NATURE

SATURDAY, MAY 23, 1925.

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Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Editorial communications should be addressed to the Editor.
Advertisements and business letters to the Publishers.

Telephone Number: GERRARD 8830.
Telegraphic Address: PHUSIS, WESTRAND, LONDON.

NO. 2899, VOL. 115]

The "Electronic Reactions of Abrams."[1]

AN acrimonious discussion has been carried on for some time past concerning the merits of a method of medical diagnosis and therapeutics generally known as the "Electronic Reactions of Abrams." Dr. Albert Abrams graduated in medicine at Heidelberg at the age of nineteen years. At thirty-seven, after many years' practice in San Francisco, he founded a therapeutic method which he called "Spondylotherapy," and six years later, in 1910, he introduced a method of diagnosis and treatment based upon a new physiological phenomenon which he claimed to have discovered and which he named "electronic vibrations." The rate of these vibrations he held to be constant for each individual, each organ, and each disease. It is measured by an Adams's "Dynamiser" in circuit with the patient or with something more or less miscellaneous belonging to the patient, his blood, sputum, saliva, or even his signature. Readings are taken according to certain changes in the abdominal percussion note of the patient or of a "subject" or "medium" interposed in the circuit with the patient's blood, sputum, or similar substance.

The "dynamiser" is a box containing three electrodes; of these the two lower, on which the specimen rests, are electrically connected to earth, while the third, which forms part of the lid, is connected in series with two (or three) resistance boxes. The first of these is called the "amplifier," while the second (and third if present) is known as a "reflexophone." From the last resistance a wire passes to another electrode held in close juxtaposition with the forehead of a normal healthy person, standing on earthed plates "facing west" and known as the "subject" or "medium." Certain areas on the abdominal wall of this "subject" are then percussed by the operator, and for each such area the first "reflexophone" is adjusted until the normal percussion note changes to "dull"; the readings of the "reflexophone" corresponding to such changes of note are known as the "rates" of "electronic vibration." Abrams's comprehensiveness was not confined to the terminology of wireless telegraphy. Sex, race, religion, as well as disease in all its varying forms and sites, had for him their proper "rates of vibration," of which they were merely the expression. So he reversed his procedure and invented the "oscilloclast," which, by producing any desired rate of "electronic vibration," might be expected to change, if not the sex, race, and religion of his patients, at least their pathological

[1] A Preliminary Communication concerning the "Electronic Reactions" of Abrams, with special reference to the "Emanometer" Technique of Boyd. Read before a Joint Meeting of the Sections of Medicine and Electro-Therapeutics of the Royal Society of Medicine, January 16, 1925, by Sir Thomas Horder on behalf of M. D. Hart, Dr. C. B. Heald, Sir Thomas Horder, Lieut.-Col. H. P. T. Lefroy, W. Whately Smith. Pp. 56. (London: John Bale, Sons and Danielsson, Ltd., 1925.) 2s. 6d. net.

states. "The climax was reached with the assertion that both numbers and letters were possessed of sexual characteristics, odd numbers and vowels being feminine, while even numbers and consonants were masculine."

The "oscilloclast" is leased to practitioners for 150*l.* on condition that it must not be opened; but according to Messrs. A. S. E. Ackermann and W. Clark, consulting engineers, the greater part of the apparatus is functionless, the essential part consisting of a simple rocking magnetic interrupter, which permits about a micro-ampere of current, interrupted about 200 times, to flow to the patient. There seems, however, to be some inconstancy in the contents of the mysterious box.

In the face of ridicule, and unchastened by numerous test results of the most ludicrous description, "E.R.A." has become an established cult. It has taken root in England, where there is now a "small British society of doctors who employ Abrams's methods," the Society of Electronic Medicine. Nevertheless, "employment" of Abrams's methods appears to be an imperfect description, for, composed of "genuine" Abrams workers, but unsuccessful in its application to the leaders of the "cult" in the United States for information concerning the machines its members use, the Society has agreed unanimously to explore the mechanism of the instruments supplied and publish all details (*British Medical Journal*, January 10, 1925). Moreover, it is made clear that the "genuine" Abrams workers, up to January 26, had not wholly embraced the theories of the master, for "our researches (apart from treatment results) have not enabled us to say more than that an as yet undefined relationship exists between 'reactions' and disease" (*British Medical Journal*, January 31, 1925).

When the claims of the Abrams school were first reported in England, they attracted the attention of Dr. C. B. Heald, Medical Adviser to the Director of Civil Aviation. The Director authorised an investigation which resulted inconclusively. In consequence, Dr. Heald, with Lieut.-Col. Lefroy, head of wireless research at the Air Ministry, Mr. M. D. Hart and Mr. Whately Smith, who are engaged on physical research on behalf of the War Office and Air Ministry respectively, carried on the investigation unofficially. Later, Sir Thomas Horder acted as chairman co-ordinating their work.

A preliminary communication concerning the investigation prosecuted from that time onwards has now been published in pamphlet form by Sir Thomas Horder. It is an exceedingly puzzling document. While it is clear that extensive and painstaking investigations have been carried out, the report is argumentative rather than critical, deals only with a modification of Abrams's box, called the Boyd "Emanometer," reserves important parts of the evidence, and while frankly denying to the electronists any shred of justification, ethical or scientific, for their practice, gives the unfortunate impression that there is "something in it" without elucidating in the slightest degree the nature of the "something" evidenced. Boyd's "emanometer" as described by Sir Thomas Horder substitutes for the variable resistances of Abrams's box "a variable inductance and a variable condenser" in series with a "receiving plate" and a "normal human subject standing on earthed plates facing west." "An outstanding feature of the Boyd apparatus is the incorporation of earthed metallic screens, which are claimed to eliminate contamination from external sources."

The "operator" and "subject" in a series of experiments in Glasgow were "two Gallowgate boys"—*i.e.* one Gallowgate boy percussed the abdomen of another Gallowgate boy, and his verdict concerning the percussion note constituted the "result." The tests consisted in (1) the discrimination between two apparently identical substances; (2) the identification of one specific substance from among a number of others; and (3) the determination of whether a specimen exhibited was "screened" or not from the receiving plate.

Most of the results were correct, and Sir Thomas Horder, setting aside the possibility of chance, considers "the veridicity of the phenomena in question" to be fully established. But what are the "phenomena in question"? What is it that "does something"?—the emanometer, the "substance," the experimenter, the Gallowgate boys, or some unconsidered factor or combination of factors? Mr. H. St. G. Anson conducted experiments extending over a period of some five months (1) to obtain instrumental evidence of some change in the electrical condition of the subject's skin concomitant to the variation of the percussion note, and second, to obtain graphical records of this acoustical phenomenon; and (2) to eliminate the possibility of the *apparent* change in the percussion note being due to the imagination of the observers. In respect of (2) "some measure of success was obtained, but the other part of the work proved entirely abortive." Yet it is hoped that these "entirely indeterminate" results "may prove of value in subsequent investigations into the physical nature of the phenomenon which it is hoped to undertake"!

A vigorous effort should be made to remove the restrictions under which Sir Thomas Horder's committee appears to have laboured, and to push the inquiry to a conclusion with the utmost expedition. The matter as it stands does no credit to scientific investigation.

Geodynamic Problems of the Alps.

(1) *Geodynamische Probleme.* 1: *Isostasie und die ursächliche Einheit von Gebirgsbildung und Vulkanismus.* Pp. 69 + 5 Tafeln. 5*s.* 3*d.* Teil 2, A: *Tektonik und Metamorphose;* B: *Die Widersprüche in der Kontraktionstheorie.* Pp. 51. 2*s.* 6*d.* Von Dr. C. G. S. Sandberg.

(2) *Geotektonische Hypothesen: eine kritische Zusammenstellung.* Von Prof. Dr. Friedrich Nölke. (Sammlung geophysikalischer Schriften, No. 2.) Pp. viii + 128. 5*s.* 2*d.*

(3) *Die alpine Faltung: ihre Anordnung in Raum und Zeit.* Von Dr. Hans Jenny. Pp. viii + 176 + 3 Tafeln. 13*s.* 2*d.*

(4) *Geologie der zentralen Balkanhalbinsel: mit einer Übersicht der dinarischen Gebirgsbaus.* Von Prof. Dr. Franz Kossmat. (Die Kriegsschauplätze 1914–1918 geologisch dargestellt, Heft 12.) Pp. v + 198. 16*s.* 6*d.* (Berlin: Gebrüder Borntraeger, 1924.)

(1) DR. C. G. S. SANDBERG, of the Institute of Applied Geology at Munich, is well known from his geological work in South Africa, and his advocacy of the Kainozoic age of some Alpine granites. He is deeply impressed by the parallelism of folds in the crust belonging to very distant dates, and though this fact has been regarded as supporting the origin of mountains by the slow contraction of the earth, he advances a theory of mountain formation which rejects emphatically that contraction. He attributes the major earth movements to the action of isostasy, under the control of the internal heat. He considers that deep-seated thermal influences may prevent the movements that would be expected if isostatic equilibrium were due to simple changes at the surface.

The variation of the load on an area by denudation removing material from one place and deposing it in another, according to Dr. Sandberg, is counter-balanced by the accompanying thermal changes. The base of the crustal block from which a sheet of sediment has been removed is cooled by the exposure on the surface of a lower layer, and in consequence some of the molten sub-crustal material freezes on to the under side of the block and thus may counteract the thinning of the crust by denudation. At the same time the spread of the sedimentary material over the ocean floor raises the temperature of the subjacent material and leads to the base of the block being melted off, and thus the weight reduced. This process is probably one of the causes why denudation and sedimentation do not always lead to isostatic variations in level.

Dr. Sandberg further considers that in the great geosynclinals the crust becomes sodden with superheated water, which, being confined by overlying impermeable layers, produces intense pressure and, at a high temperature, causes widespread thermo-metamorphism of the rocks, while the lateral pressure produces earth movements and mountain building. That these processes would operate is generally recognised by believers in isostasy, but it is doubtful whether they would have so great an effect as Dr. Sandberg considers. The weakness of his case is his denial of the contraction of the crust. He admits that mountain folding would be inevitable if the earth contracts. He reproduces Lugeon's section of the overthrust masses in the Galmhorn; and such diagrams indicate that whatever may be the ultimate cause of the pressure, the actual movements are due to lateral compression, such as would be inevitable in a rigid crust surrounding a contracting mass.

Dr. Sandberg describes some ingenious experiments on folding movements produced during the bending of sheets of clay and asphalt; but such experiments on earth structure, like statistics, though always interesting as illustrations, prove nothing. The author's work is useful by directing attention to various influences that would attend or control isostasy, but are so uncertain that little direct reference has been made to them in the literature.

(2) Diametrically opposite to the main conclusion of Dr. Sandberg is that of Prof. Nölke. His work on geotectonic hypotheses is a critical summary of the many conflicting speculations of recent years. He remarks that the problem of orogeny is without doubt the most important, and the most difficult in the whole range of geology, and he subjects all recent theories on the subject to a critical examination.

In his preliminary chapter, Prof. Nölke discusses the problems of isostasy, the periodic nature of geological phenomena, and the causes of vulcanism and glacial periods. He also discusses the permanence of oceans and continents, regarding which he adopts the moderate view that though some areas of both land and sea may have been permanent throughout geological time, the variations in other parts have been too great to admit of the permanence of the chief geographical units. He also discusses movements of the pole, and concludes that they are restricted within very narrow limits. The polar and continental wanderings advocated by Wegener, he also rejects.

The main part of the volume consists of a statement and discussion of the various rival geotectonic hypotheses. Prof Nölke concludes that the geological evidence is overwhelmingly in favour of the contraction of the earth as the main cause of crustal movements and mountain formation. The work is of great value from its careful summary of current theories and judicious conclusions of their merits.

(3) The modern literature on alpine geology is so extensive, and views have been developing so fast, that works which summarise one aspect of the subject are heartily welcome. Dr. H. Jenny, of Zurich, has prepared a short monograph on the distribution of folding east and west along the Alps, and its development in time. He adopts the view that the Alps consist of superimposed "Decken," and gives ample references to the literature on their structure; but he does not give the evidence as to their composition and the correlation of the rocks on which that theory rests. But adopting it, he correlates the various "Decken" and traces their evolution.

The theory dates back to Bertrand in 1883, who, however, afterwards abandoned his contribution to its foundation. Jenny abandons Suess's view of the asymmetric character of the Alps, and adopts Kober's conclusion that their northern and southern margins are more or less symmetrical. He has traced the movements which caused the "Decken" to a period much earlier than has been generally admitted. The story of the Alps goes back to the folding and intrusions of the Carboniferous, followed by the widespread volcanic eruptions of the Permian. The Trias was a period of geosynclinal subsidence with some deep-sea deposits. The Alpine compression began, according to Dr. Jenny, in the Pennine Alps during the Dogger, when the Lebendun, St. Bernhard, and Dent Blanche "Decken" were pushed to the north. These movements were almost confined to the Pennine Alps. They were resumed in the Middle Cretaceous, with the northward thrust of the Antigorio "Decke," contemporary with a similar movement in the eastern Alps. Further widespread northward thrusts happened during the Lower and Middle Eocene in the western Alps; there the Upper Eocene was a period of rest, though the effects of horizontal compression continued in the eastern Alps throughout the Eocene. Then in the southern Alps the lateral movements ceased; the Oligocene, Miocene, and Lower Pliocene were periods of faulting and fracture. In the northern Alps, however, the northward thrusts were continued and lasted until the Lower Pliocene.

The maintenance of the northern thrusts and overfolding on the northern side of the Alps while the southern Alps were subject to more or less vertical fracturing and subsidence has produced differences so important that they go far to justify Suess's claim for the asymmetry of the Alpine structure. The dynamometamorphic effects of these Decken movements are surprisingly slight. The old view of the Mesozoic age of the crystalline schists of the Alps on which so many early Alpine theories were based, has apparently gone for ever. Though Bonney is not mentioned, his conclusion that the pre-Cambrian schists are microscopically distinguishable from the dynamically crushed later beds, is fully admitted. Dr. Jenny, for example, p. 100, says distinctly that the crystalline schists are pre-Cambrian, and his account of the metamorphism of the later beds shows that the changes have not produced rocks of the type of the old crystalline schist.

(4) The correlation of the Alps and the contemporary mountains of the Balkans is considered in Prof. F. Kossmat's geology of the Central Balkans. This book is one of the by-products of the War, for it is the twelfth of Dr. Wilser's monographs on the geology of the fields of war. It includes the results of the surveys of Macedonia, Serbia, and Albania by a large staff of German and Austrian geologists, of whom twenty-two are enumerated. Their work has been scientifically valuable, as they surveyed areas which were imperfectly known, and they collected much new information on the structure of the West and West Central Balkans. The results are of especial interest in regard to the Dinaric Mountains, to the Kainozoic of Macedonia, and to the relations of the Vardar valley, which Prof. Kossmat compares to the Briançonnais in the western Alps, as it is a Palæozoic and Mesozoic belt folded in between two masses of older rocks. These older rocks continue eastward through the Rhodope Mountains into Asia Minor.

The references to the German, Austrian, and Serbian literature are full, but there is no reference to British work on the area, though some might have been quoted with advantage. The problem of most general interest is that of the relations of the Dinaric–Balkan Mountains to the Alps. Prof. Kossmat insists that the Adriatic is a geosynclinal which dates back to the Mesozoic, and confirms the view that the Dinaric Mountains consist of tectonic blocks which have been thrust from the Balkans westward and south-westward, towards the Adriatic depression. Some of the thrust blocks are described as "Decke," but they have been moved merely for a short distance by reverse faults.

The author lays much stress on the importance of some overthrusts to the south, and these movements simplify Alpine structure. Thus, for example, Prof. Kossmat explains some inversions in the Hohe Tauern, where the Trias lies under the gneiss and schist, not as due to a far transported "Decke" having been brought from some unknown southern root, but as a simple thrust to the south and south-west of the old rocks of the Tauern arc.

That the Dinaric Alps are older than the younger eastern Alps which cut across them is now well established; and the Dinaric movements accord with the direction which is predominant in the Balkans, whereas in the western Alps the main movement has been to the north. The eastern Alps are an intermediate zone, which has been complicated by the movements having taken place in both directions. J. W. G.

Modern Metallurgy.

(1) *The Science of Metals.* By Zay Jeffries and Robert S. Archer. Pp. xvii+460. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1924.) 25*s.* net.

(2) *The Corrosion of Metals.* By Ulick R. Evans. Pp. xi +212. (London: E. Arnold and Co., 1924.) 14*s.* net.

(3) *Cadmium: its Metallurgy, Properties and Uses.* By Dr. Norman F. Budgen. (Griffin's Scientific Text-Books.) Pp. xv+239. (London: C. Griffin and Co., Ltd., 1924.) 21*s.* net.

(1) THE subject matter of the book written by Messrs. Jeffries and Archer falls under the general heading of metallography. The authors inform us that about half of it has already been published in *Chemical and Metallurgical Engineering*, and that an effort has been made to make each chapter, to some extent, self-contained. One consequence of this is that there is a considerable amount of repetition. The authors are aware of this, but state that they do not consider this an objectionable feature, "since in general the material repeated is of such importance that it will stand repetition." As to this, opinions will perhaps vary, but it may be pointed out that the deformation of metals is treated in no less than six out of the twelve chapters of the book. The repetition, moreover, is not merely of the subject matter, but of the actual language used. Pages 149-50 are identical, word for word, with pages 403-5. Since the book is written by two Americans, there is a certain satisfaction in pointing out the work referred to in the above pages is English.

With the aim of the authors we have the fullest sympathy. Their starting-point is the fact that there is now a large body of scientific data as to the properties of metals and alloys but that few generalisations of fundamental importance have yet been reached, and that there is need for a proper classification and a more fundamental analysis of this knowledge. It is with this object that the book has been written. As already mentioned, the subject matter treated is that of metallography, but the authors have written a book which is not quite like any book on metallography that has yet been published. The keynote of their treatment is evident on p. 24, where they say "that there is an evident development of metallographic science in the direction of a thorough study of the constitution of matter." They are not content, however, to finish their analysis of structure where the microscope ends. They point out that the complete analysis of structure is concerned with the ultimate particles of matter, the electron, the atom and the molecule, and that it is not sufficient merely to recognise that such particles exist. Knowledge must be gained of the actual size of these particles, of their properties and their relations with one another. "In this way a mental picture can be formed of the manner in which metals are built up and of the mechanism of the changes of structure and properties which affect their utility. The knowledge which is now available of the ultimate particles is not enough to make the pictures complete and accurate, but it is enough to make them useful."

The early part of the book deals with the conceptions of electrons, atoms, and molecules. From there the authors pass to a detailed treatment of the crystalline structure of metals, the amorphous metal hypothesis, grain growth and recrystallisation, the mechanical properties of metals, compounds of metals, metallic solid solutions, the constitution of alloys, the structure and properties of aggregates, some general considerations on the hardness of metals, and finally to the hardening of steel. This is an interesting field to survey, and, speaking broadly, the authors have treated the subject matter adequately. At any rate, they have written a book which will be read and carefully studied by workers in this field of knowledge. It is clear, stimulating, and suggestive. Here and there, however, its assertions do not accord with the scientific evidence available. On p. 164, *e.g.*, in dealing with the deformation of single crystals, the following sentence occurs: "Any deformation short of rupture produced by an external force, disappears on removal of the force." Such a statement is decidedly wide of the facts. Again, it is surprising to notice that the iron-carbon equilibrium diagrams published on pp. 307 and 317 entirely omit the δ to γ change in pure iron and the low iron-carbon alloys. Connected with this is the statement on p. 88 that "if iron is cast it forms grains of γ iron above 900° C., crystallising with a face-centred cubic lattice." On the contrary, the iron solidifies as δ iron (with a body-centred cubic lattice) and inverts at 1410° to the γ variety.

Chapter vi. with its account of the amorphous metal hypothesis is a fair statement of the position at the present time, but the succeeding chapter on grain growth and recrystallisation is scarcely fair to those who hold that there is a distinction between these two processes. The authors maintain that "Recrystallisation is grain growth" (p. 127), and again (p. 141) they say that in their opinion "no new crystal nuclei are formed during recrystallisation"; that is, in the absence of phase changes. There is, however, definite evidence tending to show that grain growth and recrystallisation are different processes, that the former is produced by very small stresses in the metal, followed by heat treatment, when certain crystals grow by absorbing others; while for the latter to take place much greater stresses are required, when new crystals

make their appearance in the crystal boundaries, and ultimately *all* the original crystals are destroyed by the growth of the new crystals.

Some interesting results are given on pp. 61 and 62, where it is pointed out that metals crystallising in face-centred cubes are ductile throughout a considerable range of temperature, even down to that of liquid air, and that these are the best conductors of heat and electricity. Both ductile and brittle metals are found in the body-centred cubic arrangement, while metals having the hexagonal close-packed lattice harden rapidly under deformation. The statement that "twin crystals have not been observed in aluminium" is not correct. It has been shown that, at any rate with single-crystal testpieces of aluminium, both broad or narrow twins can be obtained provided the orientation is suitable. The statement on p. 92 that the columnar grains formed when a metal solidifies in a chilled mould "are of course unstrained," is certainly not correct in this unqualified form. Such crystals very often are in a state of strain. The chapter on the structure and properties of aggregates is a suggestive survey of this subject, while the discussion of the hardening of steel by quenching contained in the last chapter is worthy of its great importance. The book is well printed and illustrated, and if it reaches a second edition, as we hope it will do, it would be greatly improved by suitable editing and some diminution in the number of repetitions.

(2) To Mr. U. R. Evans has fallen the distinction of writing the best book that has yet been written on the corrosion of metals. Some two and a half years ago he published a remarkable study, in four volumes, of metals and metallic compounds, in which he brought the most modern chemical and physical knowledge to bear on the properties of these substances. It may have been during his survey of this field that his attention was directed to the strange neglect of the scientific study of corrosion. It is only within the last twenty years that any serious attempt has been made to remedy this defect. The subject is one of great practical importance. From time to time estimates of a more or less sensational nature are published in the press as to the annual wastage of metals by corrosion. It is doubtful to what extent such estimates approximate to the real figure, but in any case it must be admitted that the loss due to this cause is very large. Moreover, as Mr. Evans points out, the evil which must have troubled mankind from the earliest times has tended to increase rather than to lessen with the passage of years. In early times, before the use of iron was general, the wastage was probably relatively unimportant, but since then, and particularly since the atmosphere has tended to be increasingly contaminated by the products of combustion of coal, the damage has been correspondingly intensified.

The first serious attempt to grapple with the corrosion problem was begun some fifteen years ago by the Council of the Institute of Metals, which set up a Research Committee charged with the task of finding a remedy for the corrosion of condenser tubes used in marine service. The more the problem was investigated by Dr. Bengough and his collaborators, the more did it become obvious that a wider and more fundamental knowledge of the nature of corrosion was required. From 1916 onwards this investigation was financially assisted by the Department of Scientific and Industrial Research, and a year ago the Department itself set up a committee to deal with this subject on the broadest lines. This committee is now at work. The impetus given in this way to the study of corrosion has extended to other bodies and other workers, and the literature concerning it is now large. Accordingly, the time was ripe for an attempt to be made to gather the scientific principles governing corrosion into a single volume.

