presence of freshets of pure upland water resulting from rainfall, which descend in time of flood, thus forcing the polluted water out to sea and enabling the ascending fish to take advantage of the pure water. Low temperature and abundant rainfall are essential for the escape of the fish. Appendices on the bacteriology and plankton contents of the polluted areas, with statements of the numbers of fish caught, follow the report, with accounts of physiological experiments undertaken by Miss Meek, mainly on the amount of dissolved oxygen and the keeping of fish in observation tanks in the polluted water.

AN ARCTIC FISH IN BOSNIA.—In the *Novitates Musei Sarajevoensis*, No. 3 (November 1925), Dr. St. J. Bolkay records the discovery of the capelin (*Mallotus villosus*) fossilised in nodules in a clay at an altitude of 580 metres in S.E. Bosnia. The nodules resemble those containing the same fish which are often found in glacial clays in Greenland and near Ottawa in Canada. The fish exists at present in great numbers in Arctic seas and in the colder parts of the North Atlantic and Pacific Oceans. Its occurrence in clays of the Pleistocene period so far south as Bosnia is therefore a fact of great interest.

THE CLASSIFICATION OF THE FORAMINIFERA.—The attention of students of recent and fossil Foraminifera may be directed to Joseph A. Cushman's introduction to the morphology and classification of the Foraminifera (*Smithsonian Misc. Coll.*, vol. 77, No. 4, 1925). A brief account of the life-history, of the structure of the test, and of the distribution in present oceans is followed by suggestions for collecting, washing, sorting, and mounting recent and fossil examples. The terms employed in systematic descriptions are briefly commented upon and a classification into ten families follows. Under each family the constituent genera are concisely defined, and in most cases a figure is given. From the point of view of the student of the test the systematic summary is admirable, but if the author had added an account of the cytoplasm and nucleus in two or three typical cases, and fuller details of the life-history, the memoir would have had a still wider appeal.

THE LIFE-HISTORY OF GORDIUS.—Dr. Jan Švábeník has issued (*Publ. Fac. Sci. Univ. Masaryk*, 58, 1925) the results of his observations on the life-history of *Gordius tolosanus*, one of the "hair worms." The primary host of this worm is the larva of some midge (Chironomidæ); Corethra and Anopheles are not infected. The first host becomes infected not by way of the mouth, but by the entry of the larvæ of the worm through the soft skin of the appendages at the hind end. The author has succeeded in infecting various carabid beetles by feeding them with midges developed from infected larvæ. The largest number of worms found in one beetle was twenty. Attempts to infect Pterostichus, Haptoterus, and Poecilus had little success, and Forficula failed to become infected. It would appear that each species of Gordius has its specific primary and secondary hosts. The development of the Gordius larva in these hosts is described and figured. The adult Gordius leaves the fat body of the beetle and issues to the exterior in the spring, the parasitic life in the two hosts having extended from July of one year to February of the next. The Gordius is free living for about four months. The author states that the gonads are endodermic in origin, and he regards the Nematomorpha as a very old group.

ALTERNATE BEARING YEARS IN TREES.—This phenomenon is very familiar in horticultural literature, so many fruit trees having a well-established habit of bearing well in alternate years; much horticultural pruning practice is directed towards restricting a habit which cannot unfortunately be given an inverse correlation with market price for the fruit. Now the same habit is reported by Mr. F. Kingdon Ward for the tree rhododendrons in his interesting account of his eighth collecting expedition in Asia, which is appearing in the *Gardener's Chronicle*. This subject is discussed by him in the issue of December 19, which contains an interesting account of a very difficult but interesting journey to the falls of the Tsangpo.

CYTOPLASM AND CHROMATIN.—Prof. Charles J. Chamberlain regards these two familiar concepts of cell structure from the point of view of the morphologist, and in the light of his wide experience of the structure of the very large cells forming the egg cells of the Cycads, in the *Botanical Gazette* for October 1925. Prof. Chamberlain points out that these eggs are the largest in the plant kindgom, reaching a length of 6 mm., with a diameter of 2 mm., and the nuclei are exceptionally large; thus the egg nucleus of *Divon edule* may reach a diameter of 500 μ. Prof. Chamberlain endeavours to show that in the cycad egg cytoplasm there is an unbroken series, from large vacuoles of 100 μ or more in diameter, down to the smallest spaces demanded by the theory of Bütschli and Wilson, and that the largest and smallest spaces are of the same morphological nature. He also affirms his belief that chromatin in plants is a vacuolated substance like the cytoplasm, and that, in the plants studied, there are no such structures as chromomeres upon a linin ribbon; and he predicts that theories which cannot be reconciled with a vacuolated structure of the chromosome will have to be abandoned. It is interesting to have this definite expression of morphological opinion, though the question at issue will require examination from a much wider basis than is provided by morphology.

THE ENSTATITE-AUGITE SERIES OF PYROXENES.—The importance of the pyroxenes of the enstatite-augite series, generally referred to as *augite*, has not yet been recognised in text-books, though the last decade has seen the publication of many papers on plateau-basalts in which the very widespread occurrence of that series has been conclusively established. Dr. L. L. Fermor has conveniently summarised the evidence in the *Records of the Geological Survey of India*, vol. 58, Pt. 3, 1925. He confirms Washington's

conclusion that the common pyroxene of the Deccan Traps belongs to the enstatite-augite series of Wahl, the characteristic feature of these mixed pyroxenes being a small optic axial angle. It is pointed out that a research into the system $CaSiO_3$—$FeSiO_3$ is necessary before the homogeneous ferruginous varieties can be adequately explained. From the natural occurrence of monoclinic pyroxenes a provisional attempt at a classification and determinative scheme has already been made by Dr. Bror Asklund (*Sveriges Geologiska Undersökning*, Årsbok 17, Ser. C, No. 325, Stockholm, 1925). In this important paper it is shown that by taking into consideration both optic axial angles and refractive indices, the chemical composition may be approximately deduced from optical tests. Both writers direct attention to the fact that richness in $FeSiO_3$ favours the growth of a single homogeneous pyroxene, whereas both monoclinic and orthorhombic types tend to separate from magmas richer in magnesia. Further complications due to the presence of alumina have not yet been satisfactorily analysed.

EFFECTS OF PRIMARY SPHERICAL ABERRATION.—An experimental study of the effects of varying amounts of primary spherical aberration on the location and quality of optical images has been made by Miss H. G. Conrady, and her results are published in the *Journal of the Royal Photographic Society* (January, p. 9). She has worked out results by the geometric theory, by the physical theory, and by experimental work, and found that the results of these three methods do not agree, except of course in the paraxial region. "Beyond the Rayleigh limit, neither the physical nor the geometrical curves appear to agree with what actually occurs." The author finds that "without doubt" the presence of primary spherical aberration does increase the depth of definition of a lens system. As to resolving power, the curve based on the geometrical theory "obviously has no recognisable bearing on the actual facts." The experimental results agree closely with the physical theory up to about the Rayleigh limit, but beyond it there is a practical loss of resolving power. Miss Conrady gives full details of her work, and generalises her results so that they are applicable to any lens system.