This attempt has been made with signal success by Mr. Evans, and it is no exaggeration to say he has lifted the whole subject on to a new plane. He says, with truth, that "many chemists and engineers still seem to consider that it is impossible to find any guiding principle in corrosion. They appear to regard the destruction of metals as a more or less capricious phenomenon not governed by fixed laws in the same way as ordinary chemical reactions. Recent research, however, has shown that it is quite possible to explain why corrosion is set up at certain places and not others." This claim he justifies in his book. It opens with a historical survey and deals briefly with the earlier theories, namely, the "acid," the "hydro-peroxide," and the "electro-chemical." Attention is directed to Aston's notable paper published in 1916, in which it was pointed out that the reason why wet rust promoted further rusting was not that it acted as a cathodic contact material but as a diaphragm, screening the underlying metal from the direct access of oxygen. This led to the newer electro-chemical theory of corrosion, according to which electric currents are set up mainly by lack of uniformity in the distribution of oxygen, a theory which gives a rational explanation of many corrosion phenomena.

Succeeding chapters deal with the direct chemical combination of metals with non-metals, the passage between the metallic and ionic conditions, anodic corrosion by means of an externally applied current, corrosion involving the production of hydrogen gas, and corrosion involving the presence of dissolved oxygen. In view of its wide practical importance, a special chapter is devoted to the corrosion of copper and its alloys. Corrosion and tarnishing in a moist and polluted atmosphere and factors affecting the velocity of corrosion are next treated, while the last

two chapters are concerned with the various methods which have been devised for the minimisation and prevention of corrosion.

Mr. Evans himself is a research worker in the field of corrosion, and this fact gives his book a peculiar value, since it is written with a first-hand experimental knowledge of the subject, and many of his examples are taken from his own researches. There is no doubt that he is fully justified in adopting this course since there is great value in describing accurately phenomena which one has actually observed. The literature of corrosion contains many theories representing many points of view. Until recently something could be said for most of these, but with the clarification of the subject which has taken place particularly in the last two years, a considerable simplification of hypothesis and theory has been rendered possible, and to this Mr. Evans has himself greatly contributed. We congratulate him unreservedly on his book, and we think it will be heartily welcomed by all those for whom it is intended—the practical engineer, the works chemist, and the investigators engaged on research into corrosion and allied subjects.

(3) Dr. Budgen has written a useful book on the metal cadmium. It is the first of its kind which has appeared. Prof. Turner, who has written a foreword, states that cadmia was known to the ancients, and that metallic cadmium has been produced for more than a century. The present annual output of the metal is about 150 tons. It is mainly a by-product in the metallurgy of zinc and lead. This production could be considerably increased if more extended uses for the metal could be found. At present, however, its applications are of a minor character. It has considerable merit as a pigment but is too expensive for common use. Dr. Budgen considers there is a hopeful field of application in the anti-friction metals and in solders, as a substitute for either part or whole of the tin. The metal is being increasingly used in the form of a cadmium-copper alloy for telephonic, telegraphic, and power transmission purposes. The present volume constitutes a comprehensive digest of the available information with regard to this metal.

The early chapters of the book deal with the sources, metallurgy, and statistical information of the metal. Then follows an account of its physical and chemical and analytical properties, and this is succeeded by chapters on the binary, ternary, and quaternary alloys. Later chapters deal with the electrodeposition and uses of the metal. The book is included among Messrs. Charles Griffin and Co.'s well-known metallurgical publications. It is well printed and illustrated, and both author and publishers are to be congratulated on its appearance. H. C. H. CARPENTER.

Science and Religion.

(1) *Science and Creation: the Christian Interpretation.* By the Rev. Charles F. D'Arcy. Pp. vi+126. (London: Longmans, Green and Co., 1925.) 3*s.* 6*d.* net.

(2) *Contributions of Science to Religion.* By the Rev. Shailer Mathews. With the Co-operation of William E. Ritter, Robert A. Millikan, Edwin B. Frost, Edward B. Mathews, C. Judson Herrick, John M. Coulter, Ellsworth Faris, Charles H. Judd, John M. Dodson, Charles B. Davenport, E. Davenport, C.-E. A. Winslow, Horatio Hackett Newman. Pp. vii+427+5 plates. (New York and London: D. Appleton and Co., 1924.) 12*s.* 6*d.* net.

(3) *New Light on Genesis: or Creation during Descent in the Scriptures.* By the Rev. Morris Morris. Pp. 151. (London, Edinburgh and New York: Marshall Bros., Ltd., 1924.) 3*s.* 6*d.*

(1) THESE admirable lectures by Dr. D'Arcy, Archbishop of Armagh, display a notable capacity for keeping abreast of recent advances in science. On p. 17, for example, we discover the author's acquaintance with the new anthropological theories of the Perry, Rivers, Elliot Smith school; he realises that culture degradation as well as progress has often taken place, and that the modern savage may not be by any means the equivalent of early man, so that the universal myth of a Golden Age may have its historical foundation after all (p. 14). The bishop also displays boldness, as well as clear judgment, in rejecting the specious attractions of vitalism in biology. It is not many religious apologists who would have dared to write words which might have come from Mr. Julian Huxley:

"The general conclusion is that, whether with the physiologist we consider the actual processes of the living body, or with the biologist we consider the evolution of living forms, the whole tendency of recent scientific discovery is in favour of the mechanistic view of the processes of life and against the vitalists who think it necessary to postulate a Specific Life Force" (p. 49).

Dr. D'Arcy does not make it quite clear whether it is only the thoroughgoing vitalism of Driesch that he is rejecting, or whether he repudiates also the modified, or "methodological" vitalism of Dr. J. S. Haldane; but his discussion of hormones and glands leads one to imagine that he stands for a completely mechanistic physiology. It may be asked how, if one accepts such a point of view, room can be found for ideas of "purpose." His attitude seems to be similar to that of R. F. Hoernlé (to whom, however, he does not refer), or to that of L. T. Hobhouse; the formula of the

former being "mechanism *plus* teleology," and of the latter, "we should not distinguish mind and matter as two substances, but teleology and mechanism as two modes of action."

The bishop's view is the legitimate one that function precedes structure. This may seem "Lamarckian nonsense," and leading back to all the superstitions of vitalism, but in point of fact it is an attempt to explain the evolution of structure by the experience which we have, in our own persons, of the actual modification of neural structure. Of this we actually have experience whenever we acquire a new habit, as neurologists like Sir Charles Sherrington and Dr. Henry Head have shown.

This part of Dr. D'Arcy's work will attract the biological student who has an interest in the philosophical implications of his science; but the psychologist will not find so much here to interest him. This is a pity, because the "conflict between religion and science" has largely shifted from biological on to psychological ground. Though a biological attitude necessarily leads to an equivalent psychological attitude (*e.g.* vitalism in biology means animism in psychology), yet we should have liked to hear Dr. D'Arcy's views on the bearing of the new psychology (and for that matter, the new anthropology) upon religion. "We are just getting the guns into position" is what one anthropologist is said to have remarked, and it is what a number of psychologists believe. These sciences seem to many people very menacing to religious faith; and the bishop does not help us much here. Nevertheless, we are grateful for a courageous, sincere, well-informed, and well-written book.

(2) Dr. Shailer Mathews' work has a very ambitious scope. The book is composite, and numerous authorities explain their own sciences and show how these have no hostile bearing upon religion. There are also some essays on the practical value of the natural sciences. Dr. Mathews contributes a valuable introduction, and four final chapters on religion as a personal adjustment to environment. It is to be hoped that this volume, so encyclopædic in the information it contains, and so broad in outlook, may be widely read in the United States.

(3) As for Mr. Morris Morris's "New Light on Genesis," biologists will suppose that the strength of his argument must lie in his exegetical chapters, whereas students of the Pentateuch will imagine they must lie in his criticisms of Darwin. We shall always lament that writers like Bateson, disappointed in their rather extravagant expectations from Mendelian theories, have given the impression that evolution was itself discredited, that is, that the *fact* of evolution, and not merely its *mode*, was in doubt. Mr. Morris Morris solves the problem of the origin of variations by saying (p. 40) that they were supernaturally caused. But this is to offer a different type of explanation, and to introduce a different type of causality, from that which we have become accustomed to regard as scientific. It is equivalent to saying that there can be no scientific explanation. But this is to dogmatise; and men of science will not willingly take refuge in that *asylum ignorantiæ*.

J. C. HARDWICK.

Our Bookshelf.

Les Échinodermes des mers d'Europe. Par Prof. René Koehler. (Encyclopédie scientifique: Bibliothèque de Zoologie.) Tome 1. Pp. xiii+362+9 planches. (Paris: Gaston Doin, 1924.) 16·50 francs.

HAVING published an excellent volume on echinoderms in the series "Faune de France" (see NATURE, vol. 107, p. 776, August 18, 1921), Prof. Koehler now undertakes to provide working naturalists with a guide to the echinoderms of Europe, both the littoral species and those that live on the continental plateau, as well as a few of the more interesting forms that have been dredged from greater depths. Since no such work has previously been published, the present one by so distinguished an authority will be warmly welcomed. It is to be in two volumes, of which this first one comprises the Asteroidea and Ophiuroidea, which are represented by 65 and 60 species respectively. The work is faunistic and essentially descriptive. Keys abound, and there are nine plates crowded with admirable photographs taken by the author and supplementary to those in the "Faune de France."

We have checked the accounts in various places, as occasion offered, and find them thoroughly practical. Here and there are statements that might be criticised. It is, for example, surprising to find so learned a zoologist still regarding the supposed *dorso-central* as a primary element in the echinoderm skeleton, and, what is worse, calling it the *centro-dorsal*—a totally distinct structure. He should also know that the term *ambulacra* was not given because of any connexion with locomotion. Or, to take a question of nomenclature, it is not clear why *Gorgonocephalus caput-medusæ* (Linnæus) should yield to the later synonym *G. lincki* (Müller and Troschel). Probably Prof. Koehler, who always gives 1841 as the date of Forbes's "History of British Starfishes," has not discovered that it was published in six monthly parts from October 1, 1840, to March 1, 1841. This may not be without importance. Such lapses as these, however, do not detract from the practical value of the book.

Preceding the systematic portion are some interesting chapters on the general morphology, development, phosphorescence, mode of life, parasites, and distribution of living echinoderms. The chapter on their palæontology is not quite abreast of modern views, but the notes on methods of preservation should be useful. At present rates, the book is remarkable value for the money.

F. A. B.

The Ideal Aim of Physical Science: a Lecture delivered on November 7, 1924, before the University of London, at King's College. By Prof. E. W. Hobson. Pp. iv+34. (Cambridge: At the University Press, 1925.) 2*s.* net.

PROF. E. W. HOBSON has published in this booklet a lecture which he delivered in the autumn at King's College, London, and which is very well worth publication. He expounds briefly but clearly the view of the nature and necessary limitations of science, which received its most systematic development from Auguste Comte, but which Comte himself referred in germ to Hume. Mach, Karl Pearson, and Prof. Hobson himself are the most notable recent advocates of it, and it must be held to have made its case good, subject to a clearer definition of its meaning and limitation than have been given to it by some of its defenders in the past, not excluding Comte himself.

We keep "explaining" in science, pushing our explanation further and further back. What do we mean by "explanation"? On this point those who become interested in Prof. Hobson's pamphlet should go on to Meyerson's "Explication dans la science," where this very point is submitted to a most searching historical examination. How far does this descriptive theory of science itself involve metaphysical elements, that very reasoning about the nature of things in themselves which it seeks most carefully to exclude? What do we mean by the "nature of things-in-themselves," and what would be the basis of philosophy if it is to be so sharply severed from science as Prof. Hobson demands?

Broadly speaking, while agreeing with him in his general thesis, on the basis of the old ideas of a separate, metaphysical world of things-in-themselves, we cannot agree that the spheres of science and philosophy can be thus regarded as independent. Philosophy is rather the "science of sciences," the most general conclusions of all which we can reach, while pursuing the strict path of science as the school to which Prof. Hobson belongs would describe it. But this is far too large a subject for a short note. Prof. Hobson's pamphlet is an admirable provocative to further thought, and concludes with an enlightening account of Einstein's work as illustrating his general position.

F. S. MARVIN.

Martin Arrowsmith. By Sinclair Lewis. Pp. 480. (London: Jonathan Cape, Ltd., 1925.) 7*s.* 6*d.* net.

IT is not often that a novel calls for review in a scientific journal, but Mr. Sinclair Lewis has given us in "Martin Arrowsmith" a work of such interest and importance that notice of it should not be neglected. It is a long novel dealing with the life problem of a young medical student and practitioner in the United States, who is handicapped by the common difficulty of narrow financial straits. He is inspired by the fine fire that consumes the true research worker to the exclusion of all else, and perpetually has to fight his superiors, who demand practical results and cannot see the importance of fundamental research *per se*. If the book brings home to any of the public the force of this idea, as it surely must, then it will do a very great service to research.

The other characters are remarkably well drawn, and though the "two-fisted fighting poet Doc" Pickerbaugh, of a State Public Health Service, may appear somewhat of a caricature to British eyes, doubtless he has his prototypes in the newer civilisation of America. Max Gottlieb, the bacteriologist, is excellent, and his gospel of truth so well set out that it should be an inspiration to many others who choose the hard paths of research as it was to Martin Arrowsmith.

What is called the "human interest" is not neglected, but we can see that Mr. Lewis was much more interested in the relation of Martin's emotional life to his work than to the mere story of it; viewed only as a tale, however, it makes excellent reading.

In a preliminary note, the author acknowledges the help of Dr. Paul de Kruif afforded him with the medical parts of the work, and with his scientific philosophy, and we can only say we should be glad to meet this gentleman. Mr. Lewis showed great promise in his earlier work, but here he has surely found himself, and we have no hesitation in strongly recommending this book to all research workers. W. P. K.

Über Wärmeleitung und andere ausgleichende Vorgänge. Von Prof. Dr. Emil Warburg. Pp. x+106. (Berlin: Julius Springer, 1924.) 1·40 dollars.

THE idea of making the theory of heat conduction in solids serve as an introduction to the theory of all diffusion or levelling processes is a good one and saves a large amount of repetition of mathematical work. The use of the term thermal resistance (p. 11) in the same sense as its analogue electrical resistance is another good feature of the book. More use of the point source is made than has been customary in books on heat conduction, *e.g.* the heat section of Riemann-Partielle Differential-gleichungen. In applying the elementary theory to cases like the deposit of dew (p. 32) and the bolometer (p. 34), in which the conditions are not such as to give direct conductivity problems, the author has detracted somewhat from the value of his work for teaching purposes. The same may be said of the transition from the periodic flow of a temperature wave into the earth to the periodic change of concentration at electrodes through which an alternating current enters a solution (p. 55). Only a page (p. 64) is devoted to diffusion, and no hint is given as to the motion of the solvent. Viscosity gets twenty pages, too many of which are devoted to the old oscillating disc method.

Islands: West Indian—Ægean. By Sir Arthur E. Shipley. Pp. xii + 139 + 24 plates. (London: Martin Hopkinson and Co., Ltd., 1924.) 6*s.* net.

SIR ARTHUR SHIPLEY has reprinted in this volume a number of short newspaper articles which he contributed to the *Times* and other journals on a recent visit to the West Indies, and a cruise among the islands of the Ægean Sea. Tropical agriculture takes a prominent place in the volume, but other interests find a place. There is enough in the brief volume to make the reader ask for more, but all too little to satisfy. The chapters on the Mediterranean Islands especially are tantalisingly hurried.

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.*]

Quantum Radiation.

THE fraction $x/(e^x - 1)$, by which the quantum theory of radiation differs from the classical theory, is so important that it seemed of interest to study it for its own sake. I accordingly wrote to my brother Alfred Lodge, as a pure mathematician, asking him what he had to say about it. He directed my attention to some points which may be of interest to other students of Planck's theory as expounded in Great Britain by Dr. Jeans. First, that the function was studied by John Bernoulli and expanded in a series involving his particular numbers; and next, that it is the ratio of simple interest to continuous compound interest for the same period. Or in other words, the compound interest $h\nu$ on E, the actual basic energy, is equal to the simple interest on RT; so that E has to be reduced below the average value in order to allow compound interest to be taken on it, while the rate of interest, x, is apparently dependent on the ratio ν/T.

The expansion spoken of above runs thus:

$$\frac{x}{e^x - 1} = 1 - \frac{1}{2}x + \frac{1}{6}\frac{x^2}{2!} - \frac{1}{30}\frac{x^4}{4!} + \frac{1}{42}\cdot\frac{x^6}{6!} - \frac{1}{30}\cdot\frac{x^8}{8!} + \ldots,$$

the coefficients being the successive Bernoulli numbers. A peculiarity of this series is that there are no odd powers of x after the first; looking as if everything outside classical mechanics depended on square numbers, like the radii of Bohr orbits.

Apart from the expansion so well known to pure mathematicians, the physical suggestion is that while RT is the average energy per degree of freedom per atom, the actual individual atomic energy E accumulates continuously at compound interest, the rate of which is $x = h\nu/RT$, until some atom has attained the extra accumulation $h\nu$, which it then emits. So that $E(e^x - 1) = RTx = h\nu$.

Interest is compound until it is paid, and then begins again. Thus E is first left to grow until it equals Ee^x; then $E(e^x - 1)$ is given out, and E is left to grow again until it again equals Ee^x, when another dividend is paid.

The accumulating unit is the atom, the energy of which is RT or $3RT$ only on the average. The actual energy rises by the compound interest of thermal agitation, until an emission occurs from those which on the ground of probability have reached the critical stage: small emissions at low frequency, large emissions — if they can occur—at high frequency.

The energy E is presumably internal electronic energy, the only kind of disturbance which can affect the ether and either radiate or absorb. It is doubtless associated with some particular frequency of revolution or internal vibration. Mere molecular or mechanical energy alone would not radiate (matter alone has no link with the ether); if it did we should have the equi-partition law and its troubles. Even the internal mechanism does not radiate save in jumps or jerks. Within the atom the energy grows continuously, but it is given out spasmodically.

All this is suggestive, and may probably be put in an educational manner. I need scarcely emphasise the singular beauty of the modern theory of black-body radiation, and the fundamental way in which we are beginning to get down to the mode of interaction between matter and ether.

OLIVER LODGE.

May 9.

D. C. Miller's Recent Experiments, and the Relativity Theory.

EVIDENCE against the validity of the relativity theory was unfolded before the annual meeting, April 28, of the National Academy of Sciences by Prof. Dayton C. Miller, of the Case School of Applied Science, who, by a much-refined and improved repetition of the so-called Michelson-Morley experiment, has shown that there is a definite and measurable motion of the earth through the ether.

Prof. Miller has obtained on four occasions a small positive effect at Cleveland, namely, the equivalent of a velocity of about 2 kilometres per second at the altitude of the Case School of Applied Science, and about 3 kilometres per second on the level of the neighbouring hills. Whereas at the altitude of the Mount Wilson Observatory, in four consecutive experiments spread out over four years, he obtained with increasing precision a positive result of 10 kilometres per second, his last result this April justifies him in asserting that the result is correct to within one-half kilometre per second.

The technical details of these experiments themselves will be described shortly in special papers by Prof. Miller himself. The purpose of the present letter is to say a few words about the implications of these results from the point of view of the relativity and the ether theories.

In the first place, then, this definite result is entirely antagonistic to the Einstein relativity theory, which in fact could not be adapted to the results of Prof. Miller by any conceivable modifications, unless the very fundamental principles of Einstein's theory were given up. This, however, is as much as to say that Miller's results knock out the relativity theory radically.

In the second place, from the point of view of an ether theory, this set of results, as well as all others previously discovered, are easily explicable by means of the Stokes' ether concept, as modified by Planck and Lorentz, and discussed by the writer in a *Phil. Mag.* paper (1919).

Without entering into the mathematical details associated with this statement, we may say only that Prof. Miller's results, as obtained in Cleveland and Mount Wilson, are given immediately by the main property of such an ether, namely, to adhere almost completely to the surface of the earth, and therefore to share almost entirely its translational motion over its surface, and to have a gradually increasing velocity relative to it when we go higher and higher up.

In the third place, the result of the recent *rotational* terrestrial experiment at Clearing, Ill., near Chicago, which gave a full effect associated with the spinning motion of the earth, can be accounted for by making the natural assumption that our globe, being almost perfectly spherical and having a purely gravitational grip upon the ether, does not appreciably drag it in its rotatory motion. Also the deflexion of the light rays around the sun to the amount claimed by the Einstein formula can be easily accounted for by means of a compressible ether provided its dielectric constant is related to its density and pressure by a very simple formula published by me a few years ago in the *Philosophical Magazine*.

The amount of additional evidence for the reality of Prof. Miller's beautiful results afforded by his tables

showing the relations of the observed azimuths of drift to the sidereal time is very remarkable. These tables indicate a motion of the solar system in a direction and with a velocity in good accordance with the independent results obtained by Dr. Strömberg and others.

LUDWIK SILBERSTEIN.

Washington, D.C., April 30.

Phylogeny as an Independent Science.

UNDER the title "Phylogeny as an Independent Science," E. W. M. gives in NATURE of December 20, 1924, a critical review of my "Geschichte der Organismen." Some points in this review cannot be passed without comment.

Almost at the beginning, the reviewer sums up the tenor of the book in the words: the author "treats of the evolutionary history of every phylum both in the animal and in the vegetable kingdom!" He has thus neither learned from the title, preface, and contents of the book, nor communicated to the reader of the review, the fact that "Geschichte"—that is, history—is not identical with "evolutionary" history. In my mind, the history of organisms tends to follow three courses, namely: (1) a simple account according to the chronology of the fossils and to the recent changes of fauna and flora; (2) showing the superiority of differentiation and centralisation (integration, Herbert Spencer), in contrast with the inferiority of differentiation alone; (3) phylogenetical connexion, the latter being the hypothetical part of the history. Thus the reviewer apparently did not understand that this mode of treatment leads, among other things, to securing, for his part, in good cases phylogeny more dependent than hitherto on empirical chronology, and to gain perhaps here or there an adaptation to each other of isolated phylogenetical hypotheses.

Furthermore, the reviewer enumerates two themes, of which he laments the absence of any attempt at explanation in the book. Well, the law of recapitulation is by no means explained in detail, but "the value and the limitations of the evidence from fossils" is discussed in a distinct manner in what to me is one essential respect, namely, that, on the average, the number of fossils diminishes at an accelerated rate when we go down to the older geological formations, and that, where it completely vanishes in pre-Cambrian times, we are still in a period approximately recent relative to the periods of origin of life, as well as of forming the chief branches of the genealogical tree.

Concerning the phylogeny of the Turbellaria, the reviewer says: "Not a word is mentioned of Lang's brilliant theory of their derivation from Ctenophora . . .," etc. This theory, however, is mentioned in the book, pages 305-6, in the chapter on the Ctenophora, in some twenty lines, where I say that it seems to me "somewhat too distinct." Moreover, the more recent view of Wilhelmi, perhaps not yet known to the reviewer, is recorded and adopted. The same theory is briefly mentioned again on page 659, in order to compare the hypothetical place of the creeping ctenophores with that of the dipnoid fishes and that of the Bennettit plants.

The reviewer remarks, "how ill-founded is Franz's comparison of the cystid and the echinoid because both have a spherical shape." The book, however, says that probably the echinoids were derived "from cystids with five short arms." Therefore, according to my meaning, these cystids, besides the ancestors of those known as fossils, were not spherical, as also in the greatest number of fossils the arms are only broken off.