THE γ-RADIATION OF THE ACTINIUM SERIES.—In the issue of the *Zeitschift für Physik* of Nov. 28, Fräulein L. Meitner, using measurements of the β-ray spectra of radioactinium and its disintegration products made by her in collaboration with Dr. O. Hahn, discusses the nature of the γ-radiation which is assumed to produce them. Both radioactinium and actinium X radiate α-particles, and possess a somewhat complicated γ-ray spectrum. Owing to their short life it is possible to employ them in very thin sheets, with the result that the lines of the β-ray spectrum are much sharper than in the case of the longer lived α-radiator radium. It is shown that the photo-effect by which the β-rays are liberated actually takes place, in both cases, not in the disintegrating atom, but in that which results from the disintegration; it follows that the γ-radiation is emitted after the α-particle has been thrown out, and represents the spectrum of the nucleus after disintegration. It is shown that the absorption within the atom, or more correctly the Rosseland photo-effect produced without actual γ-radiation, takes place, when there are several electronic levels, only in the one for which the energy of expulsion is a maximum, in the case of the L levels, for example, only in the L_1-level. The probability of absorption of the K-radiation within atoms with atomic numbers $Z = 88$ and $Z = 86$ is found to be of the order of ten per cent.

THE DURATION OF X-RAY PULSES.—Previous measurements of the time during which an individual X-ray pulse continues to emit energy (*Abklingungszeit*) have led to contradictory results. Dr. F. Kirchner, in the *Annalen der Physik* for November, describes an improved method for the direct measurement of the velocity of cathode rays based on that of Wiechert, and shows how it can be adapted so as to measure the *Abklingungszeit*, t_1, of X-rays. Cathode rays are emitted in large numbers from an incandescent oxide-coated cathode, are accelerated by a powerful field, passed through holes in two screens so as to form a narrow beam, and then through a rapidly alternating electric field produced by means of two hot-wire cathode valves. The beam is thus deflected in opposite directions in turn, and falling on a screen with a hole, which lets it through when it is at one of its extreme positions, falls on an anticathode producing a sudden rush of X-rays. These pass into another tube and fall on a metal cathode, from which they liberate a swarm of photo-electrons, which are accelerated by a suitable field, formed into a narrow beam by means of diaphragms, and passed through an alternating field, worked by the same valve circuit as the first, which deflects the beam to and fro. In one position the electrons can pass through a hole in a screen into the collector of an electrometer, but this will only happen when the phase relations between the field and the electron swarms are right. This depends on the length of path and the velocity of the electrons, the phenomena being also influenced by the time t_1 and by the time t_2, which is needed for the liberation of a photo-electron. The measurements show that $t_1 + t_2$ is smaller than 7×10^{-10} sec. when the K-radiation of iron is employed; t_2 is shown to be of the same order, so that the duration of an X-ray pulse must be small.

THE CATHODE RAY OSCILLOGRAPH.—In the *Journal of the Franklin Institute* for December, F. R. Terroux suggests some useful improvements of the cathode-ray oscillograph which will greatly extend its usefulness. At the present time there are two distinct types of this instrument, a modified form of Braun tube and a type originally suggested by Sir Joseph Thomson and developed by D. A. Keys and A. B. Wood. Although these types have proved of value in research, there are difficulties in operating them. In the Braun type the cathode beam traces its deflexion on a fluorescent screen inside the glass tube and the luminous streak is photographed by an ordinary camera. In order to get a good image the curve must be retraced several times by the cathode beam, and this greatly limits its usefulness. In the Thomson type, the photographic plate is enclosed within the evacuated apparatus. Thus a single transit of the cathode beam will leave a distinct trace on the plate. Whenever the plate is to be inserted or withdrawn, however, the apparatus must be unsealed or evacuated anew. Mr. Terroux obviates this disadvantage as follows. A plane sheet of quartz is sealed across the end of the oscillograph tube, opposite to the cathode. A fluorescent screen is deposited on the inner side of the quartz, and a photographic plate is placed flat against the outer surface. Thus when the cathode beam traces a luminous curve on the screen, the curve would be reproduced directly on the photographic plate and the losses due to dispersion and absorption would be eliminated. There are three obvious advantages of this instrument as compared with the usual type. First, a vacuum pump is unnecessary as the tube is permanently sealed; secondly, no system of lenses is needed as the plate is placed against the quartz; and thirdly, the instrument can be used to study transient phenomena.

Prize Awards for 1925 of the Paris Academy of Sciences.

AT the annual public meeting of the Paris Academy of Sciences, held on December 14, the awards for the year 1925 were announced as follows :

Mathematics.—The Francœur Prize to Georges Valiron.

Mechanics.—The Montyon Prize (Mechanics) to René Risser for his " Essai sur la théorie des ondes par émersion." The Poncelet Prize to Denis Eydoux for the whole of his work in hydraulics.

Astronomy.—The Lalande Prize to Georges Fournier for his observations on planet surfaces and atmospheres. The Valz Prize to V. Michkovitch for his works on stellar statistics. The Pierre Guzman Prize between Eugène Antoniadi (2500 francs) for his researches on the surface of the planets, Fernand Baldet (2500 francs) for his researches on the constitution of comets, and Benjamin Jekhowsky (2500 francs) for his work relating to the determination of the elements of the minor planets. The G. de Pontécoulant Prize to Paul Caubet for his work on the proper motion of the stars, the inequalities of the movement of the moon, and perturbations of the planet Ino.

Geography.—The Gay Prize to Léon Lutaud for his memoir on the tectonic and morphological study of Provence. The Tchihatchef Prize to V. A. Obroutcheff for his explorations in eastern Siberia and northern China.

Navigation.—The Prix de la Marine between Pierre Marti (4000 francs) for his work on the application of sound waves to the determination of depths and positions, and André Nègre and André Vinsot (2000 francs) for their studies on the navigation of torpedoes.

Physics.—The Kastner-Boursault Prize to Eugène Darmois for his work on rotatory polarisation (natural and magnetic) and on the complex compounds of molybdic and boric acids. The Gaston Planté Prize to Joseph Bethenod for his work on the production and utilisation of high frequency alternating currents. The Hébert Prize to Édouard Roth for his work entitled " Alternateurs et moteurs synchrones." The Henri de Parville Prize to Gustave Ribaud for his work on absorption spectra and electric induction furnaces. The Hughes Prize to Jean Cabannes for his work on the molecular diffusion of light. The Clément Félix Foundation (grant of 2500 francs) to Georges Déjardin for the continuation of his researches on the excitation potentials of gaseous spectra.

Chemistry.—The Montyon Prize (Unhealthy Trades) to Maurice Javillier for his work in biological chemistry. The Jecker Prize (in equal parts) between René Locquin for his work in organic chemistry and Charles Dufraisse for his researches in organic chemistry, stereochemistry, and on autoxidation. Cahours Foundation to Léonce Bert for his work in organic chemistry. The Berthelot Prize to Émile André for his work in thermochemistry, the analysis of fats, and on squalene. The Houzeau Prize to François Bourion for his work on the preparation of anhydrous chlorides and in industrial chemistry.

Mineralogy and Geology.—The Cuvier Prize to Léopold Kober for his work entitled " Bau und Entstehung der Alpen " and for the whole of his stratigraphical and tectonic work on the Eastern Alps. The Delesse Prize to François Grandjean for his researches on anisotropic liquids and on the geology of Corsica. The Raulin Prize to Georges Dubois for his researches on the Quaternary of northern France. The Joseph Labbé Prize to Marcel Solignac for his work on the geology of Tunis.

Botany.—The Montagne Prize between André de Puymaly (1000 francs) for his researches on algæ and Auguste Loubière (500 francs) for his work entitled " Recherches sur quelques mucédinées caséicoles." The Jean Thore Prize to Marcel Denis for his studies on the distribution of plants. The de Coincy Prize to Henri Chermezon for his work on the Cyperaceæ.

Anatomy and Zoology.—The Cuvier Prize to Louis Mercier for the whole of his work in zoology. The Savigny Prize to Eugène Séguy for his book on the mosquitoes of Egypt and Syria.