With this, to be sure, I do not wish to deny that the reviewer's objection, that the sucker of attachment of asterid larvæ is identical with the attachment of the stalk of the crinoids, can be right; and here again, if I may add in short a phylogenetical consideration, I should not believe Bury's and the reviewer's phylogeny of the Echinodermata to be persuading, nor should I mean that F. Mueller's and the reviewer's interpretation of the Nauplius (ancestral) is more suggestive than mine (modified metatrochophora). As to the Echinodermata, I do not understand how it can be overlooked that by far the greatest probability is in favour of the origin of the radiometry of this great phylum in fixation, since fixation has effected all other radiometry, or, at any rate, nearly all others, in the animal and vegetable kingdom, and since Balanoglossus, the creeping allied form to the echinoderms, is not radial. There is a striking parallelism: annelids→brachiopods, enteropneusts→echinoderms, if we assume that the non-radiometry of the brachiopods has caused lower vitality or victoriousness and the less modulation of these animals also fixed, compared with the echinoderms. To present such ideas, connected with each other, though in many cases partially hypothetical, and surely to be in future again adapted to the considerations presented from other points of view, is to be one of the tasks of the "history of organisms."

As to the Nauplius, the identification, though only approximate, of a living marine larva with a Cambrian fossil would be strongly against the tendencies of the book, and to the intentions of the author. Moreover, I see no essential resemblance between the four-segmented Nauplius and the multisegmented Cambrian Marrella, without regard to the question whether this interesting form, perhaps nearly the missing-link between branchiopods and trilobites, could have been mentioned in the book.

V. FRANZ.

Zool. Inst. and Phylet. Museum,
Jena.

I AM sorry if I misunderstood the objects aimed at by Prof. Franz's book, "Die Geschichte der Organismen." I admit that the German word "Geschichte" is capable of being understood in two senses, namely, (1) a general descriptive account, and (2) evolutionary history. Since Prof. Franz holds the chair of phylogeny in his university, I understood "Geschichte" in the latter sense. All I can say is that if he intended it to be understood in the former sense, a task of such gigantic dimensions could not be attempted in a work of the size of his book. I gather that he intended to bring phylogenetic hypotheses into relation with fossil discoveries; in this aim I am in entire sympathy with him, however little success may have attended his efforts.

The object of my review was thus to point out that phylogenetic theory must remain a matter of personal taste, until the foundations on which it should rest are discussed and defined. These foundations are, as it seems to me, three, namely:

(1) When a number of closely allied species or genera are compared together, the more specialised amongst them have been evolved from the more generalised.

(2) When a close succession of allied fossil forms has been discovered in the same locality, becoming gradually changed as we pass from older to younger beds, this indicates a true evolutionary series.

(3) When the same larval form is found in the life

histories of diverse members of the same great group, it represents in modified and simplified form a common ancestor; and when the youth forms of certain members of a group closely resemble the adult forms of allied members of the same group, then these youth forms give the original structure of the allied species.

Now (1) is still able to shed strong light on the course of evolution when used with great care by our systematic experts; but its value is far more limited than was formerly supposed; its use implies that one living adult form has remained unchanged whilst other allied ones have progressed or degenerated, and this assumption is an exceedingly dangerous one, as leading palæontologists like my friend Dr. Bather have repeatedly pointed out. One has only to read Huxley's "Invertebrate Zoology" to see to what amazing conclusions the use of this method led even such a sagacious zoologist as Huxley fifty years ago.

(2) was regarded by Huxley as the best and most conclusive evidence for evolution, and in this I cordially agree with him: its range, however, is excessively limited. Such series are known only in a few cases; and only animals with hard parts intimately related to their general organisation can give by their fossil remains any real information as to the course of evolution. It does not help us at all with soft-bodied forms like Turbellaria and Annelida, and even in the case of Mollusca it gives no information as to the course of the evolution of the internal organs. Moreover, as Franz himself admits, the fossil record begins abruptly at a time when the main phyla were already differentiated.

(3) has the widest range of applicability *if the biogenetic law is sound*. But no one, even the most enthusiastic supporter of recapitulation, has denied the action of secondary simplifications and modifications in changing life history; and it seems to me that the task of a professor of phylogeny should be to analyse and discuss these secondary modifying factors.

Such factors are, for example:

(1) The changes involved in transforming a larval into an embryonic type of development.

(2) The distorting effects of yolk and of maternal nourishment by a placenta.

(3) The tendency to represent in life history only the functionally more important organs of the ancestor and to leave the less functionally active entirely unrepresented.

Now I may briefly allude to the cases cited in my review where Prof. Franz arrived at what I consider to be erroneous conclusions owing to the neglect of these principles.

These are the origin of the Turbellaria, the descent of Echinoids, and the significance of the Nauplius larva in Crustacea.

(1) Lang's theory of the origin of Turbellaria from Ctenophora is based on a careful comparison of the *larvæ* of the two forms, and that Ctenophora can take up creeping habits and become profoundly modified in the way in which Lang suggests is demonstrated by the recent genera Ctenoplana and Cœloplana. The latter of these has a "ctenophoroid" larva as Kumai has recently proved. The opposing theories favoured by Prof. Franz are based on crude comparisons of the *adult* forms of Turbellaria and Mollusca.

(2) Prof. Franz is mistaken in supposing that my main objection to the supposed cystid origin of Echinoids is that this theory is based on the superficial resemblance of a globular shape in the two groups. *The Cystid is a Pelmatozoon*, that is, a form which typically has a stalk for attachment situated in the centre of the aboral surface opposite the mouth. *The Echinoid when young is an Asteroid*, the globular shape is non-existent, and the radial canals stretch horizontally outwards from the mouth. The globular form develops as it grows older. I speak from constant observation as I have Echinoids undergoing metamorphosis in my laboratory every year. At no period in the life history is there an indication of a fixing organ in the aboral region: in the Asteroidea such an organ is developed on the *oral* surface.

(3) The Nauplius larva represents in some form a common ancestor of the Crustacea, since it appears in life histories of members of such divergent groups as the Euphausioidacea, the Malacostraca, the Cirripedia, the Copepoda, the Ostracoda, the Cladocera, and the Branchipoda. It possesses few visible segments, but it is already an arthropod with stiff cuticle and jointed legs moving like oars, in this respect differing from all Annelida. It is, however, not a crustacean, for by definition the Crustacea have *two* pairs of praeoral appendages and at least two pairs of limbs converted into jaws, whilst the Nauplius has one pair of præoral appendages and no true jaws. The Trilobita were Arthropods of just these characters; they had a single pair of antennæ, and all the post-oral limbs were alike, each provided with the rudiment of a jaw-blade but none converted into jaws, and all the limbs were of a simple foliaceous character. Now in Marrella as described by Walcott, which belongs to one of the oldest fossil faunæ known, we find the Trilobite antenna, but amongst the post-oral appendages the first two corresponding to the Naupliar post-oral second antenna and mandible *are greatly enlarged forked limbs*, whilst the more posterior limbs remain in their primitive foliaceous condition. Except for these latter limbs Marella *is* a Nauplius, and the absence of the hinder undifferentiated limbs in the modern Nauplius larva would surprise no one acquainted with comparative embryology. Since, moreover, Marrella is intermediate in structure between Trilobita and Branchipoda, as Prof. Franz justly asserts, this constitutes one more argument for regarding it as the ancestor of Branchipoda and of Crustacea in general which is represented in ontogeny by the Nauplius. E. W. M.

The Orientation of Stonehenge.

SOME persons have supposed that the intentional orientation of Stonehenge is a theory invented by Sir Norman Lockyer. As a matter of fact, it has been the opinion of every authority who has dealt with the subject from an astronomical point of view for the last two hundred years.

Owing to the gradual change in the obliquity of the ecliptic, the point on the Stonehenge horizon at which midsummer sunrise occurs is, in the course of time, slowly shifting to the eastward. At some time in the remote past the point of sunrise, viewed from the Stonehenge site, would have been beyond the azimuth of the axis line on the northern side. The midsummer sunrise now occurs to the east of the axis line, having passed that azimuth some thousands of years ago.

At some date in the past, therefore, the midsummer sunrise undoubtedly occurred at a point on the horizon in line with the axis of Stonehenge. This is not a theory, but is an absolute astronomical fact depending on the physical constitution of the solar system.

It is generally agreed as probable that the builders of the present structure of Stonehenge directed its axis, as nearly as they were able, to the point on the

horizon at which midsummer sunrise occurred at that date.

To enable us to discuss intelligently the probability of an *intentional* orientation by the Stonehenge builders, it is necessary in the first place to ascertain the approximate date at which midsummer sunrise actually occurred in line with the axis. This problem has been dealt with from time to time by different experts, and most completely by Sir Norman Lockyer. The methods adopted for this investigation are set forth in the present writer's recently published work on Stonehenge, in the chapter on "Astronomical Considerations," to which the reader is invited to refer.

On the data there set forth Lockyer found the obliquity of the ecliptic which would cause midsummer sunrise to take place at a point on the horizon on the line of the axis to be 23° 54′ 30″. According to Simon Newcomb (the eminent American astronomer) the date at which the ecliptic made this angle with the equator was about 1840 B.C.

Owing to want of precision in the data Lockyer considered that the possible error might affect the date to the extent (plus or minus) of as much as 200 years. We may conclude, therefore, that—as determined by astronomical considerations—the date at which midsummer sunrise occurred on the line of the axis of Stonehenge was sometime between 2040 B.C. and 1640 B.C.

Now it will be observed that this is just about the date now generally agreed by archæologists as the probable date of the building of Stonehenge.

We may conclude, therefore, that the builders of the present structure of Stonehenge did, as a matter of fact, direct the axis of their new building, either exactly or very nearly, to the point on the horizon at which the sunrise at midsummer then took place. It may, of course, be contended that this remarkable agreement is a mere chance coincidence. The fact, however, remains as stated.

The accuracy of Sir Norman Lockyer's calculations has never been questioned, and the results obtained can readily be checked by any competent computer. The margin of error (200 years either way) appears sufficient to allow for any want of precision in the data.

E. HERBERT STONE.

The Retreat, Devizes,
May 1.

A Stranded Cetacean.

A BRIEF account of the stranding of a Cetacean in the neighbourhood of Langness, Isle of Man, will probably interest many readers of NATURE. This event was reported to me and my colleagues on Saturday, May 9, and in the afternoon of that day I accompanied Mr. J. R. Bruce to the spot, which is a small creek on the Langness peninsula. Here we were joined by Mr. P. M. C. Kermode, Curator of the Manx Museum, Douglas, and along with him we obtained a good series of measurements and photographs. From these we conclude that the specimen is a rorqual (Balænoptera sp.), but this identification awaits confirmation. From the measurements obtained I select the following: Length, from tip of upper jaw, along back, to notch between tail-flukes, 48 ft. 6 in.; breadth of tail, from tip to tip of flukes, 11 ft. 8 in.; tip of upper jaw to centre of eye, 9 ft. 8 in.; length of pectoral fin, anterior insertion to tip, 5 ft. 6 in.

H. C. CHADWICK.

The Biological Station,
Port Erin, Isle of Man,
May 11.

Lightning.

EVER since I was a child I have heard of the idea that lightning makes a "swishing" noise when one is quite close to it, but I have looked on this as a popular superstition. I have recently, however, had occasion to wonder whether there may not be some foundation for the idea. On April 24 there was a very severe thunderstorm here, quite a number of flashes having been within a kilometre and a half of this house; a barn was struck one kilometre away, and probably also a cottage 450 metres in another direction. During the storm three men were working in a field; two of them were together close to a holly tree in a hedge; there was a very bright flash of lightning, with a just perceptible interval between the flash and the thunder. At the moment of the lightning there was quite a loud swishing sound in the holly tree, as though, they said, a sudden blast of air went through the tree; the sound occurred definitely before the thunder.

At about the time of the occurrence the wind rose to 30 miles per hour and gradually fell off to about 13 miles per hour; both men, however, are positive that there was no wind at the time, but that it got up shortly afterwards when the rain began. The flash must have been very close as they both smelt "sulphur"—nitrogen peroxide; and they could scarcely see anything for some moments. The third man was about 230 metres away and was close to an oak tree to which he had his back; he says that when the flash came there was a noise in the tree as though it were "on fire." He turned round expecting to see that it had been struck, but neither oak nor holly showed any signs of having been struck. Is it possible that in the neighbourhood of a flash, brush discharges may take place from trees and other points?

C. J. P. CAVE.

Stoner Hill, Petersfield, Hants,
May 12.

Decay and Regeneration of Radio-luminescence.

IT is well known that the luminescence produced in certain materials subjected to the action of the radio-active rays decreases with time and that the colour of the luminescence changes, while at the same time the material itself also changes in colour. From experimental work covering more than two years and still under way, we are led to believe that the decrease in luminescence of phosphorescent zinc sulphide, etc., is probably due to the masking of the radiation luminosity by the colour which the material acquires, due to the action of the radiation.

For example, small glass tubes containing radon initially glow quite brightly with a yellowish-green light, but the glass soon turns either brown or blue, and in the course of a few days the tubes glow very faintly, if at all. If the tubes be heated sufficiently just to discharge the coloration, the glow returns. This operation can be repeated with no apparent change in the property of the glass to glow under the action of the radon rays.

The coloration of the glass is not a surface phenomenon, and the colour produced, whether brown or blue, seems to reach a colour depth beyond which further radiation produces no apparent increase in the coloration.

Since the observation of the behaviour of glass under radiation and the restoration of its luminescence by discharging the coloration by heating, phosphorescent zinc sulphide has been investigated. Here again the visible radio-luminescence and the

phosphorescence decrease as the coloration increases, and eventually zinc sulphide, which originally gave a brilliant phosphorescence in daylight, no longer responds, and it is only faintly responsive to alpha radiation. However, on heating this zinc sulphide just sufficiently to discharge the coloration, no difference in any of its properties can be detected between such revived zinc sulphide and some of the same material which has not been subjected to radiation.

This investigation is being continued and a more detailed report will be given later.

CHARLES H. VIOL.
GLENN D. KAMMER.
ARTHUR L. MILLER.
Radium Research Laboratory,
Standard Chemical Company,
Pittsburg, Pennsylvania,
April 13.

Hydra and the Tadpoles.

THE following observation was made by Mr. J. T. Wadsworth, the steward of the zoological laboratory in the University of Manchester.

On April 25 a tadpole in a small aquarium was seen to be behaving in an unusual way. It was swaying to and fro with its head down, and appeared to be attached to the side of the aquarium by its tail. Further observation showed that it had been captured by a hydra and was held securely by the tip of its tail. The movements of the tadpole became feebler and feebler, and in half an hour they ceased altogether, the tadpole being evidently dead or completely narcotised. A quarter of an hour later, as no further signs of vitality appeared in the tadpole, the hydra with its enormous prey was carefully detached from the side of the aquarium and preserved in Carnoy's fluid.

The accompanying illustration (Fig. 1) is a reproduction of a careful drawing to scale made by Miss M. Jepson of this preparation. As this is the first recorded case, I believe, of a tadpole of this size (9 mm. in length) being captured by a hydra, it is probably not a common occurrence. The question might, therefore, arise as to whether the tadpole was in a normal healthy condition. It may be remarked that, as the hydra was attached to the glass about half-way between the surface and the bottom of the aquarium, the tadpole must have been captured while swimming, and when first observed the movements of the tadpole were fairly vigorous. In any event, it is a very remarkable illustration of the strength of the hydra's grasp and probably also of the toxic powers of the nematocyst fluid.

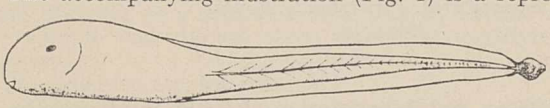


FIG. 1.—A tadpole 9 mm. in length, captured and killed by a hydra. The hydra is seen in a contracted condition, attached to the tip of the tadpole's tail. × 8.

SYDNEY J. HICKSON.
University of Manchester,
May 4.

Rainfall Correlations in Trinidad.

IN connexion with my communication to NATURE (February 7, p. 192) on the above subject, it may be of interest to mention that I have recently received a letter from my friend, Dr. Preston E. James, Department of Geography, University of Michigan, informing me that at the meeting of the Association of American Geographers at Washington last December, he recorded in an address on "Geographical Factors in the Trinidad Coconut Industry" certain correlations between rainfall and coconut yield. In connexion with data obtained from a large estate in the extreme south-east of the island, he found a positive correlation between the rainfall of one six-month period and the *quality* of the nuts six months later, "quality" being a matter of the proportion of selected nuts—which will not pass through an iron ring 4 inches in diameter—and "rejects" and "culls"—or those that will. (This grading into "selects" and "culls" is the recognised commercial practice where coconuts, as nuts and not as copra, are exported to northern markets.) Dr. James claims to have found a positive correlation of $0{\cdot}733 \pm 0{\cdot}072$. The correlation for the same six-month period, that is, without any lag, was $0{\cdot}508 \pm 0{\cdot}109$.

In my communication to NATURE, which dealt mainly with my own investigations in regard to rainfall and cacao yields, I gave the impression that rainfall and coconut yields had not been studied, being unaware of Dr. James's work, which has not yet been fully published.

Dr. James's work evidently constitutes a useful contribution to our knowledge of Trinidad's economic geography, and I presume that it is of considerable botanical interest to learn that the size of the coconut (not the entire drupe, but the endocarp and endosperm) is closely associated with rainfall, and that the extent of the relationship has been statistically determined under certain conditions.

W. R. DUNLOP.
34 Kensington Court,
London, W.8, March 26.

On the Spark Spectrum of Tungsten in a Helium Vacuum Arc.

PROF. O. W. RICHARDSON, in a paper entitled "The Striking and Breaking Potentials for Electron Discharges in Hydrogen" (Proc. Roy. Soc. 106, p. 640, December 1924), comments on the interesting fact that when a barium coated cathode burned out in an atmosphere of hydrogen, the spark lines of barium were developed instead of the arc spectrum.

We have observed a very similar phenomenon in which a hot tungsten cathode used in the operation of an arc at low pressure in pure helium is capable of developing the spark spectrum of tungsten. The conditions necessary for the development of this spectrum do not require temperatures high enough to burn out the filament; but the lines invariably make their appearance when it is raised to dazzling incandescence either by the thermo-ionic bombardment of the helium, or by a direct heating current, or preferably, by both. The relative intensities of the lines are distinctly modified from those given in the standard tables of wave-lengths, which fact is doubtless to be attributed to the presence of helium. For this reason, one has to go to some pains to be certain that the lines are those of the tungsten spark spectrum. Mr. S. J. Metzler has recently, in this laboratory, established this fact beyond a doubt.

Because of the wide use of the spark lines of refractory metals as secondary standards in wave-length determinations, and the difficulties encountered by various workers in this important field, with respect to precision determinations of these wave-lengths, due to pole effects and pressure shifts, it may be that the production of the spark spectra of these substances in helium vacuum arc conditions will enable them to be used with much greater reliability.

HARVEY B. LEMON.
Ryerson Physical Laboratory,
The University of Chicago, April 22.

The Story of the Mont Blanc Observatories.

By Dr. A. E. H. TUTTON, F.R.S.

THE announcement of the death of Joseph Vallot, the founder and director of the permanent observatory on Mont Blanc, at the age of seventy-two years, at his residence in Nice, will doubtless render the following account of some special interest. After I had made a particularly memorable ascent to the summit of Mont Blanc in magnificent weather on August 9, 1923, spending some time, both on the ascent and on the return to Chamonix, at the most welcome refuge and observatory of M. Vallot on the rocks of the Rocher des Bosses, at the height of 14,312 feet—it was obvious that the veteran mountaineer and scientist was in failing health—I was fortunately able to persuade M. Vallot to put the salient facts regarding the Mont Blanc observatories in writing. M. Vallot responded most kindly, and prepared a typed and signed statement, which is now of such interest and importance that it has been freely translated and embodied, with some additional facts of earlier date, in the following account. Indeed, M. Vallot gave special permission, almost a request, that its essence might be contributed either to NATURE or to the Royal Astronomical Society, and it is with great pleasure that this account is now at last written, although the sad circumstance of M. Vallot's passing from the magnificent scene of his life-work on Mont Blanc, in the valleys around which he will be greatly missed as a munificent friend and benefactor, renders the occasion one which the scientific world will deplore.

The summit of Mont Blanc, the highest point of Europe, 15,782 feet high, is a dome of snow absolutely unbroken by rock of any shape or kind. It is large enough to accommodate three or four parties of climbers at a time, of not more than four on each rope. When M. Eiffel made his celebrated sounding of its depth, for the purpose of deciding how the summit observatory of M. Janssen was to be erected, he excavated a tunnel or trench 150 feet long and 50 feet deep without touching anything but snow and hard ice, so that the depth of the snow cap must be immense.

It will be recalled that Mont Blanc was climbed for the first time by Jacques Balmat and Dr. Paccard (who reached the summit perhaps an hour after Balmat) on August 8, 1786, ascending by the Montagne de la Côte, where they spent the night at the edge of the glacier, the Grand Plateau, and the Rocher Rouge. The next year it is a tradition that Balmat again ascended it on July 5, with two Chamoniards, Cachat and Tournier. But whether that be fact or not, on August 1, 2, and 3, 1787, Balmat conducted to the summit the well-known savant H. B. de Saussure, accompanied by his valet and eighteen guides, mostly laden with scientific apparatus. They reached the summit about 11 A.M. on August 3, and stayed there four hours while de Saussure carried out some of his contemplated experiments. But the whole party were grievously afflicted with mountain sickness. Indeed, very few of those who ascend Mont Blanc escape after passing the 12,000 feet level, as the writer, who only suffered from it once before in twenty-five years of climbing, can well testify. Next year, 1788, de Saussure more or less completed his experiments at a lower level, in a hut on the Col du Géant, where he spent fifteen days.

In 1844 Prof. Bravais (so well known as the pioneer of our knowledge of space-lattices in crystals), with MM. Martins and Le Pileur, reached the summit, on August 17, and spent five hours in making observations.

In 1858 Prof. Tyndall ascended Mont Blanc and placed a thermometer with an iron stem four feet deep in the ice, in order to attempt to measure the winter cold. On August 21, 1859, he again made the ascent, accompanied by Prof. Frankland (afterwards Sir Edward), but they could not even find the thermometer. A second attempt failed through the thermometer being found broken. On this 1859 ascent the effects of solar radiation and of height on the rate of combustion were studied. Six candles were weighed at Chamonix, burnt for an hour in the Hotel de l'Union, and the loss of weight determined. The same candles were taken to the summit of Mont Blanc, and allowed to burn for an hour in a protective tent. The aspect of the flame surprised them, for it was "but the ghost of what it had been at Chamonix," being enlarged, pale, and feeble, suggesting diminished energy of combustion. Yet when the candles were weighed again after returning to Chamonix, it was found that the loss was almost exactly the same as before. The result was due to the greater mobility of the air at this great height, the oxygen molecules making up for their smaller numbers by their increased rapidity of movement.

Scientific observations were afterwards made on the summit by Prof. Hodgkinson on July 14, 1866, by Prof. Soret of Geneva on July 21, 1867, and on August 6, 1875, by M. Jules Violles of Grenoble, the last mentioned finding the temperature of the sun's rays to be 4° C. higher at the summit than at the foot of the Bossons glacier.

The ice movements at the summit were thus early recognised by Prof. Tyndall, whose thermometer must have moved some considerable distance. It reminds one of a statement by Capt. Sherwill, who, with Dr. E. Clarke, climbed the mountain in 1825, that Napoleon ordered a cross to be erected on Mont Blanc, and his command was carried out by Jean Marie Coutet. But the cross only remained erect for four hours, and in four days was thrown down and had entirely disappeared.

M. Joseph Vallot made his first ascent of Mont Blanc in 1880, purely as a climber. But in 1886 he returned to Chamonix, and made his first scientific expedition to the summit. The next year, 1887, he made another expedition and stayed three days on the summit, under a simple canvas tent, a feat of great hardihood which would have become tragic if the weather had changed from the fine spell. He obtained most valuable scientific results on this occasion, and decided to endeavour to continue them another summer in some more efficient protective building. In 1890, with the aid of more than a hundred guides who offered assistance, and a very small financial contribution from the Commune, he constructed the first observatory on the highest rock, which appeared to his judgment to offer

a good foundation for a durable edifice. It was a little flat rock, almost on the level of the snow, which goes down very steeply on the Italian (Courmayeur) side, in the little Col between the present refuge hut and the Grand Bosse du Dromadaire. The observatory proved immediately useful for experiments, and was enlarged twice, in the succeeding summers of 1891 and 1892. It was at a height of about 13,500 feet, measured about 16 by 10 feet, and was about 10 feet in height. It was divided into two portions, one for observers and the instruments, and the other as a refuge for climbers. Shortly afterwards, the climbing portion became such a nuisance to the observers that M. Vallot, at his entire expense, constructed the present separate refuge hut on the Rocher des Bosses at an altitude of 14,312 feet.

Unfortunately the little flat rock on which the observatory was built proved not to be the ideal spot which it was hoped it would be; the snow-field mounted up to it little by little, and ended by enveloping the little wooden structure up to the roof, rendering it unsanitary and almost uninhabitable. M. Vallot, however, was not discouraged, but, again entirely at his own expense, had a suitable foundation blasted in a part of the Rocher des Bosses, near to the refuge hut, and re-erected his observatory there, the work lasting forty-five days of the summer of 1898. The new building, constructed on a rock with a good escarpment, could not possibly be buried in the snow, and after twenty-seven years still defies the terrible tempests which break so suddenly and so often over this mountain. Each year it has afforded to scientists who desired to use it, after arranging with M. Vallot, a safe and relatively, remembering the position, most comfortable shelter in which to conduct their experiments.

Prof. P. J. C. Janssen, of Paris, the well-known astronomer, made an expedition to the Vallot observatory in 1890, and while there conceived the project of establishing an observatory of his own on the snow of the summit itself, in spite of the advice of M. Vallot, who tried to make him see that it is impossible to construct anything of stability on a glacier. M. Vallot says in a letter to the writer: "Janssen était un grand astronome, mais il ne connaissait les glaciers, et il a eu tort de ne pas vouloir écouter ceux qui les connaissaient. Il a voulu lutter contre le glacier, contre la nature; ce n'était pas possible, et il a eu un échec retentissant." At the request of M. Eiffel, M. Vallot lodged in his observatory the engineers and workmen sent by M. Janssen, and the observatory on the summit was constructed in 1893. A large telescope with 30-cm. objective was installed; but it was never possible to use this beautiful instrument on account of the instability of the glacier base. The meteorograph, constructed to work automatically, became frozen and entirely stopped in a few days. Hence, the observers had to be content with making studies in physics and astronomical physics, analogous to those which had been carried on continuously in the Vallot observatory. An expenditure of no less than 300,000 francs (then 12,000*l.*) had been incurred, furnished by public-spirited and scientific subscribers, to obtain very slight results.

Almost as soon as it was constructed, the summit observatory commenced to sink in the snow, which began to hold it as in a cup. The building was of two storeys and about 23 feet high, and the roof formed a kind of outlook-platform, approached by a spiral stairway in a little tower. In 1900 the platform had sunk to the level of the snow of the summit, and to prevent the building being engulfed altogether, the snow around it had to be excavated away each year, in order that the upper storey might be used. But this labour soon became too considerable, and was given up in 1906. The snow then mounted over the roof, and in 1908 had covered it for a depth of more than a yard, leaving only just visible the top of the tower.

M. Janssen died in 1907, and as some funds remained a committee of management was formed, and M. Vallot was made director. In 1908 a delegation met on the summit, and certified that the observatory was buried, deformed, and breaking up. It was decided to abandon it, and the instruments were brought down. At the suggestion of M. Vallot the salvage of the debris was decided on, and in 1909 it was dug out and transported, more or less piecemeal, to the Col des Bosses, near to the spot where M. Vallot had erected his first observatory, where it is being gradually used for firewood for the Vallot observatory and hut. The observers sent by the Committee were accommodated by M. Vallot in his observatory, which appears to be now well off for fuel, formerly a very grave difficulty.

When the present writer reached the Col des Bosses on August 9, 1923, the first thing that attracted his attention was the remains of the Janssen observatory, lying clearly marked on the snowfield. A few further particulars were afforded him by M. Paul Cupelin, guide chef of Chamonix. According to the latter the summit observatory, just before being dug up, had begun to work its way out towards the Chamonix side of the mountain; its transport had been a very difficult matter, the whole of the parts being entirely carried 2300 feet of descent on the backs of porters and with the help of ropes fastened to posts driven into the steep snow slope.

The Committee was very unwilling to abandon the summit, and suggested to M. Vallot that he should utilise part of the debris to construct a small light laboratory on the summit, capable of being brought to the surface each year. M. Vallot consented, but with much misgiving. He had the little hut erected, but warned the Committee that it would not be safe against thunderstorms. The next year M. Vallot's people were able to relieve it from the submerging snow, but unfortunately his warning was but too soon verified, for an expedition which had imprudently stayed in the laboratory too long were caught in a violent thunderstorm and a member of the party was killed by lightning in the hut. The next year, 1912, no workmen could be found willing to dig out the laboratory, which was deeply submerged in snow. In 1913 it had entirely disappeared, and soundings and borings made to locate it failed to find any trace of it. Doubtless, some day, this second summit observatory will work its way out to the Chamonix side, towards which the ice movement appears to be especially directed, and remind the world of its fugitive, useful existence. M. Vallot's predictions were thus once more remarkably verified.

The impression that appears to have been current, that observers spent the year in the Janssen laboratory, is, of course, quite wrong. It was only habitable for

the short summer season, from the middle of June to the middle of September, the usual climbing season. The observers prepared all their experiments in the valley, made the ascent and possibly stayed two or three days, and then descended. The Vallot observatory is visited every year by young science graduates sent out by the Société des Observatoires, and regular memoirs are printed and published. Indeed, there is usually a waiting list of young savants eager for places in the observatory, which is remarkably comfortable considering the height. Fortunately it is likely that some members of M. Vallot's family will continue the good work, and it is only right that every credit should be given to the great and generous man, great in every sense of the word, who in 1920, at the age of sixty-six, made his thirty-fourth and last expedition to the summit of Mont Blanc, and has just passed away amid the deepest regret.

Soaps and the Theory of Colloids.[1]

By Prof. J. W. McBAIN, F.R.S.

THE subject of colloids has suffered from an excess of conflicting speculations in the absence of precise and definite experimental evidence. It is still found difficult to devise methods of experiment which will yield exact, and also unambiguous, results.

At the time when we began work in this field one of the chief recognised characteristics of colloids was their changeability and the dependence of their behaviour upon the vagaries of individual specimens. The object was thoroughly to study one typical colloid in order to supply the definite evidence required for testing or building up the theory of the subject. No general theory can be true which is incompatible with carefully established experimental evidence obtained with any one typical material.

Our chief experience is that the more carefully the colloid is studied the less colloidal it is found to be. Soap is a unique material for the investigation of colloidal phenomena, because it illustrates nearly all the behaviour found in other colloidal systems, and it is one of the few common reversible colloids which have a definite, simple, known chemical formula. Last and most important, all results with soap solutions are quantitatively reproducible, and, in the many cases where our results have been tested in other laboratories, the experimental data have always been confirmed. We have been able to find one precise relationship after another, so that the results are almost lifted out of the colloidal field. Nevertheless it remains true that soaps are typical colloids, and that the results are of general significance in determining the behaviour of colloids and their relationship to other states of matter.

Soaps exhibit an apparently inexhaustible variety of behaviour, and few days pass without some new and interesting observation being made. A great deal of incidental information is obtained in the quest. For example, under certain conditions twice as much soap is required for a given amount of detergent action if the soap solution is allowed to stand for a day before use. Again, Miss Laing has carried out analyses which show that the substance which accumulates in the surface of soap solutions and of soap films is not free fatty acid but an acid sodium soap, a very slight excess of alkalinity in the soap solution converting it all to neutral sodium or potassium soap.

Soap is important as a type of a great class of substances known as colloidal electrolytes. It is essential to examine carefully the evidence obtained by a study of ordinary solutions of soap, since from it follows directly a proof of the micellar theory. The essence of the micellar theory is that not the chemical molecules but aggregates of particles are the colloidal units.

It is necessary to show that hydrolysis, although always present to a slight extent, does not account for the major properties of the solutions. There are only traces of free fatty acid present, and there is but little free alkali, far less than in sodium carbonate; this has been shown by half a dozen independent quantitative methods. Hydrolysis is only of importance in dilute solutions. This is borne out by the fact that the hydrogen soap, cetyl sulphonic acid, has properties exactly parallel to ordinary soap in concentrated solution. Hence the major properties of a strong soap solution are due to the soap itself.

We have found that in dilute solution, soaps are ordinary crystalloids, just like common salt, and dissociate into sodium and potassium ions and simple fatty ions. Upon concentrating the solutions, however, the undissociated soap molecules aggregate to form large particles of neutral soap; that is, neutral micelles. Likewise the fatty ions unite in small groups to form a new type of particle—the ionic micelle—in which there is one free charge for each fatty ion. By changing the concentration or the temperature, all intermediate proportions of these constituents can be produced. This may be summarised in the following scheme:

$$\begin{array}{ccccc} \mathrm{NaCl} & \rightleftharpoons & \mathrm{Na^{\cdot}} & + & \mathrm{Cl'} \\ \mathrm{NaP} & \rightleftharpoons & \mathrm{Na^{\cdot}} & + & \mathrm{P'} \\ \Vert\Gamma & & & & \Vert\Downarrow \\ (\mathrm{NaP})_x & \rightleftharpoons & n\mathrm{Na^{\cdot}} & + & (\mathrm{P'})_n . \end{array}$$

Neutral micelle. Ionic micelle.

The evidence for the foregoing conception is based upon a study of osmotic effects and of electrical conductivity. The osmotic effects as exemplified by the lowering of freezing point, of dew point, and of vapour pressure, and also the minimum pressure required for ultrafiltration, are in general half the values to be expected for the same concentrations of a typical salt such as sodium acetate. On the other hand, the conductivity of concentrated solutions is fully equal to that of sodium acetate. A large mass of data obtained chiefly in the laboratories of the University of Bristol has established both these truths.

If now the whole of the osmotic effect be taken as a measure of the sodium ions present, thus leaving no other crystalloidal constituent, rather less than half of the observed conductivity is accounted for. The other half of the conductivity must be due to colloidal constituents, and one of these constituents must have the same number of negative charges as there are positive ions: this is the ionic micelle. The undissociated

[1] Discourse delivered at the Royal Institution on Friday, March 20.

soap, too, must be in the form of aggregates or colloidal particles because of its negligible osmotic effect: this is the neutral micelle, and of the two it is the more important.

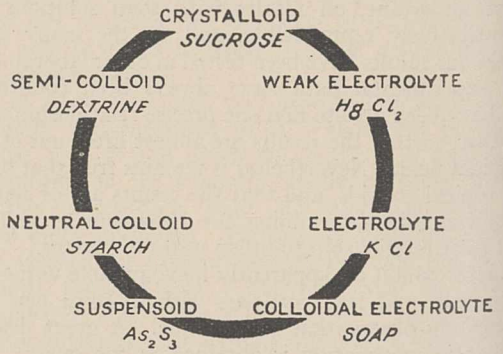
Long ago Selmi and Nägeli emphasised that not the chemical molecules, but larger aggregates, were the colloidal units out of which all larger structures are made. Nägeli in 1858 coined the word "Micell" from *mica* (a crumb), in order to have a term with no presupposition of crystal or any other particular structure. Many years of study of starch convinced him that the micelles of which these granules are composed are essentially crystalline, and now the X-ray work of Debye and Scherrer and Sponsler has shown that this is correct for such colloids as gold sols and wood.

With soaps there is no direct evidence of crystalline structure of the individual micelle, but Nägeli would have approved of the name micelle for the ordered arrangements based upon conceptions of polarity which since 1912 have become fashionable. The particles of neutral micelle in soap are found to range from a few hundred to thousands of Ångstrom units in diameter depending upon the soap and the conditions. These neutral micelles may be visualised by borrowing and modifying a suggestion of S. E. Sheppard's (NATURE, 1921, March 17, p. 73). Each particle is like a pair of military hair brushes, in which the bristles represent the hydrocarbon chains of the molecules arranged parallel to each other in sheets, two such layers being put together hydrocarbon to hydrocarbon. The two backs of the brushes on the outside represent the hydrate layer and the un-ionised electric double layer. A general survey of the facts with regard to the electrical double layers (*J. Phys. Chem.*, 1924, 28, 706) has shown that only a minute fraction of such a surface can ionise —hence the name "neutral micelle." Such a micelle would owe its stability to its internal polar arrangement of the molecules and to the external heavy hydration of the sodium and carboxyl group. The explanation of the stability of colloidal particles should be extended to the discussion of suspensoid particles where it is usually ascribed to the free electrical charges. The present conception would explain the stability by the hydration or solvation conditioned by even an undissociated double layer and at its maximum in the neighbourhood of uncompensated electrical charges. The principle here involved is the commonplace that like dissolves like, and that a particle remains in solution when it is completely surrounded or coated with chemical groups similar to those of the solvent.

The ionic micelle is more novel and is essentially different. It may be visualised by borrowing and altering a suggestion put forward by Reychler in 1914 for particles of soap, and more recently by N. K. Adam. It resembles a group of, say, less than a dozen eels tied together by the tails, and pointing outwards in all directions from the common centre. Each eel is a fatty ion with the charged carboxyl group outwards. These carboxyl groups also are probably hydrated. Such an ionic micelle cannot grow large because the electrostatic repulsion would increase as the square of the electrical charges. The diameter of the ionic micelle as measured is only a few score Ångstrom units. Many experiments on migration in an electric field have shown that the ionic and neutral micelles exist and move quite independently of each other.

The conceptions put forward are a quantitative interpretation of the constitution of soap solutions and are therefore open to many kinds of direct test. One of the most cogent has been filtration (or ultrafiltration) through such a membrane as cellophane, the familiar transparent sheets of cellulose used in wrapping chocolates and certain high grades of soap. Dense membranes may be obtained through which a soap solution passes unchanged when it is in such dilution that conductivity and osmotic effect show it to be crystalloidal; that is, consisting of simple molecules and ions. The same membranes hold back all the soap, allowing only water to pass through when the soap solution is sufficiently concentrated that, according to the argument already given, the soap is entirely in colloidal form, neutral and ionic micelles. Intermediate solutions can be tested for the amounts of crystalloidal and colloidal constituents. Further, membranes with pores of any size may be obtained the diameter of which can be measured by the pressure required to blow air through them when wet; with these it is possible to hold back the neutral micelle allowing the ionic micelle to pass through. It is evident that the membranes too have a micellar structure. Again, by using a reference substance such as a salt, it is possible to measure the hydration of the colloid which is held back by obtaining a filtrate which on occasion is twice as concentrated in reference substance as the original solution. In this way it is shown that the micelle contains about ten molecules of water for each equivalent of soap.

Throughout the foregoing discussion only solutions, that is, transparent fluids, have been mentioned. The place that these colloidal electrolytes play in the general classification of all the known varieties of solutions is shown in the following diagram, where each type merges by gradual transition into the next.



TRANSITION DIAGRAM.

States of matter exemplified by soaps and their solutions. —All soaps under suitable conditions can occur in each of several crystalline forms, in two forms of liquid crystals or anisotropic liquids, and finally in certain cases the solutions previously described may set to form true transparent jellies. These true jellies are like gelatine jellies in that they are clear and elastic, and when not under strain they are isotropic; that is, dark between crossed nicols.

On the other hand, the anisotropic forms which occur in higher concentrations are not miscible with the isotropic solutions or jellies but constitute separate phases. These doubly refracting liquids are not elastic but plastic; that is, they do not quiver when shaken, small portions do not flow under the influence of gravity

but passively remain in any position or shape which is given to them. These anisotropic liquids likewise have been found to be colloidal electrolytes.

It is remarkable that, when an ordinary soap solution sets to a true transparent jelly, such properties as conductivity and osmotic effect are unaltered. It is evident that the same equilibria and the same particles exist in each. The jelly structure must be built up by the neutral micelles linking together by bonds of residual affinity (Trans. Faraday Soc., 1924, 20, 22) to form larger structures without losing their individuality. This well explains the reversible transformation of true jellies to sols.

There are at least two crystalline forms of soap, lamellar crystals and curd fibres. Both give X-ray diagrams, whilst none of the other forms of soap solutions already described give radiograms. Figs. 1 and 2 illustrate the appearance of curd fibres under the ultra-

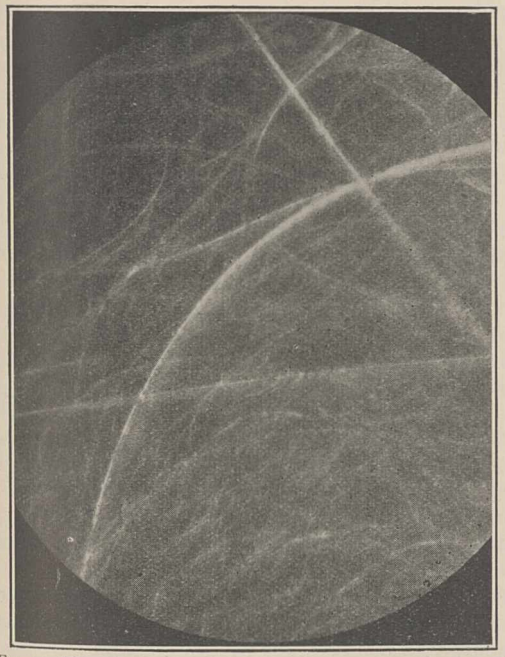


FIG. 1.—Ultramicroscopic appearance of curd fibres forming in 1·0N_{10} sodium laurate with dark ground illumination.

microscope. Fig. 3, which is strikingly similar, is taken from von Weimarn and is a similar ultramicroscopic picture of barium sulphate suddenly precipitated from concentrated solution. In all cases the curd consists of these innumerable crystalline fibres enmeshing mother liquor.

Most of the substances of the type of soaps, such as dyes, etc., exhibit many of the forms here described. Probably every soap can be brought into each of these states under suitable conditions. They exhibit a great family likeness, and the conditions differ merely in degree. All these phases are found in the two-component system water : soap, and it has been demonstrated that the phase rule applies to their equilibrium with each other. No new phases appear when salts are added.

The equilibria are surprisingly subject to law and order. Simple numerical rules relate the action of various electrolytes with each other independent of the nature of the soap. Again, simple rules hold for all soaps and their mixtures. It follows that the behaviour of the highly complicated mixtures of saponified oils and fats with various electrolytes met with in soap boiling can largely be treated on the simple basis of a three-component system. Thus by phase-rule models

FIG. 2.—Ultramicroscopic appearance of curd fibres forming in 0·05N_{10} sodium behenate, with dark ground illumination.

it is possible to follow and predict quantitatively all the soap-boiling processes.

In conclusion, the hope and expectation may be expressed that, when various investigators have carried

FIG. 3.—Ultramicroscopic appearance, according to von Weimarn, of gels of barium sulphate formed by sudden precipitation from concentrated solutions.

out sufficient careful and many-sided work with a number of definite typical materials like the soap which has been taken here as an illustration, the theory of colloids will ultimately become an exact science in which every statement will be demonstrable or subject to quantitative proof.

The Southampton Meeting of the British Association.

THE British Association is about to issue the preliminary programme of its annual meeting, which will be held in Southampton on August 26-September 2 inclusive under the presidency of Dr. Horace Lamb, lately professor of mathematics in the University of Manchester. Southampton, which the Association has not visited since 1882, is one of the most interesting centres in the south of England for a meeting of this kind. Its University College will house several sections of the Association, and affords an example of a great educational institution in the making. The town itself is a focal point of overseas communications, and with this feature and the railway centenary of the present year in view, the programme gives special attention to various aspects of transport. This will form the subject of two days' discussion in the sections of economics and engineering jointly, while Sir Archibald Denny, as president of the engineering section, will give an address upon fifty years' evolution in naval architecture and marine engineering, and an evening lecture will be given by Mr. R. V. Southwell on aeronautical problems of the past and of the future.

Among other addresses, that to the physical section by its president, Dr. G. C. Simpson, Director of the Meteorological Office, will deal with "The New Idea in Meteorology." The address by Mr. A. R. Hinks, secretary of the Royal Geographical Society, as president of the geographical section, will be concerned with the science and art of map-making, a subject appropriate to the town which is the home of the Ordnance Survey. Prof. A. V. Hill, presiding over the physiological section, will speak on the physiological basis of athletic records, and this section and that of psychology will jointly discuss the acquisition of muscular skill. Mr. Tate Regan, in the chair of the zoology section, will deal with "Organic Evolution: Facts and Theories." Dr. W. W. Vaughan, headmaster of Rugby, will address the education section on "The Warp and the Woof in Education." The sectional presidents again include a lady, Miss Lynda Grier, principal of Lady Margaret Hall, Oxford, and a distinguished economist, who will take "The Meaning of Wages" as the subject of her address to the section of economics. The speakers and subjects for other presidential addresses are: Prof. C. H. Desch on the chemistry of solids; Prof. W. A. Parks, of Toronto, on the cultural aspects of geology; Dr. T. Ashby on practical engineering in ancient Rome; Prof. C. Spearman on the mental law of diminishing returns; Prof. J. Lloyd Williams on the phæophyceæ and their problems; and Dr. J. B. Orr on the inorganic elements in animal nutrition. Sectional lectures already announced are by Mr. J. E. Barnard, on the observation of the infinitesimally small, and by Dr. D. H. Scott, on some points in the geological history of plants.

The many subjects already entered for discussion in the sections include the cost of farming and the marketing of agricultural produce; health in schools; the functional significance of size; the ignition of gases; the botanical geography of tidal lands; variations in gravitational force and direction; and recent investigations in the modern psychological field of vocational guidance.

The scientific interests of Southampton and its neighbourhood are exceptionally varied and attractive to visiting members, including the geographical and economic position of the town itself, the botanical study of the New Forest, the archæological features of Stonehenge, Winchester, and other sites, and the geological complexities both of the mainland and of the Isle of Wight. General excursions will be arranged to these and to other points, including a visit to the Channel Islands after the meeting, if there be sufficient demand; and particular scientific interests will be met by sectional excursions, such as the special visit of an anthropological party to Stonehenge, and inspections of the anti-gas school and diving-tender at Portsmouth and the aerodrome at Gosport which are being arranged on behalf of the physiological section.

The Association is maintaining its policy of attracting junior scientific workers to its meetings by making it possible for them to attend at a minimum cost, and as before has invited certain universities and colleges to nominate selected science students to "exhibitions" enabling them to participate in the meeting without expense to themselves.

The programme indicates that the Local Executive Committee for the meeting will make every endeavour to assist visiting members to obtain hotel, lodging, or hostel accommodation, and a form is provided on which they may indicate their wishes. A large attendance is hoped for, especially as the opportunity for reunion was denied to many members last year by the fact that the meeting was held in Canada.

Obituary.

Mr. W. W. Rouse Ball.