Medicine and Surgery.—Montyon Prizes (2500 francs) to Edmond Sergent, André Donatien, Louis Parrot, Félix Lestoquard, Edmond Plantureux, Mlle. Henriette Rougebief, of the Algerian Pasteur Institute, for their work entitled " Les piroplasmoses bovines d'Algérie "; to Eugène Wollman for his memoirs on proteolysis and the Abderhalden defence ferments; and to Léon Bérard and Charles Dunet for their work entitled " Cancer thyroïdien." Honourable mentions (1500 francs) to Émile Kohn-Abrest for his work on toxicological chemistry; Georges Rosenthal for his researches on blood transfusion; and Camille Lian and André Finot for their work entitled " L'hypertension artérielle." Citations to Henri Colombiès for his experimental and clinical researches on cholesterol and its metabolism; Charles Dejean for his memoir entitled " Le canal de Cloquet, ou canal central du corps vitré "; Edmund Libert for his " Précis de pathologie générale "; Philippe Bellocq for his work entitled " L'os temporal chez l'homme adulte. Iconographie et description de l'os et de ses cavités." The Barbier Prize between Mlle. Fernande Coupin for work on the nervous system of vertebrates and Raymond Weissenbach for a work entitled " Les syndriomes anémiques." The Bréant Prize (arrears) to Gaston Ramon for his work on the titration of diphtheric toxin and antitoxin by means of flocculation and on anatoxines. The Godard Prize to Robert Courrier for his memoir on the sexual cycle in the female of mammals. The Mège Prize to Roger Douris for his book on the analysis of the blood. The Bellion Prize to Alfred Thooris for his book " La vie par le stade." The Larrey Prize to Jules Beyne for his work on the protection of the aviator against the effects of atmospheric depression by means of oxygen apparatus.

Physiology.—The Montyon Prize to Mlle. France Gueylard for her book " De l'adaptation aux changements de salinité. Recherches biologiques et physicochimiques sur l'épinoche." The Pourat Prize to Serge Métalnikov for his work on the intracellular digestion and immortality of the Protozoa. The Philipeaux Prize to Pierre Mathieu and Henri Hermann for their researches on the respiratory function by use of the tracheal air divider.

Statistics.—A Montyon Prize (1000 francs) to Maurice Fréchet for the whole of his work on the calculus of probabilities. Honourable mention (500 francs) to Maurice Halbwachs for his book entitled " Le Calcul des probabilités à la portée de tous."

History and Philosophy of Science.—The Binoux Prize to Albert Maire for his bibliography of Pascal. The Henri de Parville Prize to Émile Hegh for his recent work on Termites. The Jules and Louis Jeanbernat and Barthélemy de Ferrari Doria Prize to Georges Bouligand for his work on harmonic functions.

MEDALS.—Berthelot Medals to Maurice Javillier, Charles Dufraisse, Léonce Bert, Émile André, and François Bourion.

GENERAL PRIZES.—The Grand Prize for physical sciences to Georges Mouret for the whole of his work in geology. The Lallemand Prize to Mlle. Piera Locatelli

for her researches on the influence of the nervous system on regeneration. The Petit d'Ormoy Prize (Mathematical Sciences) to Jules Drach for the whole of his work. The Petit d'Ormoy Prize (Natural Sciences) to Maurice Caullery for the whole of his work in zoology and biology. The Saintour Prize to Arnaud Denjoy for his works on the calculus of primitive functions. The Lonchampt Prize between Albert Frouin and Mlle. Maylis Guillaumie (2000 francs) for their memoir entitled "La nutrition carbonée du bacille tuberculeux," and Paul Cristol (1000 francs) for his work on cancerous tissues. The Wilde Prize (in equal parts) between Raymond Jouaust for his researches on photometry and radiotelegraphy and René Mesny for his researches on radiogoniometry and short Hertzian waves. The Gustave Roux Prize to Edmond Sollaud for his researches on the embryogeny of the crustaceans. The Thorlet Prize to Adolphe Richard.

SPECIAL FOUNDATIONS.—The Lannelongue Foundation between Mmes. Cusco and Rück. The Laplace Prize to D. J. L. Bichelonne. The L. E. Rivot Prize between D. J. L. Bichelonne (750 francs), M. E. P. Pascal (750 francs), P. C. Adam (500 francs), and R. A. M. Lehuédé (500 francs).

GRANTS FOR SCIENTIFIC RESEARCH.—The following grants for research were announced:

The Tremont Foundation to Alexandre Meunier for his cartographical work on French Western Africa. The Gegner Foundation to Léon Bultingaire for his work in connexion with the preparation and publication of the catalogue of scientific publications in the libraries of Paris. The Hirn Foundation to Georges Corroy (2500 francs) for the cost of publication of a work on stratigraphy. The Becquerel Foundation to André Danjon for his astronomical works.

The Loutreuil Foundation.—I. Grants to establishments named by the founder:

(1) The National Museum of Natural History. Louis Mangin (8000 francs) for the maritime laboratory of the Museum. Désiré Bois (4000 francs) for the publication of the third volume of a guide to the collections of plants cultivated at the Museum.

(2) The National Veterinary School of Alfort. 12,000 francs to the library of this establishment for the purchase of books and more especially of periodicals.

(3) The National Veterinary School of Lyons. Joseph Basset (3000 francs) to pursue his researches on a new method of vaccination for anthrax and on the infectious diseases of the dog. Gabriel Marotel (1000 francs) for the continuation of his researches on the treatment of the parasitic diseases of animals. L. Jung (1500 francs) for pursuing his researches on the rôle of fats in the utilisation of food albumen and on the mechanism of rumination and vomiting. Armand Tapernoux (1000 francs) to continue his researches on the hydrogen ion concentration of biological liquids, particularly of milk. M. Tagand (1000 francs) to enable him to undertake, under the direction of M. Lesbre, researches on teratogenesis in various domestic mammals.

(4) The National Veterinary School of Toulouse. Jules Girard and Pierre Pons (2000 francs) for the continuation and development of their researches on the factors modifying growth (temperature, special diet, castration). P. Bru (1000 francs) for researches on pulmonary emphysema in comparative pathology. Charles Hervieux (1000 francs) for researches on the putrefaction of food.

II. Grants to establishments admitted for one year by the President. Conservatoire National des Arts et Métiers. Jules Lemoine (2000 francs) for the purchase of apparatus for the physical laboratory. Gabriel Kœnigs (1500 francs) for the translation of American patents concerning various mechanical arrangements.

III. Independent grants. Jules Barthoux (4500 francs) for mineralogical researches in Algeria. General Sebert (5000 francs) for the publication of documents relating to the creation of the Office central de documentation technique et industrielle. Jacques Chevalier (1000 francs) for the purchase of apparatus for researches on experimental psychology at the new laboratory at the University of Grenoble. The Comité français de géodésie et géophysique (Section 6. Atmospheric electricity), 14,000 francs. Mme. Yves Delage (4000 francs) for the publication of a volume of "L'Année biologique." René Dubrisay (3000 francs) for the purchase of apparatus to pursue his researches in capillary chemistry. Louis Dunoyer (13,000 francs) to pursue his researches on certain problems relating to modern methods for the measurement of high vacua. The Fédération française des Sociétés de Sciences naturelles (7000 francs) as a new contribution to the publication of the "Faune de France." Edmond Friedel (2500 francs) for his researches on the diffraction of the X-rays by smectic bodies. Pierre Lesne (2000 francs) for the pursuit of his researches on the coleopterological fauna of peat. Charles Marie (5000 francs) for assisting the publication of the annual tables of constants of chemistry, physics, and technology. Charles Moureu (4000 francs) for the purchase of a new type of bomb calorimeter. The Marseilles Observatory (3000 francs) for the publication of the *Journal des Observateurs*. Ém. Passemard (3000 francs) for geological exploration in Syria. Jean Tilho (4000 francs) for the publication of maps resulting from his explorations of Tibesti, Borkou, Erdi, and Ennedi. J. Tissot (5000 francs) for assisting the publication of a work concerning the constitution of animal and plant organisms. Mlle. Y. Trouard-Riolle for researches in genetics. Père Lejay to complete his researches on atmospheric electricity.

(The total grants from the Loutreuil Foundation given this year amount to 124,500 francs.)

The Bouchard Foundation to Henry Cardot for his work on adaptation to change of environment, heredity, Protozoa, and micro-organisms.

Annual Meeting of the Geographical Association.

"THE world about us is the greatest of all laboratories, and Nature is the greatest demonstrator." Even by the wayside, to and from school, as Prof. J. L. Myres showed, we may see processes in operation shaping the geography of the homeland and illustrating the geography of other lands. The rhythmic flow of a river, as elaborated by Dr. Vaughan Cornish, offers ample scope for training in scientific observation. Only by seeing can the eye be trained to appreciate the complex of Nature and man, the adjustment of life—social, economic and political—to its physical environment.

Sir Halford Mackinder stressed that description must be the central fact in the teaching of geography. Material must be obtained before there can be any study of causation. To describe truly, artistically and with a true sense of proportion is to reach the highest art, and such description is essential to the appreciation of a regional organisation and entity. On these grounds, Sir Halford placed geography among the arts rather than among the sciences, though, as Prof. Lyde pointed out, artistic description implies scientific method.

Regional description demands, one might almost

say presupposes, a cadre or framework. Prof. P. M. Roxby dealt with the concept of natural regions in the teaching of geography, drawing his illustrations from China. The land frontiers, regarded as a zone rather than a political line, separate major regions differing from each other physically and biologically no less than culturally and economically. This difference between China and her neighbours being greater than the difference between the sub-regions of China, makes for unity in spite of its regional diversity. The major sub-regions also—the North China plain, the lower Yang-tze basin, Szechwan, south-east China and the highlands of Yunnan—reveal the same coincidence, broadly speaking, of natural and cultural divisions. Here, then, is a cadre, apparently permanent, giving definition to the geographical region with its internal complex and its external relationships.

Mr. A. G. Ogilvie outlined the extent to which such studies have been carried in South America and Africa and defined broadly the line upon which future geographical research must proceed. In both continents rapid progress is being made in topographic surveys and in the production of maps adequate for the needs of research workers. But much remains to be done. Under the auspices of the American Geographical Society much geographical work has been done in South America and more is being undertaken. In Africa little geographical research has as yet been carried out, especially in British territory.

Sir John Russell, in his account of "Cotton and the Nile," gave geographers two illustrations of great interest in the complexity and change of regional activities. Naturally the Anglo-Egyptian Sudan offers an important field for extensive cotton cultivation. Can the Nilotic tribes be induced to change their mode of life and grow cotton for the European market? In Egypt, on the other hand, a very distressing situation has arisen. After the expenditure of millions of pounds sterling on great schemes of irrigation, the land has begun to deteriorate quickly. For the first time in the long history of Egypt, it has been necessary to import fertilisers. Egypt is now a large buyer of nitrate of soda for the growing of crops.

Geographical economics, a term applied to the study of economics on a regional or geographic basis, forms one of the most important and most urgent fields for research. What are the fundamental causes, for example, why Malaya and British Guiana, comparable in size, position, climate and fertility of soil, should differ so widely in their total population and the export of domestic products? One has a population of 3,300,000 with export value of 78,714,225*l.* (1923), the other a population of 300,000 and export value of 3,757,647*l.* This illustration, quoted by Mr. Ormsby Gore, served as an introduction to his presidential address on "The Economic Geography of the British Empire." Under present conditions, some regions are primary producing countries, others are manufacturing. The two are complementary and both require that their economic life should be studied on a regional or geographic basis, however fully trade statistics may be studied in the abstract. To many statesmen in 1763, Guadaloupe with its slaves and sugar appeared of far greater worth than the vast forest and prairie lands of Canada because the potential geographic value was not suspected. The observations of a trained geographer capable of getting the economic survey away from a narrow view of economics on to a much wider plane are of immense value, not merely to those engaged in administration, but also for those engaged in commerce. Unfortunately, little has as yet been done in the British Empire in this direction. Innumerable factors enter into an acceleration of primary production with the consequent increase of purchasing power of manufactured goods. Even in manufacturing countries, Sir Richard Gregory pointed out, inventive genius and adaptability may serve or create new needs and thus maintain or even enlarge the volume of trade between manufacturing and primary producing countries.

Altogether the papers presented at the annual meeting of the Geographical Association on January 7-9 furnished an excellent series illustrative of the theory and practice of geography.

Geodetic Observations in the United States of America.

AN official coastal survey of the United States was first authorised under President Jefferson in 1807, and since that date, with some vicissitudes, continual progress has been made in the survey of the country, both coast and inland. The Coast Survey, on account of its extended work, was renamed the Coast and Geodetic Survey, as now, in 1878. Besides the work done by this department, determinations of latitude, longitude, and azimuth have been made at various times by the U.S. Lake and Geological Surveys, the U.S. General Land Office, the U.S. and Canada Boundary Commission, the U.S. Army, and other bodies. Some of these determinations have hitherto remained unprinted, while others are scattered throughout many reports. The Coast and Geodetic Survey has therefore collected them all in one volume and made them readily and permanently available for scientific purposes.[1]

The preparation of the volume has been made by Sarah Beall, mathematician to the Survey, who acknowledges the help given by Dr. Bowie, chief of the Division of Geodesy, and all the other members of the staff of this Division. The compilation has been done in an admirably workmanlike fashion, with concise but adequate historical introductions and descriptions of the various classes of observations. There are four chapters dealing respectively with longitudes, latitudes, azimuths, and deflexions of the vertical, followed by a final chapter (occupying rather more than half the volume), giving detailed particulars of the stations. In each case the principal instruments and methods of observation and computation are described and illustrated, and the other relevant facts are summarised.

For a volume of this kind the letterpress contrives to be surprisingly interesting. The bulk of the volume, apart from the final chapter, is naturally devoted to tabular matter; the results (both as observed, and after making the various necessary adjustments) are given in order of date, the probable errors being indicated, except in the case of the deflexions of the vertical. Reference to any individual station is facilitated by a comprehensive index to stations. All those who have occasion to make use of geodetic data for the United States will feel grateful to the author, and to Dr. Lester Jones, the Director of the Survey, for this very valuable collected work.

[1] Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 283. "Astronomic Determinations by United States Coast and Geodetic Survey and other Organizations." By Sarah Beall. Special Publication No. 110, pp. v+337+13 plates. (Washington: Government Printing Office, 1925.) 80 cents.

Contemporary Birthdays.

January 23, 1856. Brig.-Gen. Sir Henry C. L. Holden, K.C.B., F.R.S.
January 27, 1864. Prof. John Walter Gregory, F.R.S.
January 27, 1856. Prof. Edward B. Poulton, F.R.S.

Sir HENRY HOLDEN was born at Cheltenham. Educated at Ipswich School, he joined the Royal Military Academy, Woolwich, afterwards entering (1875) the Royal Artillery, and then came service in India, until 1881. The inventor of many instruments connected with electrical science and artillery problems, he became Superintendent of the Royal Gun and Carriage Factory at Woolwich; afterwards he was (1914–16) Director of Mechanical Transport at the War Office.