WALTER WILLIAM ROUSE BALL was born in London on August 14, 1850, and was educated at University College School and afterwards at University College. He was primarily a mathematician, but his studies were not confined to one subject, for besides gaining the gold medal for mathematics in the M.A. examination of the University of London, he obtained a first-class in mental and moral science in the final honours examination for the B.A. degree in 1869. He commenced residence at Trinity College, Cambridge, in 1870 and graduated as second wrangler and first Smith's prizeman in 1874. He was called to the bar, and although he did not practise, he published a "Student's Guide to the Bar," which ran through many editions. He was elected a fellow of Trinity College in 1875, and was a mathematical lecturer at the College from 1878 until 1905. He also held the post of tutor from 1893 until 1905, an office for which he was admirably qualified by his methodical habits, his sense of justice, and his wide sympathies.

With the exception of a few short papers Ball's published work on mathematics relates to the history of the subject, and appeared between the years 1888 and 1893. It stopped abruptly when he became tutor, and although afterwards he wrote again, he directed his attention to new subjects. But that he still retained his interest in mathematics was shown when

in 1922 he endowed the University of Cambridge with funds for establishing a special annual lecture in that subject.

In 1888 Ball published "A Short History of Mathematics," which reached a sixth edition in 1915. It contains, along with short biographies of the more prominent mathematicians, an interesting and well-written account of the development of the subject from the earliest times to the end of the nineteenth century. In 1889 the general history was followed by a "History of the Study of Mathematics at Cambridge," which, in addition to the information suggested by the title, contains an account of the general scheme of education at the University in medieval times and explains how this gave rise to the modern system of honours examinations with their curious name *Tripos*. He was especially interested in the works of Newton, and besides a paper on "Newton's Classification of Cubic Curves," printed in the Proceedings of the London Mathematical Society (vol. 22, 1891), he published in 1893 "An Essay on Newton's Principia." It is interesting to learn from the essay, along with more important information, that we may still repeat the story of Newton and the apple; for it appears to have been told by persons well acquainted with Newton, one of whom was vice-president of the Royal Society at the time when Newton himself was president. In 1892 appeared the "Mathematical Recreations and Problems," which is perhaps the best known of Ball's books, as it reached a tenth edition in 1922. The subject was a congenial one, for it was his hobby to collect information about all kinds of tricks, puzzles, and paradoxes, and a small book on "String Figures," which he published later, was another illustration of this habit of mind.

Ball's later publications deal mainly with the history of the University and Trinity College. They include "Cambridge Notes," "Cambridge Papers," a short monograph on Trinity College, an account of the King's Scholars and King's Hall, and a "History of the First Trinity Boat Club." He was also engaged for many years in editing, with the assistance of Mr. J. A. Venn, the five large volumes which contain the "Admissions to Trinity College, Cambridge."

The record of Ball's literary work is a lengthy one, but it only represents a part of his activity, for he was able to get through an immense amount of work. He took his full share (and something more) of administrative work both in his College and in the University, and for the last twenty years of his life he was one of the University representatives on the Town Council of Cambridge. His judgment was sound, and his advice was often sought and freely given. He was a warm friend, a delightful companion, and a courteous opponent, whose temper could not be ruffled. He had an especial sympathy with young people, which he retained to the last; for the same number of the *Cambridge Review* which contains his obituary notice contains also a full account of his speech at the centenary dinner of the First Trinity Boat Club. His full and active life came to an end on April 4.

WE regret to announce the following deaths:

Father A. L. Cortie, *S.J.*, Director of Stoneyhurst College Observatory, and Director of the Solar Section of the British Astronometrical Association from 1900 until 1910, on May 13, aged sixty-six.

Mr. H. Ling Roth, for many years keeper of the Bankfield Museum, Halifax, Yorkshire, on May 12, aged seventy-one.

Current Topics and Events.

CONGRATULATIONS are due to Sir George Taubman Goldie, K.C.M.G., F.R.S. (elected 1902), who entered on his eightieth year on May 20. He is held in honour as the founder of Nigeria, the first Governor of which, Sir Frederick Lugard, appointed in 1914, was his friend and co-helper. Goldie made acquaintance with the wild Niger districts in 1877, when little more than thirty years of age, but earlier he had acquired a considerable knowledge of the African continent, which stood him in good stead when new possibilities loomed on the horizon. To add to the British Empire the tracts of the lower and middle Niger, already more or less penetrated by British traders, became Goldie's creative purpose. The introduction of ordered sway by chartered companies was an early conception, and some united efforts were made. In 1881 he sought to obtain a charter from the Imperial Government, but there were difficulties. In 1884 he succeeded in buying out the French traders, and the year 1886 saw the establishment of the Royal Niger Company, with Lord Aberdare as Governor and himself as Vice-Governor. The Germans, led by Prince Bismarck, were markedly antagonistic to all schemes. However, Goldie's efforts to obtain treaties with the numberless chiefs were eminently successful, and ultimately the British sphere was recognised. In 1900 the Company transferred its territories to the British Government, and by 1903 British sovereignty was acknowledged. Sir George was made a privy councillor in 1898. In 1905 he was elected president of the Royal Geographical Society, holding office for three years. He is an Hon. D.C.L. (Oxon.) and LL.D. (Camb.), honours conferred in 1897.

LORD BIRKENHEAD, in presenting the triennial gold medal of the Royal Asiatic Society to Prof. A. H. Sayce at a meeting of the Society held on May 12, paid an eloquent tribute to the value of the work on the archæology of the East which Prof. Sayce has now pursued continuously ever since 1870. He referred to Prof. Sayce's edition of Herodotus, which, as he said, might well have engaged the life of most men, and pointed out that the great new linguistic studies in the East to which he passed on restlessly and insatiably, have proved of great intellectual consequence. Prof. Sayce and other scholars like him have rendered a service to Great Britain which is scarcely ever adequately measured, and never adequately rewarded, by their contemporaries. While the discoveries and sophistication of the West are not denied to the East, the reading of the incalculable minds of the East is a fundamentally more difficult task; but it has been

given to a few gifted Englishmen to understand more closely, with more sympathy, the mentality of the East than any other men in their day and in their generation. Lord Birkenhead referred in this connexion to Sir Richard Burton, and said that Prof. Sayce had achieved that learning mainly by his extraordinary gift for acquiring a mastery of Eastern languages and dialects, by an incredible degree of industry, and still more by a natural sympathy with the peoples, languages, and histories of ancient long-dead civilisations. Prof. Sayce's friends and colleagues will cordially unite in echoing Lord Birkenhead's closing words, in which he expressed a hope that Prof. Sayce, who has retained his physical strength and is now in the full maturity of his intellectual power, may enrich still further the field of human knowledge.

THE first Lister Memorial Lecture was delivered by Sir W. Watson Cheyne, Bart., F.R.S., on May 14, at the Royal College of Surgeons. This lecture forms part of the memorial to Lord Lister which was decided upon so long ago as October 1912. Part of the funds raised were devoted to placing a medallion in Westminster Abbey, part to the monument unveiled in Portland Place, London, in March 1924 (see NATURE, March 22, 1924, p. 430), and the remainder formed an International Lister Memorial Fund for the advancement of surgery. The Royal College of Surgeons of England became trustee for this latter fund, and it was resolved to award a bronze medal, with a sum of 500*l.*, every three years, in recognition of noteworthy contributions to surgery. Sir W. Watson Cheyne is the first recipient of the medal, and the award is particularly appropriate, apart from Sir William's scientific achievements, in that he was, with the late Sir Rickman Godlee, assistant to Lister in London. Sir William's lecture on the occasion of the presentation of the medal was a general account of Lister's aims and achievements, and the full and detailed story is promised in a forthcoming volume. Lister's early work at Glasgow is passed in review, leading up to the time when he learned of the work of Pasteur on fermentation and putrescence. The use which Lister made of this knowledge and the wonderful extensions of the work in surgery caused a revolution in surgical methods, for, as Sir William Cheyne says, "not only has his work led to the practical disappearance of septic diseases after operations, but it has enabled the surgeon to perform many operations which prolong life, restore movements, rectify deformities, and add to the usefulness and comfort of mankind." The complete lecture appears in the *Lancet* of May 16.

THE Tennessee Legislature recently enacted a law forbidding the exposition, in any educational institution supported by public funds, of theories holding that man is descended from the lower animals. Mr. J. T. Scopes, a high-school teacher, is to be prosecuted, presumably for contravening the law (the *Times* New York correspondent says "teaching of the theory of evolution," which is not quite the same thing), and Mr. W. J. Bryan has offered his services as associate counsel. The legal offence being, it appears, admitted, the American Civil Liberties Union, with Judge Neal for the defence, will concentrate on the issue whether the State has the right to restrict theoretical inquiry (which also does not seem to be the point). The prosecution, however, we are told on the same authority, "stands ready to deal with the whole question of evolution." If this be admitted, the trial will at any rate add to the gaiety of nations. It has not yet been announced whether a rack, a thumb-screw, and the other means of compelling evidence in such cases have been provided by the State. Probably Mr. Bryan's scarifying eloquence will suffice.

IN distributing electrical energy for lighting and power purposes, it is necessary to have good electrical conductors to carry the current, and also to have good insulating materials to prevent leakage and accidental damage by short-circuits. During the last twenty years the progress made by the industry in improving insulating materials has not been in proportion to the great amount of work expended on the subject by research associations in almost every country. For insulating cables, paper and fibrous materials, which are impregnated by oils and waxes of various kinds, are usually employed. Their resistance varies enormously with the amount of moisture they contain, so that data obtained by measurement are practically useless unless their exact hygroscopic condition be accurately specified. Most experimenters also make the assumption that the resistance is independent of the direction of flow of the current, an assumption that can only be justified in few cases. At a meeting of the Institution of Electrical Engineers on April 23, K. G. Maxwell and A. Monkhouse read a paper on recent improvements of insulation. They devoted considerable attention to the discussion of the papers and pressboards, which are widely used in practice. Much was expected of asbestos, but its capacity for taking up moisture, and the fact that it often contains conducting fibres of magnetite, militate against its use. Vulcanised fibre is shown to be one of the poorest of the insulating materials, and it is curious that it is still so widely used. The use of machine building instead of hand building has considerably improved the quality of mica products. Perhaps the most satisfactory progress has been made in improving the best quality insulating varnishes. The authors pointed out that from the commercial point of view it would well pay modern firms to train specialised operatives. Many firms expend large sums of money in obtaining apparatus for testing insulation. For testing porcelain alone, one firm is stated to have spent 20,000*l.* on apparatus.

THE difficulties arising out of the administration and control of religious trusts in India, as exemplified in the dispute over the Sikh shrines in recent years, for the settlement of which legislation is now under consideration, are illustrated further by a case upon which judgment was given by the Judicial Committee of the Privy Council on an appeal for the High Court of Calcutta, which is reported in the

Times of April 28. A wealthy Hindu who died in 1846 set up a household god and provided for its continued worship. On the reconstruction of the house by his son many years later, two houses were built and a separate house was set up for all the household gods. When on the death of the son the estate was divided under a rule of the Court into three equal shares, a house was allotted to the eldest and the youngest sons, while the second son received provision to build a house. Under the scheme for the worship of the god, each son in turn conducted worship for a year; but after the idol had been taken to the second son's house on two occasions, objection was taken on the third occasion on the ground that it could not be moved from the dwelling of the household gods. Hence the litigation. The Judicial Committee decided that account must be taken of the personality of the idol, which is no mere chattel. It must therefore be represented by a guardian or a friend appointed by the Court, and further, as it is to be worshipped by both sexes, the interests of the daughters must be taken into account. A scheme of worship must therefore be framed by the High Court.

ON May 11 and 12, two lectures were delivered in the University of Oxford by Prof. R. Chambers, of Cornell University, on the results of his studies in micro-dissection. A description, illustrated by photographs, was given of the apparatus which has rendered possible the dissection of a single cell, and even the extraction of a single chromosome from a dividing nucleus. The same apparatus has also enabled Prof. Chambers to inject solutions of various salts into living cells, with curious results dependent in some measure on the strength of the solution. The "needles" employed for the manipulation are formed of glass tubing protracted into extreme fineness, and converted, if required, into pipettes by fracture of the drawn-out end. The objects to be dissected are contained in a hanging preparation on the lower surface of a cover-slip which forms the roof of a damp chamber with sides sufficiently patent to allow free play to the operating needles. Many interesting results have already followed from the use of the method, particularly with reference to the protoplasmic communication between cells without the intervention of the nervous system; the transmission of impulses controlling ciliary action; the exact points of adhesion between adjacent cells, and so on. The effects of injection upon isolated cells are striking, especially the trail of coagulated protoplasm left behind by an amœba in endeavouring to roll away, so to speak, from the point where the puncture of a pipette has admitted a minimal quantity of calcium chloride. There is little doubt that the further employment of this valuable method will lead to results of still greater importance.

SOME further literature issued by the Industrial Institute (102 Belgrave Road, S.W.1) outlines the aims of that body in fuller detail. Industry consists in a threefold process, making, marketing, and financing. There is need for a central clearing house to co-ordinate data on these operations. Irregularities in the demand for goods, associated with "trade-cycles," lead to wide variations in selling prices and unemployment. It appears that the national annual savings in Great Britain should suffice to employ the present annual increase in population. Authorities of the Treasury and the Bank of England have suggested that, in determining the flow of investment, consideration should be given to the problem of employment. The committee advising on the supply of credit under the Trade Facilities Act is understood to concentrate on the support of industries immediately productive of employment. It is thought that the representative character and experience of members of the Institute should be of special value in connexion with this suggestion, and it is proposed that a special committee should be set up to consider the whole problem on scientific lines and endeavour to bring about co-ordinated effort in industry.

THE Association to Aid Scientific Research by Women announces that it has just awarded the Ellen Richards Research Grant of 1000 dollars for the year 1925 to Miss Katherine MacFarland Chamberlain, of Detroit, Michigan, U.S.A. Eighteen theses were submitted in competition for the Research Prize, 8 of these from the United States, 7 from England, 2 from Wales, and 1 from South Africa; and while no one of these theses was, in the opinion of the experts who examined them, up to the standard set by the association for the Prize, the paper submitted by Miss Chamberlain was of such a character that the judges were unanimously of the opinion that opportunity for further research should be given to her. Miss Chamberlain graduated from the University of Michigan in 1914, receiving the degree of Doctor of Science in 1924, and she is at present instructor in mathematics in the College of the City of Detroit. Her work for the Prize was on "The Fine Structure of Certain X-Ray Absorption Edges," and was carried out in the laboratories of the University of Michigan between August 1924 and January 1925. A preliminary report upon this investigation appeared in our issue of October 4, 1924, p. 500. The Prize is not to be awarded again until 1927.

SIR WILLIAM H. ELLIS has been elected president of the Institution of Civil Engineers, and will take up office on the first Tuesday in November.

THE DUKE OF YORK has graciously consented to accept the honorary presidentship of the thirty-sixth Congress of the Royal Sanitary Institute to be held at Edinburgh on July 20-25, at which the Right Hon. Sir John Gilmour, Bart., Secretary for Scotland, will preside, and deliver the inaugural address. A Health Exhibition is being held in connexion with the Congress.

AT the annual general meeting of Manchester Literary and Philosophical Society the following officers were elected:—*President*, Rev. A. L. Cortie, *S.J.*; *Vice-Presidents*, Prof. W. L. Bragg, Prof. H. B. Dixon, Mr. Francis Jones, Prof. T. H. Pear; *Secretaries*, Mr. John Allan, Dr. W. H. Lang; *Treasurer*, Mr.

R. H. Clayton; *Librarians*, Mr. C. L. Barnes, Dr. Wilfrid Robinson; *Curator*, Mr. W. W. Haldane Gee.

THE next International Congress of Entomology will meet this summer at Zürich on July 19-26, with the well-known Swiss entomologist Dr. A. von Schulthess as president. The gathering will be representative of all branches of biology interested in entomology pure or applied, and many institutes and societies of zoology, hygiene, tropical medicine, plant pathology, forestry, etc., are sending delegates. Further particulars can be obtained from the Zoological Museum, Tring, Herts, or from H. Kutter, Zolliker-Str. 76, Zürich 8.

MR. K. S. MURRAY, who has been for many years the managing director of the British Oxygen Co., has been elected to the chairmanship of that Company, which has been rendered vacant by the death of Mr. E. B. Ellice Clark. Mr. Murray will for the present continue also to discharge the duties of managing director. He joined the Company as assistant engineer in 1887, and since then has been intimately associated with the development of the oxygen industry, and the remarkable industrial applications of oxygen which have taken place since the commencement of the present century.

DR. F. A. F. C. WENT, professor of botany in the University of Utrecht, is giving at various universities in England a series of lectures under the auspices of the Anglo-Batavian Society. Went is well known for his work on the development of the Podostemaceæ and on the Triuridaceæ and Polygalaceæ. He is also an authority on tropical crops, such as cocoa and sugar-cane, and on many physiological aspects of plants, *e.g.* the physiology of fungi and of the irritable movements of plants. His lecture in London will be given at the Imperial College of Science and Technology on Monday, May 25, the subject being "Modern Conceptions of Light Stimuli in Plants."

ACCORDING to *Science*, Dr. H. S. Jennings, professor of zoology in the Johns Hopkins University, Baltimore, is to receive the first Joseph Leidy Memorial Award of the Academy of Natural Science of Philadelphia "in appreciation of his researches upon the Protozoa and the Rotatoria, and in recognition of his broad knowledge and keen understanding of the significance of biological phenomena." The award was endowed by a fund created in 1923 which will provide a bronze medal and an honorarium every three years "for the best publication, exploration, discovery or research in the natural sciences."

THAT indefatigable Autolycus, the curator of the Hull Museums, has for many years been snapping up such old and unconsidered vehicles as fell in his way, from bone-shakers to hansom-cabs, and storing them in any corner he could find. Hull's exhibit at Wembley last year and the emptiness of an old Corn Exchange, gave him an opportunity seized with his usual acumen and energy. "A Commercial Museum for Hull" was a good slogan, and the business firms responded admirably with exhibits and cases. But there was still space to spare, and what more suitable to fill it than the shandrydans, for "the success of a commercial community depends largely on its means of transport." So the whole was fittingly opened on April 16 by Brigadier-General Sir Henry Maybury, of the Ministry of Transport, and Mr. T. Sheppard added another item to his collection of museums.

THE Rockefeller Medical Fellowships for the academic year 1925-26 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 10. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council, in accordance with the desire of the Foundation, to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery, and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than 350*l.* a year for a single Fellow, with extra allowance for a married Fellow, payable monthly in advance. Travelling expenses and some other allowances will be made in addition. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

IN the notice of Mr. W. S. Jones's book, "Timbers: their Structure and Identification," which appeared in NATURE, April 25, p. 601, two corrections are necessary. The genera of conifers treated are 19 in number, and not 14 as stated. The writer of the notice regrets that in some unaccountable way he overlooked the mode of distinguishing the woods of Populus and Salix, which is given in p. 73 of the book, namely, that the medullary rays are homogeneous in the former and heterogeneous in the latter genus.

CATALOGUE No. 795 of "Sotheran's Price Current of Literature" has just been issued. It comprises Part VI. of this well-known serial publication, and is as interesting and valuable as former parts. It gives the titles and full bibliographical details of nearly 3000 works on geology, mineralogy, crystallography, physical geography, meteorology, and microscopy, and, in addition, of sets or long runs of scientific periodicals and proceedings of scientific societies. The present part is noteworthy in that it includes the libraries of the late Prof. T. G. Bonney and Prof. G. A. J. Cole, and many volumes formerly the property of the late Sir Archibald Geikie. The catalogue should certainly be obtained by readers of NATURE interested in the subjects dealt with.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Lecturers in applied mathematics, geology, and botany in the University of Durham (Durham Division)—The Head of the Department of Pure Science, South Road, Durham (May 28). A junior assistant (physical

chemist) in the Colloid Chemistry Laboratories of the British Cotton Industry Research Association—The Director, Shirley Institute, Didsbury, Manchester (May 28). A manager recorder of experimental work in breeding poultry for table use, at the South-Eastern Agricultural College, Wye, Kent — The Secretary, South-Eastern Agricultural College, Wye, Kent. A technical assistant at the Marine Aircraft Experimental Establishment, Felixstowe—Secretary, Air Ministry, Adastral House, Kingsway, W.C.2. Inspectors of agriculture under the Sudan Government—Controller, London Office, Sudan Government, Wellington House, Buckingham Gate, S.W.1. A demonstrator in the department of inorganic and physical chemistry of Bedford College for Women—Secretary, Bedford College for Women, Regent's Park, N.W.1 (June 3). An assistant lecturer in mathematics and geography at Bristol University—The Registrar (June 3). A demonstrator in chemistry at the London (R.F.H.) School of Medicine for Women, Hunter Street, W.C.1 — The Warden and Secretary (June 6). A woman lecturer in education, in the Department of Education, Bristol University—The Registrar (June 8). An assistant lecturer in the physics department, Leeds University — The Registrar (June 15). A mistress for botany and physics at the County School for Girls, Tunbridge Wells—Headmistress. Professor of organic chemistry in the University of the Witwatersrand, Johannesburg—Secretary, Office of the High Commissioner for the Union of South Africa, Trafalgar Square, W.C.2 (July 15). A mistress to teach botany, chemistry, and mathematics at the North London Collegiate School, Sandall Road, N.W.5—The Head Mistress. Instructor Lieutenants in the Royal Navy — The Adviser on Education, Admiralty, Whitehall, S.W.1. A master for chemistry at Taunton School — The Headmaster.

Our Astronomical Column.

THE 13-MONTH YEAR.—Calendar reform has moved a step forward in the reply just forwarded to the League of Nations by the representatives of British railways; in this they state that they are unanimously in favour of the adoption of a year of 13 months of 28 days each with one extra day (2 in leap years). This exact equality of the months would be a great convenience from the wage point of view. The objection is sometimes made that the division into quarters would be inconvenient: but our present "quarter days" are neither at the end of months nor equidistant from each other, so that the placing of them at the end of the first week of the fourth month, the second of the seventh, and so on, would be no worse than at present.

Most people who advocate the 13-month division of the year couple it with the plan of making every month begin with the same week-day, so that the days that stand outside the month would also be outside the week. However, the proposal to interfere with the regular sequence of week-days meets with strong opposition, and has little chance of adoption, but the 13-month reform would be quite useful even without this point. All the months of any year would still begin with the same week-day, but the day would change from one year to another.

COMETS.—A Harvard circular gives an elliptical orbit of Reid's Comet by Mr. Maxwell from observations extending from March 24 to April 7.

T = 1925 July 28·34 G.M.T. (new)
ω 258° 45′ 54″ } 1925·0
Ω 5 13 37 }
i 25 36 12
e 0·912875
Period 81·212 years.

Mr. G. Merton and Dr. A. C. D. Crommelin tested this period by including the observations of Mr. B. M. Peek, which extended to April 24. Their research gave a period of more than 12,000 years, so that the departure from a parabola seems to be much slighter than that announced by Mr. Maxwell. This comet is now too low down for English observers, but will come north again at the end of the year.

Very diverse statements have been published as to the date of the next return of Faye's Comet. *Popular Astronomy* gave the date as the autumn of 1924, nearly a year too early. Mr. F. R. Cripps has now investigated the perturbations by Jupiter (B.A.A. Journ., vol. 35, No. 6), and finds Aug. 6 next as the date of perihelion. Major Levin and Mr. Gaddum give an ephemeris, which starts on May 15, but the distance from the earth is now so great that detection is unlikely for two or three months. Every effort should then be made to find the comet, as it has not been seen since 1910. No accurate ephemeris was prepared in 1918, astronomy being short-handed owing to the War.