Prof. J. W. GREGORY, geologist and exploring traveller in many regions, was educated at Stepney Grammar School. Originally he was associated with his father in the wool trade, but in 1887, having qualified for an assistantship in the Geological Department of the British Museum, he henceforth devoted himself to scientific pursuits. He left London and Government service in 1900 to take up the post of professor of geology and mining at the University of Melbourne (combined with survey work), returning in 1904 on his election as professor of geology at the University of Glasgow. A voluminous writer in different branches of geology, Prof. Gregory has studied in particular the features of the Alps, the Mediterranean basin, Africa, the West Indies, and Australia. Among his publications are "The Origin of the Great Rift Valley in East Africa," "The Origin of Fjords," "The Evolution of the River Systems in Chinese Tibet." Prof. Gregory was president of the Section of Geology, British Association, 1907, and of the Section of Geography, 1919.

Prof. E. B. POULTON was born at Reading, the son of an architect resident there. He was educated in the first instance at a private school, afterwards entering and graduating at Jesus College, Oxford. For many years (and still) Hope professor of zoology in the University of Oxford, early a Burdett-Coutts university scholar, an ex-president of the Oxford Society, lecturer in natural science at Jesus College, sometime tutor at Keble, formerly a member of the Oxford Hebdomadal Council—in short, all Prof. Poulton's traditions and implications savour of Oxford. President of the Linnean Society, 1912–16, he was awarded (1922) the Linnean gold medal, in token of the Society's appreciation of services to zoological science. Sir A. Smith Woodward remarked at the time that Prof. Poulton had begun by traversing a wide field, from bone-caves and Pleistocene geology to the structure of the tongues of marsupials—histological work which culminated in the interesting discovery of true teeth in the embryo Ornithorhynchus. Prof. Poulton's inclinations, however, were always towards entomology, and for many years he has been regarded as the chief exponent of the theory of protective resemblance and mimicry in insects. His keepership of the Hope collection at Oxford has resulted in the creation of a museum of entomological specimens illustrative of variation, geographical distribution, and mimicry bearing on the theory of evolution. He has also carried out experimental breeding work on variable protective resemblance, demonstrating the dependence of the coloration of certain larvæ and pupæ on the particular circumstances of their environment. His work was rewarded in 1914 by the Royal Society's Darwin medal.

Early Science at Oxford.

January 25, 1683–4. A letter from Mr. Aston gave an account, of ye specific difference between ye Christalls of Sea-salts and common salt, or Inland salt, which consists in this: The angles of ye Chrystalls of common salt are entire (as likewise are those of *Sal Gemmæ* and ye lixiviated marine salts of Dr. Grew) but ye angles of true sea-salt are cut off, into triangular planes, at least in one of ye sides. Dr. Plot shewed us some Chrystalls of sea-salt, in which we observed ye triangular plane mentioned in Mr. Aston's letter. The severity of ye frost led us then to discourse of cold, particularly of making holes in ye Ice with salt, which eats through ye ice, which means ye common-people make use of, in opening their frozen pumps.

January 26, 1685–6. A paper of Dr. Papin's explaining his new way of raising water was presented and read.

Mr. LLoyd communicated a paper containing an account of some plants, which grow in North Wales, and are omitted in Mr. Ray's catalogue.

Dr. Plot presented an old almanack sent him out of Somersetshire.

January 27, 1684–5. An answer to Dr. Middleton, provost of Kings Colledge in Aberdene, was drawn up, concerning the establishing a Correspondence between us of this Society, and ye Gentlemen of Aberdene.

The Society, being acquainted, that, in Hullington-fields, in Wiltshire, there is an odd sort of light barren earth; and that severall curious plants grow thereabout; gave order, that Dr. Plot, at his return to Oxford, be desired, to write to Mr. Cole of Bristoll, (to whom this land belongs,) and make use of his interest with that gentleman, for ye procuring an account of these matters.

Sir William Petty having thought it worth his while, to enquire into ye proportion of ye materials, used in making severall sorts of Mortar, the following report was drawn up: The Mortar used by our Plaisterers is generally of two sorts, course or ffine: 1. *Course* mortar is made of Lime, sand, and hair: the Lime used here at Oxford is of 2 sorts, viz Chalk-lime, made of a Chalk-stone dug at Nettlebed, and other places, and burnt: or 2dly Hard stone lime, which is made of hard rag stone, burnt; this last sort of lime is much stronger, and will go 2 yards square in five, farther, (for it takes up far greater quantity of sand, and water,) than ye former, which is the finer of ye two, and ye more beautifull, and glorious, to the eye.

One bushell of chalk lime, one bushell of sand, and one peck of hair, mixt all together with water, will make *course* Mortar: but if you use hard stone lime, then one bushell of Lime will require a bushell and ½, or 2 bushells, of sand, and a bushell of hair. In ye making of *fine* mortar mix one bushell of chalk lime with ½ a peck of hair, or a bushell of hard stone lime with a peck of hair, and as much water as is necessary. Course mortar is used next to ye lathing, or ye stone, or brick-wall; ffine mortar is drawn on ye other, makes it white, and beautifull.

Clay mortar, or Loam mortar, is made with clay, and as much chopt straw, as ye clay will take in by ye help of water.

Whiting is made by dissolving Spanish white either in size, or in water, that with size is not easily rub'd off.

That substance, which is commonly sold at London for about 1d. p pound for Spanish white, is supposed to be made of chalk ground, and made up into Balls with water.

Societies and Academies.

LONDON.

Royal Society, January 14.—Leonard **Hill** and Y. **Azuma**: Effects of ultra-violet radiation upon involuntary muscle and the supposed physiological interference of visible rays. No physiological interference is produced by dark heat or visible rays with the exciting action of ultra-violet on involuntary muscle. The action of ultra-violet rays antagonises that of adrenalin on involuntary muscle, but not that of emetin. The presence of calcium in the nutritive fluid is necessary for the increase of tone produced by ultra-violet rays.—I. de B. **Daly**: A closed-circuit heart-lung preparation; effect of alterations in the peripheral resistance and in the capacity of the circulation. A diminution in capacity of the systemic circulation produces the same effects qualitatively and quantitatively as an increase in the volume of circulating blood, namely, a rise in pressure in both auricles, the aorta and the pulmonary artery, and an increase in the cardiac output. An increase in peripheral resistance has an opposite effect. "Resistance," "capacity" and blood distribution effects are interdependent, their relative effects being determined by the physical constants of the circulation.—C. H. **Best**: On the effect of insulin on the dextrose consumption of perfused skeletal muscle. Insulin greatly accelerates the rate of sugar disappearance from defibrinated blood used to perfuse the isolated limbs of the cat. The action is attributable to its effect on the metabolism of the skeletal muscles.—T. S. P. **Strangeways** and Honor B. **Fell**: Experimental studies on the differentiation of embryonic tissues growing *in vivo* and *in vitro*. (i.) The development of the undifferentiated limb-bud (*a*) when subcutaneously grafted into the post-embryonic chick, and (*b*) when cultivated *in vitro*. —C. N. **Long**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt. xiv. The relation in man between the oxygen intake during exercise and the lactic acid content of the muscles. In men, as well as in the isolated muscle, the rate of removal of lactic acid, as measured by the oxygen intake, is proportional to the square of the lactic acid concentration in the fluids which are in contact with the muscle fibres. Lactic acid apparently acts as a "governor of oxidation" in the recovery process of muscle.—K. F. **Hetzel** and C. N. **Long**: The metabolism of the diabetic individual during and after muscular exercise. Muscular exercise in the diabetic individual appears to be accompanied by the same metabolic changes as in the normal. Exercise increases the combustion of carbohydrate. For short periods of exercise, with insulin administered during the last 17 hours, the respiratory quotient of the excess metabolism is unity, exactly as in normal men: for exercise of moderate duration its value is intermediate, while for exercise of long duration it tends to fall towards that of the previous resting metabolism. In this respect the diabetic individual with recent insulin, on a diet poor in carbohydrate, behaves in a manner exactly similar to a normal man on a diet consisting mainly of fat, though the phenomena are more exaggerated. In a diabetic individual without insulin, the respiratory quotient of the excess metabolism is always low. It may be supposed that a muscle, for its oxidative processes in recovery from exertion, uses carbohydrate only; that in the presence of insulin there are stores of carbohydrate in a form readily available for use by the muscle, and that a short interval of exercise does not sufficiently deplete these stores to render an immediate restoration necessary from other substances in the body. In the absence of insulin, these ready stores of carbohydrate have run low. Prolonged muscular exertion, a diet poor in carbohydrate, and the absence of insulin, all produce the same effect, namely, a lowering of the respiratory quotient of the excess metabolism due to exercise. All these factors might be expected to deplete the stores of carbohydrate readily available.—W. G. **Millar**: The diffraction method of measuring the diameter of erythrocytes.