THE VELOCITY OF LIGHT FROM THE STARS.—It has been pointed out by Prof. La Rosa that if the velocity of a distant star compounds with that of light, the observed intensity depends upon the acceleration of the radial motion. When there is acceleration towards the observer, light which is emitted at any moment will tend to catch up with that emitted at a previous instant. Thus the flux of light into an observer's eye will be greater than when the acceleration is zero and still greater than when it is negative. The effect will increase with the distance of the star. In the *C.R. Acad. Sci.*, Paris, March 2, M. Salet points out that de Sitter has concluded that no such compounding takes place, on the ground that the motion observed visually or spectroscopically in double stars is a regular Newtonian one. These stars, however, are not very distant, and it seems possible that, though the velocity of the source may not compound fully with that of light, the latter may be altered to a small extent. This might produce an effect in the case of very distant stars, only the brightness of which can be observed. The brightness of Algol does not vary by 0·1 mag. in the interval between successive minima, although the radial velocity varies continuously. The conclusion is that the velocity of the emitted light is not changed by more than 1/200 of the velocity of the star. There are stars of the same type which are much fainter, and it is probable that their distances are much greater, while their radial velocities are of the same order as that of Algol; it thus becomes possible to arrive at a much closer limit for the effect, which can be regarded as negligible even for the most distant of these stars.

Research Items.

STENCIL IN FIJI.—Mr. Henry Balfour offers an attractive suggestion as to the origin of the art of stencil in Fiji in vol. 54, Part 2, of the Journal of the Royal Anthropological Institute. In patterning the borders of bark cloth the Fijian woman used a strip of banana leaf in which a pattern had been cut to make a stencil. Stencil is very rare among primitive peoples, and certainly does not occur elsewhere in the South Pacific. It was not introduced into Fiji by immigrants, nor is it probable that it was a heritage from the Melanesian stock, otherwise it would be found among other members of that stock. It must therefore be an indigenous development. If so, the idea of using perforated leaves may have been suggested by leaves naturally perforated by the larvæ of an insect. Bamboo leaves collected in the Naga Hills, which have been thus perforated before unfolding, exhibit resemblances to some of the Fijian patterns. These are always displayed transversely and never along the leaf, in exactly the same way as the perforation due to insect action. If correct, this explanation points to independent invention of the art of stencil in the Pacific and in Asia and Europe.

THE PERUVIAN QUIPUS.—Baron Nordenskiöld in a further instalment of his studies of South American Ethnography (*Comparative Ethnographical Studies*, 6, Pt. I., Göteborg, Elanders Boktryckeri Aktiebolag) describes a number of ancient Peruvian quipus and discusses their meaning and purpose. The quipus always consist of a main cord to which are attached a number of cords, usually arranged in groups and hanging down like a fringe. To these are usually attached subsidiary cords, with sometimes a further subsidiary set. A large number of knots occur on the hanging cords but not on the main cord. These knots are single or "long," *i.e.* the cord has been passed two, three, four, or more times up to nine through the loop. These knots indicate numbers in a decimal system, and comparative study points to the number 7 as playing an important part, although it had previously been held that the number 7 was seldom or never regarded as lucky or unlucky in the New World as it was in the Old World. In the early literature relating to Peru the quipus are stated to have been used for population statistics, accounts, and even memoranda of historical dates; but the fact that all that have been preserved have come from graves in association with so-called Inca pottery precludes them from having served as a record connected with the living. They must have some magical purpose connected with the dead. The subject will be considered further and in more detail in a second part of the volume to be issued later.

SKILL IN RELATION TO PRODUCTION.—In the presidential address to the Société des Ingénieurs Civils de France (British Section), February 18 last, Mr. L. A. Legros took as his subject "Skill in Relation to Production." He traces the evolution of some industrial processes during the past century, showing the changes which have taken place, involving the gradual displacement of skill from the actual manufacturing processes to the repairing processes. To work a machine may demand no skill, but to diagnose where a machine is wrong and to put it right demands skill of a high order; a good example of this type of skill is the marine engineer. Mr. Legros then discusses the attitude taken up by the trades unions, particularly in the so-called ca-canny methods characteristic of some trades at the present time. He deals sympathetically with the workers' point of view, but shows where it breaks down, and is very critical of the attempt to bring down the rate of work to that of the poorest worker. The problem of monotony is touched upon, and Mr. Legros does not make the mistake of looking upon it as merely a question of repetition of movement. A very interesting section is devoted to the nervousness characteristic of the very highly skilled worker, a mental factor which has too frequently been overlooked both by the employer and the less skilled worker; realisation of temperamental peculiarities would guide those responsible into alleviating the conditions of their workers. He makes a plea for the education of most boys in manual skill so that those who govern should not be looked upon as ignorant by those who work. The address is very valuable and should be read and considered by all employers, intelligent workers and educationists.

VACCINATION OF CATTLE AGAINST BOVINE INFECTIOUS ABORTION.—Attempts to protect cattle against Bang's infectious abortion by the use of vaccines consisting of dead cultures of the causative micro-organism (*B. abortus*) have been unsuccessful. L. Forest Huddleson has therefore (Technical Bull. No. 65, Agricultural Experiment Station, Michigan Agricultural College) experimented with a living, highly antigenic, but non-virulent strain of *B. abortus*, with the view of using it as a protective vaccine. Several herds were treated, some of the animals in each herd being kept as controls. The breeding efficiency in Herd I was 87·5 per cent. for the treated, and 33·3 per cent. for the untreated, animals; in Herd H, 100 per cent. for the treated, and 75 per cent. for the untreated, animals. The results so far are encouraging, but much more work is necessary before a definite conclusion can be established.

GERMICIDAL ACTION OF ULTRA-VIOLET RAYS.—Previous investigations have been interpreted as indicating that the long wave-length limit of germicidal action is in the region of 297 $\mu\mu$. W. W. Coblentz and H. R. Fulton (Scientific Papers, No. 495. Department of Commerce, Bureau of Standards, Washington, 1924) find that germicidal action is produced by ultra-violet radiation throughout the spectral range from the very short wave-lengths (Schumann rays) to and including 365 $\mu\mu$. The shortest rays have the most violent lethal action, which decreases in intensity with increase in wave-length. The lethal action of radiations of wave-lengths longer than 305 $\mu\mu$ was found to be very slow in comparison with those of less than 280 $\mu\mu$, and ceased with wave-lengths above 365 $\mu\mu$. The energy value of the most active germicidal radiations from the quartz-mercury arc (170-280 $\mu\mu$) required to kill a bacterium is very small, being of the order of 19×10^{-12} watt.

REVERSED SYMMETRY IN SNAILS.—A type of genetic behaviour which offers some interesting anomalies is exhibited by the cases of reversed symmetry in snails. It is known that many species and genera are normally dextral, but occasionally produce sinistral individuals. Some genera are sinistral, and others still contain species of both kinds with only occasional reversal, while some species of Achatinella and Partula commonly produce both types freely. It is known that the reversal shows itself in the first cleavage of the egg, but the causes of reversal are unknown. A study of the inheritance of sinistrality in the normally dextral gastropod *Limnæa peregra* has been made by Capt. C. Diver, with Prof. A. E. Boycott and Miss

Sylvia Garstang (*Journ. Genetics*, vol. 15, No. 2), based on more than 600 broods (from hermaphroditic parents), and 53,000 young. The broods fell into six types: all dextral or sinistral, 3D : 1S, 1D : 1S, mostly S or mostly D; and all types can be obtained from D or S parents. In a closely reasoned presentation of the results, a hypothesis is reached which is too complicated to consider here, but it is assumed that the asymmetry of any individual is determined by the combined (or antagonistic) action of the chromosomes concerned, this action having a delayed effect. It is not considered that maternal inheritance will account for all the facts observed.

CRYSTALLINE MICELLÆ IN THE PLANT CELL WALL.—Taking up the micellar hypothesis, Nägeli applied it to starch and the cell wall so long ago as 1862. Steinbrinck, in the *Biol. Centralblatt*, vol. 45, pp. 1-19, 1925, shows how well this hypothesis helps to explain the data now accumulating with modern technique. For some time subsequent to Nägeli, the view was warmly supported that the optical anisotropy of the cell wall resulted from a state of strain. Nägeli's original observations made this unlikely, whilst Ambronn's recent observations (*Zeitschr. für Kolloidchem.*, 1916 and 1917) make it clear that in addition to the anisotropic effect due to layers of crystals with their long axes parallel, lying in a medium of markedly different refractive index, cellulose walls, and even nitrated cellulose in solvents such as celloidin, have doubly refractive properties depending upon the anisotropic qualities of the micellæ themselves. Steinbrinck now summarises the results of Röntgen ray investigation, with some photographs published for the first time, which lead to the conclusion that in hemp and ramie fibre the crystalline micellæ must be arranged symmetrically to the long axis of the fibre. In cotton wool, the diagrams obtained (by the Debye-Scherrer method) are in agreement with the assumption that the micellæ are symmetrically placed with reference to the direction of the spirals running with frequent reversals at an angle to the long axis of the hair. The fact that Katz obtains with the dry wall and with the wall after imbibition of water the same type of X-ray diagram supports Nägeli's original assumption that, in the main, the water is adsorbed into the spaces between the particles and not taken up into the micellæ. The German work summarised in this paper appears to be in very good general agreement with the work upon similar problems published in recent years by Dr. W. L. Balls and his colleagues (NATURE, June 21, 1924, p. 910).

CONTROL OF DISEASE IN CROPS.—The Natural History Survey of Illinois has been engaged for three years on the accumulation of a complete catalogue of the bacterial and fungus diseases present on the more important crop plants, together with their distribution throughout the State, the results to date being published by L. R. Tehon in Bull. 4, Vol. 15, Division of Natural History Survey. The diseases are grouped according to the crops that are subject to them, those of cereals, forage crops, fruit, vegetable and field crops and of a few commonly grown ornamental plants being dealt with in turn. In the text is given a brief description of the disease, a short summary of its history in Illinois, a statement of its distribution as now known, and a statement of the usual methods of control. This information is graphically illustrated by a comprehensive series of maps giving the distribution of each crop and of each disease described in the various counties of the State. In addition, the statistical figures are set forth in forty-two tables, many of which give the estimated reduction in crop caused by the various diseases and the financial loss resulting therefrom, together with various observations on susceptibility and percentage of infection with different varieties in various districts. For the 44 crops investigated, 115 serious diseases are tabulated, with 50 of a less virulent type. For 16 of the serious diseases only, the average annual reduction in crop for wheat, oats, corn, apple, peach and pear is estimated as 56,398,929 bushels, the average annual loss being 44,452,053 dollars. These figures would doubtless be multiplied many times if it were possible to estimate the loss due to the remaining 49 serious diseases and the damage done by the 50 less serious ones, but, as it is, they are sufficiently large to impress on all cultivators the importance of adopting as widely as possible the approved methods of prevention and control advocated in the bulletin.

JURASSIC ECHINODERMS OF SINAI.—The late René Fourtau made many contributions to the palæontology of the echinoids of Egypt; at the time of his death in 1920 he had completed a memoir on the Jurassic echinoderms of Sinai, which has now been published by the Geological Survey of Egypt (Catal. Invertébrés foss. Égypte, Terrains jurass., 1, Echinodermes, 1924). The Jurassic deposits in North Sinai, from which the fossils were obtained, were discovered in 1913–14, and the Mollusca have already been described by H. Douvillé, who concluded that the horizons represented are Bajocian, Bathonian, Callovian, and Oxfordian. Fourtau finds evidence of the presence of deposits of later date, the Lusitanian. The echinoids are represented by 43 species belonging to the families Cidaridæ, Saleniidæ, Diadematidæ, Echinidæ, Holectypidæ, Cassidulidæ, and Dysasteridæ. The crinoids belong to the genera Apiocrinus, Millericrinus, Pentacrinus, and Cyclocrinus. Altogether 52 species of echinoderms have been found, of which 19 appear to be peculiar to Sinai, while 27 are identified with species already known in the Jurassic deposits of western or southern Europe.

PETROLEUM IN UGANDA.—The occurrence and possibilities of development of petroleum are discussed in a report issued by the Uganda Geological Survey, by E. J. Wayland. The report is divided into five sections, embracing history, geology, petroleum, the Lake Albert field, and recommendations regarding exploration for oil. Four appendices are added, dealing with the outline geology of Uganda, the Kaiso bone beds, the origin and significance of Lake Albert petroleum, and notes on Lake Albert itself. The critical oil geology of the region centres round Lake Albert, a depression forming part of the Great Rift Valley system. The floor of this depression is in crystalline rocks, and on these rest a great thickness of shallow water sediments divisible into two groups separated by an unconformity; the lower series are thought to be of Miocene age, while the upper have been shown palæontologically to represent late Pliocene or early Pleistocene deposition. The sedimentary rocks show a general tilt to the N.E., and locally have been folded into anticlines running parallel with the valley sides. Seepages of oil have been located in three places, at Mswa, Kibero and Kibuku, and the report recommends exploratory boring to test the petroleum possibilities of this Albertine depression, more particularly what is known as the Waki dome. The author states that "the presence of seepages . . . indicate that oil has been formed in enormous quantity in the Lake Albert depression; but not the slightest evidence has been found to show that either volcanic or tectonic processes have

played a part in its production." While the existence of seepages can never be, on general technical grounds, any criterion of magnitude of oil formation, the last part of that statement is indeed significant. The author's recommendations for exploration are carefully worded, though we fear that the "Rift Valley storehouses of petroleum," even if existent, are more likely to be found empty than full; we wish it were otherwise.

SWEDISH METEOROLOGICAL RESEARCH.—The publication of the data for 1917 of the observatory at Abisko in Swedish Lapland gives a complete series of observations from 1917 to 1922 (*Observations météorologiques à Abisko en 1917*, Upsala, 1924). The observatory has particular value as being one of the most northerly in the world, lying about two degrees north of the Arctic circle. The hourly records are given in full throughout the year, but there is no comparison with other years. Another valuable publication deals with the flow and temperature of Swedish rivers (*Hydrografiska mätningar i Sverige*), and is published as Part 5 of the year-book of the Statens Meteorologisk-Hydrografiska Anstalt.

ATOMIC DISINTEGRATION.—The *Physikalische Zeitschrift* of November 15, 1924, contains an account of work by Drs. H. Pettersson and G. Kirsch, of the Vienna Institut für Radiumforschung, on this subject. They describe their earlier methods, by means of which they claim to have observed atomic fragments with a range so low as 10 to 12 cm.; and they criticise the results of Bates and Rogers, which tend to show that radium-C gives off α-particles with ranges of 9·3, 11·2 and 13·3 cm. in addition to the normal ones with a range of 7 cm., and would make the observation mentioned above impossible. Frau Dagmar Pettersson has investigated the problem and is of opinion that these long range α-particles do not exist. The methods used are based on the author's explosion theory. The particles which fly off from the disintegrated atom in a direction at right angles to the original path of the α-particle are observed, and by means of these it has been possible to measure the maximum range of H-particles from carbon, about 6 cm. Using a small ring of thin copper, activated on one side with radium-C, the α rays from which fall on the substance to be investigated, it is possible to observe particles thrown off in the retrograde direction on to a zinc sulphide screen, with ranges so low as 11 mm.

A HOT WIRE APPARATUS FOR MEASURING HIGH ALTITUDES.—An apparatus described by MM. E. Huguenard, A. Mangan, and A. Planiol in the *C.R. Acad. Sci.*, Paris, March 16, employs two batteries, one of 16 and the other 18 volts, in series, the hot wire being connected between the positive pole of the first and the negative of the second, and an adjustable resistance R between the other two poles. The two negative poles are connected by a voltmeter, and R is adjusted so that the voltmeter reads zero when the pressure of the surrounding air is 760 mm. When the pressure is reduced, the temperature of the environment remaining constant, the convection from the hot wire diminishes, its temperature increases, the electrical balance is disturbed, the voltmeter deviates, and it is possible to determine experimentally the relation between deviation and pressure. If R is made of wire which has the same temperature coefficient as platinum, the readings may be rendered independent of the surrounding temperature. The sensitiveness of the apparatus to change in height increases as the pressure diminishes, and is about 1·8 times as great at about 14,000 metres altitude as at the surface of the earth. With a barometer, on the other hand, the variation in reading for the same increase in height is about 4·4 times less at 14,000 metres than at the surface, so that the hot wire instrument at this altitude is eight times as sensitive as the barometer.

RADIO-FIELD INTENSITIES.—The Austin-Cohen formula used in radio-telegraphy gives as nearly as can be measured the radio-field intensity of the waves due to an antenna, after passing over salt water and during daylight, for distances up to about 5000 kilometres, provided that the frequency of the emitted waves lies between 60 and 1000 kilocycles. This corresponds to wave-lengths lying between 5000 and 300 metres. Several experimenters have stated that for greater distances and for higher or lower frequencies its inaccuracy is so large that it is practically useless. For long distance communication, frequencies so low as 15 kilocycles are sometimes used. In this case various observers have found that at a distance of 6000 kilometres the ratio of the observed to the calculated value of the radio-field intensity is about two to one. In order to get more trustworthy data, L. W. Austin has made some trans-pacific measurements of radio-field intensity, and has published the results in the Journal of the Washington Academy of Sciences for April 4, 1925. Observations were made at San Diego, California, on the radio-field intensity of the signals emitted from Cavite and from Malabar, Java. The distance from Cavite to San Diego is 11,800 km. and the time difference is eight hours. This gives about two hours for observations in September without approaching the time of sunrise or sunset too closely. The distance from Malabar is 14,700 km., with a time difference of nine hours. On account of the weakness of the signals in comparison with atmospheric disturbances, a maximum inaccuracy of about 20 per cent. was possible. The final results show that when the observations were made in daylight, the observed value of the field strength of the signals from Cavite were about three times the value found from the Austin-Cohen formula, while the observed strength of the Malabar signals was about twice the calculated value. The frequency of the Cavite signals was 19·34 kilocycles (wave-length 15,500 m.), and of the Malabar signals 18·98 kilocycles.

ATOMIC WEIGHT OF BORON.—A recent redetermination of the atomic weight of boron has been carried out by H. V. A. Briscoe and P. L. Robinson and is described in the March issue of the Journal of the Chemical Society. The ratio $BCl_3 : 3Ag$ was determined, the materials being very carefully purified. The final results gave an atomic weight of 10·82 for boron derived from Europe and Asia Minor and 10·84 for boron derived from North American deposits. The question is raised as to whether this difference is due to different proportions of isotopes in the two samples.

DETECTING COMPLEX IONS.—A method of determining the presence or absence of complex ions in solution is described by W. H. Patterson and J. Duckett in the March issue of the Journal of the Chemical Society. The miscibility temperature of two liquids (critical solution temperature) is elevated by the presence of impurities. This elevation is approximately a linear function of the concentration of the added salt. In the case of salt pairs, additive values for the elevation imply that neither complexes nor double molecules exist in the solution. Deviations from the separately calculated values measure the molecular complexity.

Institut International de Chimie Solvay.

THE second of the triennial chemical conferences under the Ernest Solvay Trust was held in Brussels, on April 16-24, at the Fondation Universitaire, a palatial new club established since the War, under the presidency of "Sir Pope de Cambridge," who filled the office with distinction at the first conference. To quote *Le Soir*: "Chacun loue la clarté précise, la pondération, la pénétration et le tact parfait de sa présidence."

The members of the Scientific Committee present were: Mm. E. Briner (Geneva), O. Dony-Henault (Brussels), J. Duclaux (Paris), F. M. Jaeger (Groningen), A. Job (Paris), J. Perrin (Paris), F. Swarts (Ghent). In addition, the following attended by invitation: H. E. Armstrong (London), E. F. Armstrong (Warrington), G. Barger (Edinburgh), W. Barlow (London), A. Berthoud (Neuchatel), J. Boeseken (Delft), W. L. Bragg (Manchester), C. S. Gibson (London), Sir W. B. Hardy (Cambridge), T. M. Lowry (Cambridge), Ch. Maugin (Paris), Ch. Moureu (Paris), E. K. Rideal (Cambridge), H. Staudinger (Zurich), H. von Euler (Stockholm). The following professors in the University of Brussels were also present: G. Chavanne, J. Timmermans, H. Wuyts, E. Saerens, E. Herzen.

Twelve sittings were held, occupying six whole days, so the meeting was no mere joy-ride, the more as it took place under continental conditions of air and light and was a severe linguistic trial, English alternating with French in several tongues; indeed, even a little Swiss-German was introduced. That our self-sacrificing devotion was not unappreciated, is clear from a notice in *L'Indépendance Belge*: "Nous l'avons dit, les Conseils de Chimie, les conseils de Physique ne sont pas des congrès. Tout le temps dont disposent les savants qu'ils réunissent est consacré au travail. Généralement, on travaille encore au cours du déjeuner quotidien: la tâche n'est jamais interrompue."

The Council was received by His Majesty the King of the Belgians, at the Royal Palace, on the afternoon of Friday, April 17. Messrs. Heger and Lefebure, Sir William Pope, Sir William Hardy, and Profs. Armstrong, Jaeger, Moureu, and Perrin had the honour of dining with the King and Queen and members of the Royal family at the Palace at Laeken on the Saturday evening. On both occasions all were much impressed by the cordiality and sincerity of our reception and by the obvious appreciation the King showed of the service the Guild of Science is rendering. The meeting was the subject of serious notice in the press, and we learnt from lady friends, who made purchases in the city, that the conference was talked of even in *lingerie* circles. Such notice in Great Britain is unthinkable. These matters are ordered differently abroad. The courtesy shown to their visitors by M. Heger and his colleagues and by Madame Solvay and other members of her family cannot be adequately acknowledged.

The following reports were presented and considered:

The Mechanism of Chemical Change, T. M. Lowry; Les Relations interatomiques médiates dans les composés organiques, F. Swarts; L'Adsorption en relation avec la catalyse et les actions enzymiques, J. Duclaux; Les Réactions intermédiaires dans la catalyse, Andre Job; Lumière et réactions chimique, Jean Perrin; On the Spreading of Fluids on Water and Solids and the Thickness of a Primary Film, W. B. Hardy; Structure des matières colloidales à l'état solide, M. J. Duclaux; The X-ray Analysis of Crystal Structure and its Bearing on Chemical Constitution, W. L. Bragg; Organic Crystals, W. H. Bragg; The Configuration of the Carbon Atom and the Geometrical Relations of this Configuration to those of other Atoms as evidenced in the Chemical and Crystallographic Structures of Organic Chemistry, W. Barlow; Recent Developments in the Theory of Catalytic Processes in Heterogeneous Reactions, E. K. Rideal; Catalysis at Solid Surfaces, E. F. Armstrong and T. P. Hilditch; Considérations sur l'autoxydation et les phénomènes catalytiques qui s'y rattachent, C. Moureu et C. Dufraisse; Catalysis and Oxidation, Henry E. Armstrong; General Views on Catalysis in Enzyme Reactions, H. v. Euler.

As to the outcome. The Conference was definitely an advance on the first. The subjects considered were more fundamental and of critical importance. It cannot be pretended, however, that the reports were adequately discussed. When published, probably at an early date, they will undoubtedly serve to stimulate a far more complete consideration of the issues raised. The discussions were not reported verbatim and will be known only in the form of brief summaries. Few of the reports were circulated in time and several were obviously insufficiently thought out. At the next Conference it should be made a condition that reports are all in the hands of those who are to participate in their discussion at least three, better six, months before the meeting. Instead of reproducing discussions, except in the briefest possible manner, to indicate who speaks and to what end, it may be better to allow each reporter to supplement his contribution and give a considered opinion, if not upon the proceedings as a whole, at least on the problems with which he is specially concerned. Remarks made almost casually at such meetings may be of profound significance.

M. Ernest Solvay undoubtedly did great service to science in endowing the foundation to which his name is now permanently attached. The organisation is destined to play an important part in the future development of physical science, by focussing attention, at suitable intervals, upon fundamental theoretical issues. There has been far too little serious discussion of this kind, and, as a consequence, chemistry, in particular, is encumbered with a mass of loose speculation by workers whose outlook is far too narrow for them to discuss with advantage the problems they affect to consider. We need to put an end to the present-day tendency, particularly obvious in chemical circles at the moment, to paraphrase in terms of new fashions, without in any way getting down to fact or making any real advance in treatment.

The great advantage of such international gatherings is that different mentalities are brought into contact and opportunity given to bring out the facts. The physical school to-day, unfortunately, has little regard for facts: its main office seems to be to distort them in the service of the fashion by which it is dominated. The most recently published text-books are witness of this tendency: a great volume of pseudo-mathematical sack is provided, but the bread of fact is scarce regarded, and there is not the faintest indication of the "proportionate judgment" being brought into play the use of which was so strongly insisted upon by Faraday—which he contended, moreover, should be the great outcome of devotion to scientific inquiry.

At the Conference, two main topics were under discussion—the nature of chemical change in its various forms, and molecular structure as revealed by X-ray and geometric analysis. No particular advance was made in dealing with the former, but the issues were presented probably more clearly and definitely than they have been hitherto: the view

of the French school was certainly broadened. The tendency is growing to recognise that the phenomena are of greater complexity than has been supposed, and even to hark back to Faraday's conceptions. It is an astounding fact and a great reproach to our science, that we are in no way agreed as to the precise mechanism underlying the simplest case of chemical change. We simply have no criteria. Unfortunately, we have wandered during forty years in the wilderness, wearing teutonic blinkers. At the root of our difficulty is the lack of philosophical outlook, due to narrowness of practical experience, insufficient knowledge of materials and processes, and undue specialisation. We need a Wagner to knit our scattered themes into rhythmic form: we need also to pay far more attention to fact.

The discussion of the structure of solids was probably the most important part of the proceedings. A great difference of opinion between chemist and physicist was apparent. The able account of the results of the X-ray analysis of crystals given by Prof. Bragg was much appreciated. It is clear that it is possible to determine the orientation of atomic centres in crystals, but it is in no way proved that the partitioning of the atoms among the molecules can be ascertained: Prof. Bragg was prepared to admit this. The volume occupied or influenced by the atom was also much discussed. Here again it was agreed that the X-ray method, at present, affords no direct information and that only the distance between atomic centres can be fixed. Precision was given to this latter problem by Mr. Barlow, who gave an account of the way in which he has modified the original Barlow-Pope valency-volume hypothesis, by using a cell of unit-valency and forming models of atoms of higher valency by associating such unit-cells in the appropriate numbers. Mr. Barlow has constructed close-packed models of a considerable number of benzene derivatives which are in direct near agreement with crystallographic data: several of these were exhibited. The writer was able to point out how closely the properties of carbon were reproduced in the model of the carbon atom—a pyramid of four unit-dodecahedral cells—used by Mr. Barlow in constructing his models. Finally, the existence of atoms in the crystal—in common salt, for example, —as independent units was brought under discussion. Mr. Barlow exhibited a model of the molecule of potassium chloride, composed of two similar 13-faced cells; such *molecular* units may be close-packed in any numbers to give crystal units having all the geometric properties shown by potassium chloride. The writer expressed the opinion that it was impossible, from the chemist's point of view, on present evidence, to believe for one moment that the molecule lost its individuality in the crystal. H. E. A.

Heavy-Oil Engines.

THE James Forrest Lecture for 1925 was delivered by Capt. H. Riall Sankey before the Institution of Civil Engineers on May 5, and dealt with some outstanding questions relating to large engines of the self-ignition type. The discussion was limited to engines working either on the two- or the four-stroke cycle, and compressing air to a temperature sufficient for the self-ignition of an injected fuel of not less than 0·82 specific gravity.

There are many difficulties in connexion with fuel-injection, and much research is still required before practical perfection is reached and the best method finally established. The two methods employed are air-injection and mechanical injection (also called solid injection). The former requires an air-compressor, and introduces oxygen with the oil, producing probably a small initial explosion together with an air-blast which causes turbulence and drives the oil into all parts of the combustion chamber. The expansion of the air cools the jet by some 100° F., which has to be allowed for by a higher initial pressure of the air in the cylinder. The air injector is able to impart greater energy to the atomised oil, to which is probably due the fact that a greater indicated mean effective pressure is possible with air than with mechanical injection, as has been found by Engineer-Commander Hawkes. The cooling effect of air-injection is especially noticeable at light loads, and may cause misfires and explosion troubles; mechanical injection is much freer from these troubles. It would appear that at present the economical results per I.H.P. are better with air-injection than with mechanical.

High temperatures and pressures occurring in heavy-oil-engine cylinders cause stresses which are difficult to meet. The parts principally affected are the cylinder head, the cylinder walls, and the piston. Cast steel is generally employed for the heads, since the same strength can be obtained with much thinner walls, and the temperature-stresses are thereby substantially reduced. In large cylinders with thick walls the temperature-stresses in the walls exceed the ring-stress due to the internal pressure. Various ways of strengthening the walls have been employed and were mentioned by the lecturer. Some idea of the relative ring- and temperature-stresses may be obtained from the following figures given by Mr. A. D. Bruce for a 40-in. cylinder:

Thickness of Cylinder Wall.	Tension in lb. per sq. inch due to	
	Ring Stress.	Temperature-Stress.
2 in.	5000	10,630
3·5 in.	2800	18,600

Temperature affects the design of pistons profoundly. Hopkinson has shown that a gas-engine piston 11·5 in. in diameter, without water or oil cooling, may have a temperature-stress of tension at the outside rim amounting to 7·5 tons per sq. inch. Hence, for larger diameters, cooling arrangements have to be adopted. Such arrangements—except in experimental engines—have not been successfully applied to pistons exceeding 33 in. in diameter.

A large mean effective pressure is desirable to reduce the weight of and the space occupied by the engine, and can be obtained by increasing the weight of oil injected per stroke if arrangements are made for reasonably perfect combustion. This requires an increase of oxygen packed into the compression space, and is known as supercharging. The method has been successfully worked to obtain higher powers with aeroplanes at high altitudes. It has been estimated that about 50 per cent. more indicated power may be obtained by supercharging, but a deduction of about 10 per cent. must be made for the power required, leaving a net gain of 40 per cent. It cannot be said that supercharging has advanced very far at present, except in two-stroke engines, but it may be expected to produce great improvements in the future.

Among other matters dealt with by Capt. Riall

Sankey is the question of compounding. A group of American engineers, headed by Mr. Sperry (of gyroscope fame), has been working on this subject for thirty years. Complete success with a small engine was reported in 1918, but Capt. Riall Sankey stated that he was not aware whether any large engine has yet been made or is under construction. In the small engine the mean effective pressure in each cylinder was 330 lb. per sq. inch, and the weight of the engine was about 0·1 that of an ordinary engine. The mechanical efficiency was said to be extremely high.

Capt. Riall Sankey, in concluding his lecture, urged the necessity for co-operation in research, and offered his appreciation of the work done at the Admiralty Research Laboratory and so freely communicated in papers read before the Institution of Naval Architects. The outstanding problem for the merchant marine is the production of a low-speed engine of much greater power than at present possible, and of lighter weight per B.H.P., but before this can be solved the many subsidiary problems discussed in the lecture must be solved satisfactorily.

Tertiary Floras.[1]

DR. BERRY continues to add to his vast series of researches into the Upper Cretaceous and Tertiary floras, a subject which has long been somewhat neglected in Great Britain. The question of the evolution of angiosperms is almost the greatest outstanding problem of palæobotany. We have practically no light upon it as yet; all that can be done is to record the history of the class as accurately as possible, and to this history Dr. Berry has long been the most indefatigable contributor.

The present memoir deals with a Middle and an Upper Eocene flora of North America, the former known as the Claiborne, the latter as the Jackson flora. The author had previously described the much richer Lower Eocene Wilcox flora. The Wilcox includes 350 known species, while from the Claiborne only 90, and from the Jackson 133 are recorded. These differences appear to be due rather to the conditions of deposition than to any poverty of vegetation in the later periods.

The Claiborne deposits extend at intervals from Georgia to south-western Texas; they are marine in origin, which helps to account for the scantiness of the remains. The plants include 1 fungus, 6 ferns, 5 conifers, 8 monocotyledons and 70 dicotyledons. The largest family is the Lauraceæ, of which 13 species are recorded, while the Leguminosæ are represented by 8 and the palms by 6. Some of the species (a cypress and two laurels) are represented in the form of petrified wood, of which sections are figured. The same is the case with some of the Jackson plants, including a beautiful specimen of palm-wood. Most of the commoner species occur also in the underlying Wilcox and the succeeding Jackson formations. Many of the genera had already appeared in the Upper Cretaceous. Among the dicotyledons only three families out of 27 are gamopetalous. Two of the gamopetalous genera (Diospyros and Apocynophyllum) go back to the Upper Cretaceous. Dr. Berry thinks that the Gamopetaleæ were actually the last plants to appear, and that their wealth of species may only have been attained in post-glacial times. The comparative poverty of this group in trees and shrubs may, however, account for their rarity as fossils.

The Jackson flora has a similar geographical distribution to that of the Claiborne beds. The 133 species include 4 fungi, 1 liverwort (a Marchantites), 4 ferns, 1 Equisetum, 2 or 3 conifers, 15 monocotyledons, and 106 dicotyledons. There are 8 palms, 12 Leguminosæ, and no less than 16 Lauraceæ. Among the Fagaceæ, it is interesting to learn that the genus Dryophyllum is regarded as an "ancestral" stock, which gave rise to Castanea, Quercus, and other genera. One of the leaf-species is referred to the Proteaceous genus Banksia, now limited to Australia. Among the lime family there is a Grewiopsis, an ancient Upper Cretaceous genus, and also a Tilia of quite modern type.

These few notes can give little idea of the abundance of information in this extensive memoir. It is splendidly illustrated; most of the 65 plates portray the fossil specimens; a few show views of the localities, restorations, or analogous contemporary vegetation. One of the restored landscapes introduces animal life in the form of a Zeuglodon, an early and, to all appearance, ferocious whale. Dr. Berry is much to be congratulated on this fine memoir, his latest contribution to the subject to which his life has been devoted.

[1] The Middle and Upper Eocene Floras of South-eastern North America. By E. W. Berry. United States Geological Survey. Professional Paper No. 92. Pp. 206+65 plates. (Washington: Government Printing Office, 1924.)

The Royal Society Conversazione.

ON May 13 the first of the two annual conversaziones of the Royal Society was held in the Society's rooms, and numerous interesting exhibits and pieces of apparatus were arranged for inspection by fellows and guests of the Society.

Among the exhibits from the British Museum (Natural History) were some oceanic angler fishes shown by Mr. C. Tate Regan (Department of Zoology). These fishes inhabit the middle depths of the ocean about 500 to 1500 metres below the surface. The males have become dwarfed and parasitic on the females, to which they become attached probably soon after they are hatched, when they are relatively numerous.

The Geological Department showed deinosaur bones from Tendaguru, Tanganyika Territory, a selection from the material sent home by Mr. W. E. Cutler of the British Museum Tanganyika Expedition. The largest and smallest femora (4 ft. 1 in. and 2 ft. 6 in. long) belonged to sauropodous deinosaurs which inhabited the estuarine waters of a great river running from west to east. The other femur (3 ft. 4 in. long) was from one of the armoured and terrestrial deinosaurs, such as Omosaurus, which is found in the Jurassic of England.

The National Institute for Medical Research had a demonstration showing a colour reaction for vitamin A (Dr. O. Rosenheim and Dr. J. C. Drummond). A brilliant ultramarine-blue colour reaction is given when arsenic chloride is added to a substance containing vitamin A. The reaction has been adopted for the colorimetric determination of the growth-promoting activity of medicinal cod-liver oils and butter.

The Cambridge Instrument Co., Ltd., showed, among other things, experiments with the Shakespear katharometer applied to the thermal-conductivity method of gas analysis. The instrument has small

capacity, a small time lag, and is very sensitive to certain gases having thermal conductivities differing from one another. It can be used for demonstrating the partial separation of two gases from a uniform mixture by introducing a temperature gradient within the gas, an effect first pointed out by Prof. S. Chapman and called by him "thermal diffusion"; for the measurement of the respiration of gas from a single insect, *e.g.* a fly; and provides an easy method of estimating a small quantity of carbon dioxide as carbonate in a mixture. The National Physical Laboratory exhibits included some photo-electric cells of different alkali metals used to detect a difference of colour in sources of light (Mr. T. H. Harrison). A rubidium and a sodium cell are connected in series, and the photo-electric currents balanced against each other when the two cells are exposed to the illumination of the same electric lamp. If the temperature of the lamp is raised the sodium cell becomes relatively more sensitive and vice versa. By this method lamps can be colour-matched to within 1° K. of the equivalent temperature and within 0·1 per cent. voltage. The Research Department, Woolwich, showed an apparatus for determining the flash velocity and pressure factors of ignitory detonators; the former by passing the hot gases through gaps—at specified distances apart—in separate electrical circuits whereby the circuits are completed, the instants of completion being registered by means of an Einthoven galvanometer; and the latter by means of a piezo-electric crystal. Prof. W. M. Thornton exhibited a miner's electric lamp which indicates and measures firedamp.

Mr. George H. Gabb showed a curious trumpet-shaped telescope bearing the name and date "Iacob Cvnigham 1661." The optical system is of the most elementary Galilean form, consisting of a bi-convex object glass, with a plano-convex eye lens, and gives a magnification of about 3 diameters at a focal length of 2 ft. It is focussed by two draw tubes covered with the characteristic marbled paper of the Charles II. period.

Demonstrations were given during the evening of a cinematograph film by Pathé Frères showing Brownian motion. The film was taken by the aid of a high power microscope, and showed the translatory, and in some cases the rotational, movements of particles in colloidal silver, smoke, etc.

Apparatus was also exhibited by the Thermal Syndicate, Ltd., the International Western Electric Co., and Messrs. Adam Hilger, Ltd.

University and Educational Intelligence.

ABERDEEN.—The University Court proposes to proceed to the foundation of chairs in bacteriology and forestry.

The plans of a new building to accommodate the Department of Forestry, and to be erected in the Cruickshank Botanic Gardens, have been approved.

BELFAST.—At a special meeting of the Senate of the Queen's University held on May 13, it was resolved to grant the degrees of D.Sc. (*honoris causa*) to Prof. F. G. Donnan, professor of inorganic chemistry in University College, London, and to Prof. E. W. MacBride, professor of zoology in the Imperial College of Science, S. Kensington, both of whom are former students of Queen's College, Belfast.

BIRMINGHAM.—The University has arranged to hold receptions at Edgbaston for the meetings of the following Societies: Institute of Electrical Engineers (June 10), Medico-Psychological Society (July 7), Iron and Steel Institute (September 10), Library Association (September 16).

CAMBRIDGE.—The Raymond Horton-Smith Prize has been awarded to Dr. M. B. R. Swann, Gonville and Caius College, for a thesis on "The Immediate Effect of X-Rays on the Functions of Certain Tissues and Organs." *Proxime accessit*, Dr. D. V. Pickering, Emmanuel College, whose thesis was on "Difficulties in the Dietetic Treatment of Diabetes."

It is proposed to confer the degree of Doctor of Laws, *honoris causa*, upon His Excellency the Right Honourable the Earl of Reading, Governor-General of India.

Prof. Nuttall, Magdalene College, Dr. H. Scott, Trinity College, and Mr. W. A. F. Balfour-Browne, Gonville and Caius College, are to be the representatives of the University at the international congress of entomology to be held at Zürich in July.

LONDON.—The Report of the Principal Officer of the University for the year 1924–25, read on Presentation Day (May 13), records no important development of the scientific side of the University's work. Candidates for first and higher degrees have reached record totals of 3063 and 357, and a grand total of 3420, of whom 2079 were internal and 1341 external. The roll of internal students comprises 9002 names, also a record. The total admissions by all channels amounted to 7603, as compared with 3852 in the last year before the War. Of these, 5542 came in through the ordinary Matriculation Examination, 360 as graduates of other universities, 1481 as holders of approved certificates, and 220 after examination under Statute 116. As there were 20,869 candidates for Matriculation and Registration, the high proportion of failures at the Matriculation Examination, which has recently provoked discussion, is evident. Grateful reference is made in the Report to the serious losses the University suffered in the deaths of Sir Sydney Russell-Wells, its representative in Parliament, Dr. R. M. Walmsley, chairman of Convocation, and Prof. Arthur Dendy. Referring to the work of the Departmental Committee of the Board of Education, the Principal Officer says: "We may feel sure that the deliberations of the Committee, which has now been sitting for some months, will be guided by a single purpose, namely, our corporate welfare; and we may await with confidence its findings, not unmindful that in whatever form the body of our constitution be moulded, the spirit which gives life and growth remains always within ourselves alone." The list of benefactions received by the University during the year is somewhat meagre; but several of the colleges and medical schools have received generous gifts, notably the Middlesex Hospital Medical School, which has received 20,000*l.* from Mr. S. A. Courtauld for the endowment of a University chair of anatomy.

MAJOR K. W. BRAID, assistant in the Herbarium, Royal Botanic Gardens, Kew, since November 1923, has been appointed to the chair of agricultural botany in the West of Scotland Agricultural College, Glasgow.

NOTICE is given that applications for grants from the Chemical Society Research Fund must be made to the Assistant Secretary of the Society, Burlington House, Piccadilly, W.1, by June 1, on a special form to be supplied upon request.

APPLICATIONS for junior Beit Memorial Fellowships for Medical Research must be received not later than June 1, upon a prescribed form, by Sir James K. Fowler, Honorary Secretary, 35 Clarges Street, W.1. The fellowships are of the annual value of 350*l.* and tenable normally for 3 years.

Early Science at Oxford.

May 26, 1685. Mr. Pulleyn is desired to take ye Chair.

A Letter from Mr. Maunders, dated Dunstar-Castle April 24 1685, was communicated by Mr. Crouch. With it there came some of ye shells of the purple fish from the shore near Dunstar; the Fish it self would have been sent, but it will not bear carriage hither. That matter, which gives the purple, is (as Mr. Maunders affirmes) a little wat'ry substance in ye back of the fish, and not enough to make above six or seven letters. With these shells (some of which are ordered to be preserved in the Musæum, others to be sent ye Royall and Dublin Societies) there came specimens of 2 sorts of Laver (or *Lichen Marinus*) growing on the same shore; the one green and large, the other blackish and lesse; this last sort is that, which is pickled and brought to table, the former is not used in those parts. There came also a little piece of Lignum Fossile from Watchet.

Another Letter from ye same Person, dated Milton-Abby (in Dorsetshire) May 16, 1685. was read; it gave an account of what number of Persons were killed by cold in Dorsetshire on ye dreadfull 23 of December last.

The Society ordered their thankes to Mr. Maunders for these considerable communications.

A Letter from Mr. Aston dated May 21, 1685. was read; it contained a draught of ye Hony-combes mentioned in the Minutes of ye Royall Society and lately sent ye Society by Monsieur Villermont.

An account of a New Callesh invented at Dublin (the advantage of which is, that it may overturn without any danger to any Person in it) was read.

May 27, 1684. A Letter from Mr. Aston, dated May 15th, was read, with an Extract out of 2 manuscripts (supposed to be writ at least 300 years agoe;) concerning *Ignis Græcus*.

On this occasion Mr. Bernard affirmed, that there is an account of *Ignis Græcus* in an Arabick manuscript, in St. John's College Library in this Univrsity, and in Julius Africanus's Cesti cap: 45. Mr. Piggot said he was told, by one that makes fireworkes, that Rockets made of Sulphur vive will burn under water. Dr. Plot shewed ye following Experiment: he held a live coal to ye lower part of an *hour-Glass* which immediatly stopped ye running of ye sand; this he repeated two, or three, times with ye like success.

Another Letter from Mr. Aston dated May 22, was read; it mentioned an Experiment of weighing air. Mr. Aston was desired by ye Society to give them an account of ye method usd in that Experiment.

A Paper of Mr. Flamsteeds was read, which gave an account of a *spot* which he had observed in ye *Sun*, about a month since.

The Answers of Mr. Proctor Clarke of Magdalen College and of Mr. King in Staffordshire, to some Queries about ye splitting of Trees in ye *frost*, were read. Dr. Plot said ye white grape vines in ye Physick Garden are dead, but not ye red, tho growing on ye same wall.

Mr. President observed, that severall vines which are split, are dead above ye place split.

Then Mr. Walker produced a modell of ye *Roof* of a Church, which may be built 70 foot wide, without any pillars in it, and a paper was read by him to prove, that such a roof would be strong enough for use.

Mr. Cooke, a gentleman near Newberry, and Mr. Packer M.B. a physician of Reading were elected. Mr. Todd M.A., fellow of University College and Mr. Benbrigg M.A. of the same College were proposed for election into the Philosophical Society.

Societies and Academies.

LONDON.