SYDNEY.

Royal Society of New South Wales, December 2.—A. R. **Penfold** and R. **Grant**: The germicidal values of some Australian essential oils and their pure constituents, together with those for some essential oils. The published value for terpineol (Rideal-Walker test) is 16. Some other results are: *Atherosperma moschata* (crude oil), 18; formic acid, 5; butaldehyde, 12 (5); butyric acid (normal), 1 (8); butyl butyrate, 13 (17). Figures in brackets are due to either increased or decreased dispersion brought about by solution in alcohol instead of 7·5 per cent. rosin soap solution. —A. R. **Penfold**: The essential oil of *Bæckea Gunniana* var. *latifolia* (F. v. M.). This Myrtaceous shrub is widely distributed throughout the mountains of New South Wales. The yield of oil from the leaves amounted to 0·33 to 0·74 per cent., and its melting-point was 43° to 47° C. It is the only Australian essential oil which has yet been recorded that becomes a solid at ordinary temperatures. It contains more than 60 per cent. eudesmol, eudesmene, b-pinene, small quantities of unidentified phenolic bodies, and valeric acid ester and a stearoptene.—F. A. **Coombs**, W. **McGlynn**, and M. B. **Welch**: The black cypress pine (*Callitris calcarata*, R. Br.) tannins and their distribution in the bark. This tree occurs over a large area of Australia, and possesses a valuable tan-bark containing up to 36 per cent. tannin. Difficulty has been experienced in obtaining a satisfactory commercial extraction, due to regularly recurring bands of cork cells, impervious to water, at close intervals now observed. By grinding the bark to a powder, this difficulty can be overcome. Starch, which is a most important agent in the destruction of tannin when extraction is carried out at high temperatures, was observed in those cells of the inner living bark in which tannin is situated. The bark of this tree is available in large quantities, and is very suitable for the production of a tanning extract. It resembles in many respects the North American hemlock bark, but its tannin content is at least double.—C. A. **Sussmilch**: On the occurrence of waterworn pebbles of coal in the Upper Coal Measures at Red Head, N.S.W. Analysis of one of the pebbles, together with its physical character, indicates a probable derivation from the Greta Coal Seam in the Lower Coal Measures. This indicates that the Lower Coal Measures must have been undergoing denudation during the time that the Upper Coal Measures were being laid down, and therefore, that some crustal movements must have taken place between the deposition of the two coal measures.—Ida A. **Brown**: Some tertiary formations on the south coast of N.S. Wales, with special reference to the age and origin of the so-called "silica" rocks. The flinty quartzites discussed occur on the south coast of New South Wales and in the Ulladulla District, and are quarried as "silica" for use in the manufacture of bricks for lining steel-furnaces. Hitherto they have been regarded as the result of the metamorphism of Upper Marine (Permo-Carboniferous) sandstones by volcanic dykes, but it is considered that they are derived from very pure siliceous sediments of Tertiary age, which have been hardened and

compacted by subsequent flows of olivine basalt. Well-preserved fragments of the stems and roots of a dicotyledonous angiosperm were found in the quartzite.

VIENNA.

Academy of Sciences, November 5.—K. **Chudoba**: The dispersion of plagioclase. The gray-position-method has already been applied to determine the situation of the optical axes for different wave-lengths in orthoclase. With albite the dispersion of the B-axis is about three times as great as that of the A-axis. Measurements were made with monochromatic light of six different wave-lengths, and the situation of the axes controlled by the right angle method.—B. P. **Wiesner**: On the function of the germinal gland before puberty; experiments on rats. (I.) Castration of new-born males. The development of sexual characters at puberty is dependent on the endocrine function of the reproductive system. Castration was performed twelve hours after birth, and the after-growth of castrated, one-side castrated, and entire animals compared at various ages. Development continues for a few days only after complete castration; normal and half-castrated animals develop alike. (II.) Spaying of new-born females. In contrast to the males, the normal and spayed females develop alike up to puberty, and only the onset of the œstrus cycle and its periodic recurrence proves the secretory function of the ovary. There is no œstrus in spayed animals, but the earlier stages of the development of sexual characters are independent of the ovary. Details of these researches will appear in *Pflüger's Archiv f. d. ges. Physiologie*.—P. **Weiss**: The morphological impotence of regeneration tissue. The formation of extremities from tail material from Triton. Transplantation was made from the middle of the tail into the body wall near the fore-limb. Various effects took place—healing over, a small tail, warty lumps or a differentiated limb. The regeneration tissue when young seemed to be undifferentiated, and its subsequent growth was determined by the position into which it was transplanted (morphological impotence). Older material, to a certain degree determined as tail, formed tail after transplanting.—K. **Grobben**: Attempt at an explanation of the alternation of layers in pearls.—H. P. **Cornelius** and M. **Cornelius-Furlani**: Report on geological inquiries on the Insubrisch line in the lower Val Tellina. Two quite different zones occur; in the north, highly crystallised biotite-gneiss with intrusions, and in the south, uniform quartz-phyllite.

November 20.—G. **Weissenberger**, S. **Baumgarten** and R. **Henke**: Absorption by charcoal from viscous media.—J. **Zellner** and others: Contributions to the comparative chemistry of plants, XI. The chemistry of barks. In the barks of Cornus, Tilia and Carpinus, substances have been found such as alnulin, coryliresinol and platanol acid.—J. **Braunhauser**: The chemistry of heterotrophic phanerogams. Mistletoe berries have been analysed.—A. **Huber**: Newton's method of approximation.—**Skrabal** and A. **Zahorka**: The hydrolysis of acetic acid ester by acids.—J. **Pia**: The structure of the Alpine middle-trias deduced from the diplopores.—H. **Handel-Mazzetti**: New Chinese plants (36). Includes species of Aconitum and Corydalis.

November 26.—K. **Umrath**: On the conduction of irritability in Mimosa. In *M. Spegazzinii* as in *M. pudica* there are several stimulus conducting systems. Three velocities of conduction were found in the leaf and two in the stem.—O. **Pesta**: Problems of the hydrobiology in the mountains of the Eastern Alps. Chemical analyses have been made of the waters of mountain lakes.

December 3.—H. **Hahn**: On a theorem of existence in the calculus of variations, and on the method of arithmetical means in the theory of generalised Fourier integrals.—H. **Handel-Mazzetti**: New Chinese plants (37). Three species of Pedicularis are described.

December 10.—F. **Becke** and J. E. **Hibsch**: On nephelines with zonal structure.

Official Publications Received.

Beiträge zur Natur- und Kulturgeschichte Lithauens und angrenzender Gebiete. Herausgegeben von Prof. Dr. E. Stechow. Einleitung, von Prof. Dr. E. Stechow. Vögel, von Dr. H. Sachtleben. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band. Einleitung und 1 Abhandlung.) Pp. 232. Steinzeitliche Funde aus Lithauen, von Prof. Dr. F. Birkner. Parasitische Insekten aus Lithauen, von Prof. Dr. Günther Enderlein. Parasitische Trematoden aus Lithauen, von Dr. L. Scheuring. Biologische Beobachtungen, von Prof. Dr. E. Stechow. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band. 2-5 Abhandlung.) Pp. 233-256+6 Tafeln. Die Zweiflügler der Urwaldes von Bialowies, von Prof. Dr. P. Sack. Hymenoptera (Aculeata, Ichneumonidae, Chalastogastra), von Dr. H. Bischoff. Trichopteren und Ephemeropteren aus dem Bialowieser Wald, von Dr. G. Ulmer. Über Waldbienenzucht in Lithauen und einigen Nachbargebieten, von Dr. H. Klose. (Abhandlungen der math.-phys. Klasse der Bayer. Akademie der Wissenschaften. Suppl.-Band. 6-9 Abhandlung.) Pp. 257-406+9 Tafeln. (München: Verlag der Bayerischen Akademie der Wissenschaften.)

U.S. Department of Agriculture: Weather Bureau. W.B. No. 866: Instructions to Marine Meteorological Observers. (Circular M, Marine Division, Fourth edition.) Pp. x+99+8 plates. (Washington: Government Printing Office.)

Transactions of the Royal Society of Edinburgh. Vol. 54, Part 2, No. 5: Studies in Irregular Nutrition. No. 1: The Parasitism of Cuscuta reflexa (Roxb.). By John Thomson. Pp. 343-356+8 plates. (Edinburgh: R. Grant and Son; London: Williams and Norgate, Ltd.) 6s. 6d.

The South-Eastern Naturalist: being the Thirtieth Volume of Transactions of the South-Eastern Union of Scientific Societies, including the Proceedings at the Thirtieth Annual Congress, held at Folkestone, 1925. Edited by A. F. Ravenshear. Pp. lxxxii+126. (London.)

Ministry of Public Works, Egypt: Physical Department. The Lake Plateau Basin of the Nile. By Dr. H. E. Hurst. (Physical Department Paper No. 21.) Pp. vi+75+41 plates+12 charts. (Cairo: Government Publications Office.) 10 P.T.

Proceedings and Transactions of the Croydon Natural History and Scientific Society. Vol. 9, No. 4, February 1923 to January 1925. Pp. xxxiii-xlix+38+187-224+50. (Croydon.) 5s. net.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 20: Statistics of Kindergartens 1923-24. Pp. ii+7. (Washington: Government Printing Office.) 5 cents.

United States Department of Agriculture. Farmers' Bulletin No. 789: Mushroom Pests and How to Control Them. By C. H. Popence. Pp. ii+6. (Washington: Government Printing Office.) 5 cents.

Memoirs and Proceedings of the Manchester Literary and Philosophical Society, 1924–25. Vol. 69. Pp. 102+xlii+viii. (Manchester.) 12s.

Report of the Institute for Science of Labour, July 1921–June 1925. Pp. ii+35+2 plates. (Kurasiki, Japan.)

Aeronautical Research Committee. Reports and Memoranda, No. 980 (Ae. 193): The Rolling and Yawing Moments of an Aerofoil in Straight Flight. By H. Glauert. (A.3.a. Aerofoils—general, 152—T. 2105.) Pp. 5. (London: H.M. Stationery Office.) 3d. net.

The Institution of Civil Engineers. Engineering Abstracts prepared from the Current Periodical Literature of Engineering and Applied Science, published outside the United Kingdom. Supplement to the Minutes of Proceedings of the Institution. Edited by W. F. Spear. New Series, No. 25, October. Pp. 230. (London.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 36, Part 4. Pp. 321-462. (London: E. Stanford, Ltd.) 5s.

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1925. Pp. 24+5 plates. (Bristol.)

Koninklijk Magnetisch en Meteorologisch Observatorium te Batavia. Verhandelingen No. 14: Regenval in Nederlandsch-Indië (Rainfall in the Netherlands Indies). Door (by) Dr. J. Boerema. Deel 2 (Vol. 2): Kaarten van den gemiddelden jaarlijkschen en maandelijkschen regenval op Java en Madoera, met een kaart der regenstations (Maps of the Mean Yearly and Monthly Rainfall on Java and Madoera, with a Map showing the Position of the Rainfall Stations). Pp. ii+14 Maps. (Weltevreden: Landsdrukkerij.)

Department of Agriculture, Ceylon. Bulletin No. 73: Import of Fertilizers into Ceylon. By Alexander Bruce. Pp. 41. (Peradeniya.) 40 cents.

Scientific Reports of the Agricultural Research Institute, Pusa (including the Reports of the Imperial Dairy Expert, Physiological Chemist, Government Sugarcane Expert, and Secretary, Sugar Bureau), 1924–25. Pp. v+163. (Calcutta: Government of India Central Publication Branch.) 2.4 rupees; 4s.

Annuaire de l'Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique, 1925. (91e année.) Pp. 265+8 plates. (Bruxelles: Maurice Lamertin.)

Government of India: Department of Industries and Labour, Public Works Branch. Triennial Review of Irrigation in India, 1921–1924. Pp. ii+71. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 9d.

Diary of Societies and Public Lectures.

SATURDAY, JANUARY 23.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—B. Barnes: Preliminary Observations on the Physiology of *Lachnea*.—A. Chaston Chapman: A Plea for a National Institute of Industrial Micro-Biology.—Kodak Ltd.: The Eastman Colorimeter.—J. Ramsbottom: Fragmenta Mycologica V.—G. Tandy: Cytology of *Pyronema domesticum*, Sacc.—W. M. Ware: *Pseudoperonospora Humuli*, Miyabe and Tak, and its Mycelial Invasion of the Host Plant.

ELECTRICAL ASSOCIATION FOR WOMEN (at Æolian Hall), at 3.—Demonstration of the Application of Electricity in the Production of Music for the Home.—H. V. Spanner: The Place of Music in the Home (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. Balfour: The Evolution of Currency and Coinage.

PHYSIOLOGICAL SOCIETY (at National Institute for Medical Research).

MONDAY, JANUARY 25.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—Prof. T. J. Jehu and R. M. Craig: Geology of the Outer Hebrides. Part 3, North Uist and Benbecula.—Dr. P. M. Finlay: The Old Red Sandstone of Shetland. Part 1, Eastern Area. With Notes on the Fossil Fishes of the Old Red Sandstone of the Shetland Islands. By Sir A. Smith Woodward and E. I. White.—Prof. J. K. Charlesworth: (*a*) The Great Re-Advance Kame-Moraines of the South of Scotland, and some Later Stages of Retreats; (*b*) The Glacial Geology of the Southern Uplands of Scotland, West of Annandale and Upper Clydesdale.—Dr. A. E. M. Geddes: The Distribution of Electric Force in High Voltage Discharges.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lt.-Commdr. V. L. Trumper: Modern Science in the Book of Job.

INSTITUTE OF ACTUARIES, at 5.—C. F. Warren: An Investigation into the Mortality experienced by Pensioners of the Staffs of Banks and Insurance Companies, with a Note on the Mortality experienced by Deferred Annuitants.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (4). The Taungs Anthropoid: its Zoological and Geological Position.

ROYAL SOCIETY OF MEDICINE, at 5.—Lord Dawson of Penn and others: Discussion on Hyperpiesis.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Discussion: Impressions on my Visit to America, mainly about Switchgear.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Capt. P. P. Eckersley: The Past, Present, and Future of Wireless Telephony.

ROYAL SOCIETY OF ARTS, at 8.—H. P. Shapland: The Decoration of Furniture (Cantor Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—A. W. Wellings: Some Points in the Anatomy of the Capillaries of the Tooth Pulp.—W. Harrison and E. W. Lowe: Notes of a Complicated Removal of a Third Lower Molar—Fatal Sequel.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—H. J. L. Beadnell: Recent Travels in Central Sinai.

MEDICAL SOCIETY OF LONDON, at 8.30.—R. C. Elmslie, W. R. Bristow, and others: Discussion on Manipulative Treatment in Medicine and Surgery.

TUESDAY, JANUARY 26.

ROYAL DUBLIN SOCIETY (at Ball's Bridge, Dublin), at 4.15.—Prof. F. E. Hackett and others: Discussion on Recent Theories of Stellar Evolution.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. A. Crowther: X-rays and Living Matter (2).

INSTITUTION OF CIVIL ENGINEERS, at 6.—A. S. Angwin and T. Walmsley: Rugby Radio Station.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—F. A. Best: The Flettner Rudder.

INSTITUTION OF AUTOMOBILE ENGINEERS (Informal Meeting) (at 83 Pall Mall), at 7.—Discussion on Tire Pumps and Jacks.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—L. H. A. Carr: The Use of Induction Regulators in Feeder Circuits.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—A. S. Newman: Three Fallacies in Kinematography.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at 39 Elmbank Crescent, Glasgow), at 7.30.—G. J. Lugt: The Werkspoor Diesel Engine.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—Anniversary Meeting.

ROYAL SOCIETY OF MEDICINE (Medicine and Comparative Medicine Sections), at 8.30.—Sir Humphry Rolleston (Medicine), Prof. Wooldridge (Comparative Medicine), and others: Discussion on Hodgkin's Disease in Man and Animals.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (South Wales Institute of Engineers, Cardiff).—A. P. Trotter: Illumination and Light (Faraday Lecture).

WEDNESDAY, JANUARY 27.

LEEDS PHILOSOPHICAL SOCIETY, at 5.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section), at 5.—Prof. R. H. A. Plimmer: The Relation of Quantity of Vitamin B to Quantity of Food.—Prof. J. C. Drummond: New Facts concerning the Fat-soluble Vitamins.

ROYAL COLLEGE OF SURGEONS, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (5). Fossil Anthropoids of Europe and of Asia.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—D. Brownlie: John George Bodmer, his Life and Work, particularly in the Evolution of Mechanical Stoking.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 5.30.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—C. E. Webb: The Power Losses in Magnetic Sheet Material at High Flux Densities.

INSTITUTE OF METALS (Birmingham Local Section) (jointly with Birmingham Metallurgical Society) (at Temperance Hall, Temple Street, Birmingham), at 7.—W. R. Barclay: Metallurgy of Nickel with Special Reference to Work in Canada.

INSTITUTION OF AUTOMOBILE ENGINEERS (North of England Centre) (at 244 Deansgate, Manchester), at 7.15.—J. D. Parkes: Logic applied to Failures.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (jointly with Andersonian Chemical Society), at 7.30.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) and SOCIETY OF CHEMICAL INDUSTRY (Edinburgh and East of Scotland Section) (at 36 York Place, Edinburgh), at 7.30.—Dr. A. E. Dunstan: Recent Developments in the Refining of Petroleum.

ROYAL SOCIETY OF ARTS, at 8.—Prof. J. McLean Thompson: Some General Problems of the Transport by Sea and Conservation in Store of Ripe Fruit (Aldred Lecture).

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—Prof. F. G. Parsons: The Earlier Inhabitants of London.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—Dr. M. Culpin: Investigations into the Predisposition to Breakdown.

THURSDAY, JANUARY 28.

ROYAL SOCIETY, at 4.30.—Prof. A. C. Seward: The Cretaceous Plant-Bearing Rocks of Western Greenland.—Dr. W. L. Balls and H. A. Hancock: Measurements of the Reversing Spiral in Cotton Hairs.—R. H. Burne: A Contribution to the Anatomy of the Ductless Glands and Lymphatic System of the Angler Fish (*Lophius Piscatorius*).—I. Gordon: The Development of the Calcareous Test of *Echinus miliaris*.—*To be read in title only*:—F. G. Gregory and L. Batten: A Critical Statistical Study of Experimental Data on the Effect of Minute Electric Currents on the Growth Rate of the Coleoptile of Barley.—H. M. Fox: Chlorocruorin: a Pigment allied to Hæmoglobin.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. C. J. Patten: The Breeding Factor in Birds.

INSTITUTE OF CHEMISTRY STUDENTS' ASSOCIATION (London) (at Institute of Chemistry), at 8.—G. Lemonens: The Transference of Chemical Processes to the Large Scale (Address).

FRIDAY, JANUARY 29.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Fossil Remains of Ape and Man (6). The Kivu Gorilla and its Bearing on the Problems of Human Evolution.

INSTITUTION OF STRUCTURAL ENGINEERS (Yorkshire Branch) (at Great Northern Hotel, Leeds), at 6.30.—D. Davidson: A New System of Reinforced Concrete Construction and its Application to Foundations on Silt and Running Sand.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. N. Moon: Comfort in Railway Travel from the Point of View of the Engineer.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir William B. Hardy: On Films.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY.

SATURDAY, JANUARY 30.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—H. Balfour: The British Coracle, or Skin-covered Boat, and its Affinities.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (at Neville Hall, Newcastle-upon-Tyne), at 5.—P. F. Hope: The Sinking of Monkton Shaft.—J. T. Pringle: Housing of Workmen (Discussion).

INSTITUTE OF METALS (North-East Coast Local Section) (jointly with Institution of British Foundrymen) (at Neville Hall, Newcastle-upon-Tyne), at 6.15.

PUBLIC LECTURES.

SATURDAY, JANUARY 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Europe's Debt to the Ancient Egyptians.

MONDAY, JANUARY 25.

UNIVERSITY OF LEEDS, at 5.15.—Prof. G. Watson: Approximations.

KING'S COLLEGE, at 5.30.—Dr. F. A. P. Aveling: The Human Will: Medieval Views.

UNIVERSITY COLLEGE, at 6.—H. D. J. White: Psychology of Art: Beauty and the Unconscious.

TUESDAY, JANUARY 26.

UNIVERSITY COLLEGE, at 5.30.—Miss M. A. Murray: Egyptian Architecture.

SATURDAY, JANUARY 30.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. Harcourt: Glimpses of Indian Places and Peoples.

CONFERENCE.

WEDNESDAY, JANUARY 27.

ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, at 11.30 A.M.—The Growing of Lucerne. Chairman: Lord Clinton. Speakers: Sir E. J. Russell: Spread of Lucerne Growing.—Prof. R. G. Stapledon: Lucerne in High and Wet Districts.—J. Mackintosh: Lucerne for the Dairy Farmer.—A. Cunningham: Scottish Experiments with Lucerne.—H. G. Thornton: Inoculation of Lucerne.