Royal Society, May 14.—E. C. C. **Baly** and Elizabeth **Semmens**: The selective photochemical action of polarised light. I. The hydrolysis of starch. Starch grains in weak enzyme solution are hydrolysed under the influence of polarised light, whilst very little or no action takes place in ordinary light of the same intensity. In the case of potato and maize starch diastase was used, whilst in the case of wheat starch the natural enzyme sufficed. The slides were placed on microscope stages and illuminated from below so that the progress of the hydrolysis could be watched. Both daylight and artificial light were used with equal success.—R. B. **Thomson** and H. B. **Sifton**: Resin canals in the spruce (Picea). An anatomical and œcological study and its bearings on phylogeny. Anastomosis between different systems of resin-canals is rare in Picea. The bast has only horizontal canals, with bulbous expansions. Horizontal canals are strictly confined to the *secondary* rays. The canals, except in the wood, show cambial growth in size and thickness of wall. Formation of canals is not dependent on increased vigour or food-supply, and in secondary tissues it is always connected with injury or irritation of the cambium. The root, being very subject to injury, has a well-developed system of canals. In primary wood of the root the appearance of canals is preceded by that of solid strands of cellular tissue. Accumulation of repeated wound-stimuli explains the sporadic occurrence of canals in twigs of trees of species from which canals are otherwise absent. The whole evidence favours the hypothesis of a phylogenetic increase of sensitiveness to wound-stimuli among Coniferæ.—H. G. **Cannon**: On the segmental excretory organs of certain fresh-water ostracods. The "shell gland" of the fresh-water ostracods, which has previously been described as the antennal gland, is of unknown function, but is in no way serially homologous with the true segmental excretory organs. These occur in both antennal and maxillary segments. The antennal gland (hitherto undescribed) consists of an end-sac with an intracellular duct leading to the exterior, consisting of three cells only. It attains its maximum development in the fourth larval stage, after which it loses connexion with the exterior and degenerates. The maxillary gland consists of an end-sac with an efferent intracellular duct consisting of four cells only. Its end-sac is a true cœlomic sac. Its duct is formed by an ingrowth of ectodermal cells, that finally become overgrown by the surrounding ectoderm. The development of the "shell gland" has been partly described. The part previously considered as a typical end-sac, and therefore of mesodermal origin, arises from a group of ectodermal cells in outer layer of shell-fold.—E. G. T. **Liddell** and J. F. **Fulton**: Observations on ipsilateral contraction and "inhibitory" rhythm. Simultaneous mechanical and electrical records have been obtained (with string galvanometer and torsion-wire myograph of high frequency) of responses of quadriceps extensor muscle (cat) to various forms of reflex stimulation, before and shortly after section of the posterior root supply of the muscle. When the normal muscle is reflexly stimulated at 50 per sec. through the sciatic nerve of the same side, a small rapidly developed contraction ("ipsilateral") results, in which the rhythm of stimulus may be seen in both string and myograph. Crossed stimulation at 15 to 20 sec. before cutting the posterior roots also produces a response, but later, the rhythm tends to be obliterated through the

appearance of increasingly large numbers of "secondary" waves. *After* cutting, the secondary waves are more numerous from the start. Increase in mechanical tension increases amplitude of both primary and secondary waves. A single moderately strong break-shock inhibition during a crossed extension response causes, through suppression of secondary waves (repetitive asynchronous after-discharge), an enhancement of primary excitatory rhythm in both string and myograph. Repetitive inhibition, if weak, produces the same effect; if strong, it gives rise to a rhythm of its own rate in both records. This "inhibitory" rhythm during "complete" inhibition seems to be due to the small uninhibitable increment of ipsilateral contraction.—K. **Furusawa**: Muscular exercise, lactic acid, and the supply and utilisation of oxygen. Pt. X. The oxygen intake during exercise while breathing mixtures rich in oxygen. As was shown before, the maximum oxygen intake may be increased 50 per cent. by the breathing of a mixture rich in oxygen. This can be attributed only to an increased circulation rate of the blood.—J. S. **Yeates**: The nucleolus of *Tmesipteris Tannensis* Bernh. In Tmesipteris the maximum number of nucleoli in resting cells of the sporophyte is six. These are formed at telophase by aggregation of small bodies and are often visibly continuous with telophase chromosomes. In sister-telophase nuclei they frequently correspond in number, in size, and in position. During prophase and metaphase the nucleoli are connected with the ends of chromosomes, from which they finally become detached and pass irregularly towards the poles of the spindle. In some cases the full number of these nucleoli remains visible in the cytoplasm when a new generation of nucleoli has arisen in the daughter nuclei. In resting cells of the gametophyte the maximum number of nucleoli is three. The nucleolus is not an independent, self-perpetuating body, but seems to owe its origin to the chromosomes, and arises *de novo* in each cell-generation.

Physical Society, March 27.—H. W. **Gilbert** and P. E. **Shaw**: The electrical conditions arising at a liquid-gas interface. Many of the results may be explained in terms of the modern theory of orientation and polarisation at the liquid-gas interface, but there are other facts which do not appear to come within the scope of any established principles.—L. **Hartshorn**: A contact theory of dielectric absorption and power losses. A simple explanation is proposed of absorption residual charge and allied phenomena in solid dielectrics. In accordance with classical theory, the dielectric is assumed to possess a certain true capacity, defined by its dielectric constant, and a certain conductance, here considered as probably electrolytic in type. The so-called anomalous properties are considered to be due to the properties of the contact surfaces of the dielectric and its metal electrodes. These contact surfaces appear to offer great resistance to the passage of ions or electrons across them, so that when an E.M.F. is applied to a condenser there is an accumulation of charges at the surfaces. These charges form the absorbed and residual charges. The behaviour of each contact surface is such that it may be represented by a large capacity in parallel with a high resistance, and thus a capacity-resistance combination is suggested, which is equivalent to an actual condenser.

Linnean Society, April 2.—W. R. B. **Oliver**: Biogeographical relations of the New Zealand region. From a biological view-point the outstanding characteristics of the fauna and flora of the New Zealand region are the absence of mammals, the marked dissimilarity of its plant and animal productions to those of Australia, and the presence of an element common to two or more of the southern land-masses. A large proportion of the plants and animals at present living in New Zealand are such as require continuous land connexion for their dispersal. Their presence demands that at some period in the past New Zealand was joined to the other land-mass of the globe. Most of these animals and plants are related to species now found in lands to the north. The so-called "Antarctic" element appears to be a mixture of several elements. Eliminating the genera and species of plants common to New Zealand and South America which may be explained by migration from the north overland and from the west overseas, there remains a residue which seems to demand a more direct land route between New Zealand and South America.—W. C. F. **Newton**: The cytology of the genus Tulipa. The basic number of chromosomes is twelve, but as a result of fragmentation one species has sixteen. Alteration in the relative size of the chromosomes may occur independently of fragmentation. Tetraploid and hexaploid varieties and species occur. The different kinds of tetrad found in Tulipeæ have their exact parallels in the Acrididæ, thus helping to emphasise the essential similarity of the meiotic phase in plants and animals.

PARIS.

Academy of Sciences, April 13.—G. **Ferrie** and R. **Jouast**: The use of photo-electric cells for the observation and maintenance of astronomical pendulums. A mirror is attached to the pendulum and light from this falls on a photo-electric cell: the resulting current is amplified by three or four valves. Measurements are being taken to compare, with the highest possible precision, the results obtained by this method with that given by the ordinary electrical contact.—Jules **Andrade**: The general mechanism of synchronisation.—Gaston **Julia**: A type of quasi-analytical functions.—Oscar **Zariski**: The development of an algebroid function in a domain containing several critical points.—S. Ch. **Bochner**: The nearly periodic functions of Bohr.—Comas **Sola**: The Schain comet (1925a) found independently. A photograph taken on the night of March 23 has shown the new comet found on the preceding night by Schain.—Charles **Nordmann** and C. Le **Morvan**: The ballistic theory and stars with continuous variation. Some deductions from the ballistic hypothesis of La Rosa.—Louis **Damblanc**: An apparatus applicable to aviation motors for reducing the loss of power with altitude.—Jean **Dubief**: The variation of the viscosity of fluids as a function of the volume. The relation between the viscosity of a gas μ, at a fixed temperature, compressed to a volume v is equal to that of a perfect gas multiplied by the factor $v/(v-b)$, where b is the co-volume of Van der Waals. The results calculated from this formula are in good agreement with the experimental figures of Philipps.—Jean **Thibaud**: The quantity of heat given off, in the form of the γ radiation, during radioactive disintegration. The energy emitted in the form of the γ radiation is never negligible: for radium B + C, it amounts to 16 per cent. of the total calorific effect.—Louis Jacques **Simon**: The viscosimetric neutralisation of the monoacids by alkalies. Comparison of the alkaline chlorate, bromate and nitrate. Measurements of viscosity in aqueous solution enable the course of the neutralisation of the acids to be closely followed. No relation between viscosity and isomorphism could be made out.—**Volmar**: The photolysis of the dibasic acids. In the cases of oxalic, malonic, succinic, and glutaric acids there was agree-

ment between the experimental facts and the law of photochemical equivalence.—P. **Bugnon**: Leaf homologies in the sweet violet: stamens and carpels. In the violet the stamens are homologous with the petals.—O. **Munerati**: Variations in the composition of the juice of a beetroot according to the state of disintegration of the tissue and the methods of expression. Two variables are studied, the state of disintegration before applying pressure, and the magnitude of the pressure applied. The variations observed are expressed in terms of the percentage of sugar in the expressed juice.—H. **Lagatu** and L. **Maume**: The linear relation between the successive quantities of phosphoric acid and nitrogen contained in the leaf of the well-nourished vine.—Émile F. **Terroine** and Mlle. S. **Trautmann** and R. **Bonnet**: The quantitative bio-energy law of the formation of carbohydrates at the expense of proteids and fats in plants. The transformation of proteids into carbohydrates in plants is accompanied by a loss of 35 per cent. of the metabolised energy; with fats there is a loss of 23 per cent.—E. **Aubel** and J. **Salabartan**: The mechanism of the production of hydrogen at the expense of glucose by the coli bacillus. Evidence is given in support of the view that the glucose is converted into equal molecules of pyruvic acid and hydrogen.—H. **Labbé** and F. **Lavagna**: The chemical composition of the normal and pathological crystalline lens. Determinations of water and various forms of combined nitrogen in a normal lens and one with cataract. In cataract there is a modification of the normal proteid content, a sensible disintegration of the albumen, and a large increase in the proportion of aminoacids and in the products of incomplete hydrolysis of the albumens. These characters point to the intense proteolysis which accompanies the evolution of cataracts.—C. **Levaditi**, S. **Nicolau**, and P. **Poincloux**. The etiological rôle of *Streptobacillus moniliformis* in acute septicæmic polymorphic erythema.

CALCUTTA.

Asiatic Society of Bengal, March 4.—H. **Bruce Hannah**: Indian origins. The Pāncha-Janāh mentioned in the Rig-Veda were probably four concrete communities of Western Asia who had belonged to the invading forces defeated in Syria *c.* 1156 B.C., by Rāmēsēs III., and had afterwards plunged off eastwards, plus a *drūj*-folk picked up in or near Gāndhāraland. The Dasyūs of Sapta-Sindhavāh were diffused representatives, east of the Indus, of the ancient and widespread Dahyūs of Central Asia.—Sri Ram **Sharma**: A forgotten hero of Marwar.—D. **Majumder**: Physical characteristics of the Hos of Kolhan. Anthropometric measurements of 200 Hos of different septs and localities are given.—Satyendra **Ray**: The earth's electric field and vertical potential gradient. The potential of the earth's electric field falls much more rapidly with height than would be expected with a radial field. The curve showing the variation of the potential gradient with height, as given by Schweidler and Kohlrausch, suggests an exponential curve. From theoretical considerations a formula is obtained which fits the curve and explains simultaneously the variation of the potential with pressure and the atmospheric "pollution."

WASHINGTON, D.C.

National Academy of Sciences (Proc. Vol. 11, No. 2, February).—E. H. **Hall**: Conditions of electric equilibrium at boundary surfaces: Volta effect. A theoretical development based on the theory of "free" and "associated" electrons in metals.—A. H. **Compton** and J. A. **Bearden**: The effect of a surrounding box on the spectrum of scattered X-rays. A water-cooled molybdenum target X-ray tube and sulphur secondary radiator with no surrounding box were set up outside a window and the spectrum photographed. Modified lines were found in the position indicated by Compton's theory.—R. A. **Millikan** and I. S. **Bowen**: The significance of the discovery of X-ray laws in the field of optics. Work on the spectra of stripped atoms of phosphorus (P V.), sulphur (S VI.), and chlorine (Cl VII.) has completed the proof that Moseley's law and its corollary, the irregular doublet law, holds in optics. To account for the regular or relativity doublet law in optics requires a new hypothesis. The doublets of atomic hydrogen and ionised helium are attributed to a true relativity cause, but those of lithium and all heavier elements to a non-relativistic cause, perhaps of magnetic or electrostatic and magnetic origin, giving similar results.—Y. H. **Woo**: The Compton effect and tertiary X-radiation. The water-cooled molybdenum target X-ray tube was enclosed in a box lined with $\frac{1}{16}$ in. lead sheet, and rock-salt, magnesium, aluminium, silicon, and sulphur were used as secondary radiators. Shifted lines were found in accordance with the predictions of Compton's theory, but there was no evidence of the tertiary radiation observed by Clark, Duane, and Stifler.—E. **Condon**: The age of the stars. The relativistic relation between energy and mass leads to a means, independent of atomic processes, of estimating the age of the stars.—W. J. **Luyten**: Notes on stellar statistics. III.: On the calculation of a mean absolute magnitude from apparent magnitudes, angular proper motions, and linear radial velocities.—E. B. **Wilson** and W. J. **Luyten**: (1) The frequency distribution on apparent magnitude of the non-Magellanic O-type stars. Among the O-type stars there is probably a fairly large dispersion in intrinsic brightness and a fairly large scattering through space. (2) The population of New York city and its environs. The ultimate population of New York city and its environs predicted by means of the Pearl-Reed curve would be 35 millions. Applying the same method to the population of the States including this area gives only about 22 millions. Hence one or both of the populations will probably soon enter upon a new cycle of growth. The Pearl-Reed method predicts "saturation" with a population but does not allow for the condition of additivity. It can give more probable results if modified constants are used.—J. W. **Alexander**: On the intersection invariants of a manifold.—P. **Franklin**: The rotating disc. Einstein's qualitative discussion indicates that the geometry on the disc cannot remain Euclidean; quantitative discussions by Lorentz and Eddington start from equations of transformation corresponding to a Euclidean rotation and end by computing contraction. An attempt is made at reconciling these opposed points of view.—G. A. **Miller**: Transitive groups involving direct products of lower degree.—A. C. **Redfield** and A. L. **Hurd**: The respiratory functions of the hæmocyanins. The blue colour of the blood of the squid and horse-shoe crab is due to "oxhyæmocyanin," but the hæmocyanin of the crab has much greater affinity for oxygen. This affinity is increased by carbon dioxide, whereas in the squid it is decreased, a fact which seems related to the mode of life.—T. M. **Carpenter**: Prolonged fasting as affecting the composition of steers' urine.—P. **Heymans** and W. J. **Heymans**: The torsion problem of curved beams.—E. M. **East** and A. J. **Mangelsdorf**: A new interpretation of the heredity behaviour of self-sterile plants. Self-sterility in Nicotiana is a Mendelian recessive in crosses between self-fertile and self-sterile species. Members of a self-sterility group are cross-fertile with members of other similar groups, but the class of the mother is never represented in the progeny.

Official Publications Received.

Department of the Interior: United States Geological Survey. Forty-fifth Annual Report of the Director of the United States Geological Survey to the Secretary of the Interior for the Fiscal Year ended June 30, 1924. Pp. ii+83+1 plate. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Bulletin 750-G: Bauxite in Northeastern Mississippi. By Ernest F. Burchard. Pp. ii+101-148. Bulletin 751-D: Geologic Structure of San Juan Canyon and Adjacent Country, Utah. By Hugh D. Miser. Pp. iv+115-155+plates 15-20. Bulletin 751-F: The Ekalaka Lignite Field, Southeastern Montana. By Clyde Max Bauer. Pp. iv+231-267+plates 30-34. Bulletin 751-G: Geology and Oil and Gas Prospects of part of Moffat County, Colorado, and Southern Sweetwater County, Wyoming. By Julian D. Sears. Pp. v+269-319+plates 35-37. 20 cents. Bulletin 753: Geology and Oil Resources of a part of Los Angeles and Ventura Counties, California. By William S. W. Kew. Pp. viii+202+17 plates. 50 cents. Bulletin 760-B: The Physical Features of Central Massachusetts. By William C. Alden. Pp. v+13-105+plates 6-22. Bulletin 761: Molybdenum Deposits; a short Review. By Frank L. Hess. Pp. iv+35+10 plates. 15 cents. Bulletin 762: Geology and Ore Deposits of the Rochester District, Nevada. By Adolph Knopf. Pp. ix+78+4 plates. 15 cents. Bulletin 765: Geology of the Region around Lead, South Dakota, and its Bearing on the Homestake Ore Body. By Sidney Paige. Pp. iv+58+11 plates. 20 cents. (Washington: Government Printing Office.)

Department of the Interior: United States Geological Survey. Professional Paper 134: Upper Cretaceous and Tertiary Formations of the Western Part of the San Juan Basin, Colorado, and New Mexico, by John B. Reeside, Jr.; and Flora of the Animas Formation, by F. H. Knowlton. Pp. iv+117+19 plates. 40 cents. Professional Paper 135: The Composition of the River and Lake Waters of the United States. By Frank Wigglesworth Clarke. Pp. iv+199. 50 cents. (Washington: Government Printing Office.)

Publications of the United States Naval Observatory. Second Series, Vol. 10, Part 2, Appendix: Total Solar Eclipses of August 30, 1905, and June 8, 1918, with Aviators' Notes on the Total Solar Eclipse of September 10, 1923. Pp. iii+B416+50 plates. (Washington: Government Printing Office.)

Review of Agricultural Operations in India, 1923-24. Pp. vii+152+8 plates. (Calcutta: Government of India Press.) 1.9 rupees; 2*s.* 9*d.*

Memoirs of the Department of Agriculture in India. Chemical Series, Vol. 7, No. 5: The Buffer Action of some Burma Soils. By J. Charlton. Pp. iii+101-121. (Calcutta: Thacker, Spink and Co.; London: W. Thacker and Co.) 12 annas; 1*s.*

Report of the Kodaikanal Observatory for the Year 1924. Pp. ii+4. (Madras: Government Press.) 6 annas.

Imperial Department of Agriculture for the West Indies. Sugar-Cane Experiments in the Leeward Islands: Report on Experiments with varieties of Sugar-Cane conducted in Antigua, St. Kitts-Nevis and Montserrat in the Season 1922-23. Pp. ii+54. (Barbados.) 1*s.*

The Indian Forest Records. Chemical Series, Vol. 11, Part 5: The Constituents of some Indian Essential Oils. Part 16: Note on the Rate of Oxidation of $d-\Delta^3$ Carene and other Terpenes in the presence of Catalysts. By Madyar Gopal Rao. Pp. ii+10+7 plates. (Calcutta: Government of India Central Publication Branch.) 12 annas; 1*s.* 3*d.*

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, Dominica, 1923-24. Pp. iv+35. (Barbados.) 6*d.*

Records of the Survey of India. Vol. 18 (Supplementary to General Report 1921-22): Annual Reports of Parties and Offices, 1921-22. Prepared under the Direction of Col. C. H. D. Ryder. Pp. iv+132+10 maps. (Dehra Dun: Trigonometrical Survey.) 4 rupees; 8*s.*

Proceedings of the United States National Museum. Vol. 65, Art. 9: A Revision of the West Indian Coleoptera of the family Buprestidæ. By Warren S. Fisher. (No. 2522.) Pp. 207. (Washington: Government Printing Office.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 36, Part 1, 1925. Pp. 106+11 plates. (London: Edward Stanford, Ltd.) 5*s.*

Smithsonian Institution: United States National Museum. Contributions from the United States National Herbarium. Vol. 23, Part 4: Trees and Shrubs of Mexico (Passifloraceæ—Scrophulariaceæ). By Paul C. Standley. Pp. 849-1312+xxxix. (Washington: Government Printing Office.) 60 cents.

Diary of Societies.

SATURDAY, MAY 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (I.).

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

MONDAY, MAY 25.

ROYAL SOCIETY OF MEDICINE (Balneology and Climatology Section) (at Brighton), at 3.30.—Dr. D. Forbes: The Climate of Brighton.

ROYAL IRISH ACADEMY, at 4.15.

ROYAL SOCIETY OF EDINBURGH, at 4.30.—C. W. Wardlaw: Size in Relation to Internal Morphology. No. 2. The Vascular System of Selaginella.—J. Thomson: The Parasitism of *Cuscuta reflexa*, Roxb.—S. Williams: Some Points in the "Anatomy of Dicksonia."—Dr. A. E. Trueman and Miss Williams: Studies in Ammonites of the Family Echioceratidæ.

ROYAL SOCIETY OF MEDICINE (Odontology Section) (Annual General Meeting) (at Royal College of Surgeons of England), at 5.30.—E. W. Fish: Circulation of Lymph in the Dentine (Preliminary Report).

SOCIETY OF GLASS TECHNOLOGY (at Royal Society of Arts), at 7.30.—Prof. W. E. S. Turner: The Nature and Constitution of Glass.—Prof. G. Tammann: On Glasses as Supercooled Liquids.—Dr. F. Eckert: Some Remarks on the Constitution of Glass.—Dr. A. Q. Tool and E. E. Hill: On the Constitution and Density of Glass.—Prof. H. Le Chatelier: On the Viscosity and Allotropy of Glass.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Col. C. H. D. Ryder: The Demarcation of the Turco-Persian Boundary in 1914.

TUESDAY, MAY 26.

SOCIETY OF GLASS TECHNOLOGY (at University College), at 2.30.—Sir W. H. Bragg: The Structure of Quartz and Silica.—V. H. Stott: The Viscosity of Glass.—Dr. G. W. Morey and Dr. N. L. Bowen: The Melting Relations of the Soda-Lime-Silica Glasses.—Dr. A. A. Lebedeff: Polymorphic Transformations in Glass.—Dr. G. W. Morey and Dr. R. W. G. Wyckoff: X-ray Studies of Soda-Lime-Silica Glasses.

ROYAL DUBLIN SOCIETY, at 4.15.

LINNEAN SOCIETY OF LONDON, at 5.—Anniversary Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. R. Whiddington: The Passage of Electricity through Vacuum Tubes (Tyndall Lectures) (II.).

ROYAL SOCIETY OF MEDICINE, at 5.30.—Annual General Meeting.

BRITISH SOCIETY OF MASTER GLASS-PAINTERS (at Art Workers' Guild, 6 Queen Square, W.C.1), at 6.—Annual General Meeting and Exhibition of Cartoons and Photographs of Stained Glass.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group), at 7.—H. C. Brewer: The Pattern of the Picture.

ROYAL ANTHROPOLOGICAL INSTITUTE (jointly with Eugenics Education Society) (at Royal Anthropological Institute), at 8.30.—Dr. H. F. B. Walker and others: Discussion on Miscegenation in South Africa.

WEDNESDAY, MAY 27.

ROYAL SOCIETY OF ARTS, at 4.30.—Sir Alfred Mond, Bart.: The Unemployment Problem.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine Section) (Annual General Meeting), at 5.—Dr. J. H. Sequeira: Parasitic Affections of the Skin communicated from Animals to Man.

ROYAL MICROSCOPICAL SOCIETY (Industrial Applications Section), at 7.30.—Dr. J. A. Murray: Lecture Demonstration on The Making of Microscopical Preparations. III. Staining.—The Microscope in Soil Microbiology:—G. Thornton: Soil Bacteria; D. W. Cutler: Soil Protozoa; Mrs. B. M. Roach: Soil Algæ.—Dr. W. B. Brierley: The Microscope and Plant Pathology.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Royal Society of Medicine), at 8.30.—L. S. Penrose: The Relation of the Pleasure-Pain Principle of Freud to the Question of Growth.

THURSDAY, MAY 28.

ROYAL SOCIETY, at 4.30.—R. J. Ludford: (*a*) Cell Organs during Secretion in the Epididymis; (*b*) Nuclear Activity in Tissue Cultures.—J. Needham and Dorothy Needham: The Hydrogen Ion Concentration and the Oxidation Reduction Potential of the Cell Interior. A Micro-injection Study.—Dr. F. W. R. Brambell: The Oogenesis of the Fowl (*Gallus Bankiva*).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. F. O. Bower: The Natural Classification of Ferns as a Study in Evolution (II.).

ROYAL SOCIETY OF MEDICINE (Epidemiology and State Medicine Section) (Annual General Meeting), at 5.30.—Dr. J. Brownlee: The Health of London in the Eighteenth Century.

FRIDAY, MAY 29.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—Prof. F. G. Donnan: Principles governing Passage through Membranes.—W. Stiles: Problems of Permeability in Plant Cells.—J. A. Hewitt: Absorption from the Intestine.—L. J. Harris: Acidimetry, Ampholytes, and Proteins, followed by a discussion by Prof. A. V. Hill, Prof. S. B. Schryver, Prof. W. Ramsden, and others.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 2.—H. Munro Fox: On Chlorocruorin.—E. Stedman: The Oxygen Dissociation Curve of Hæmocyanin.—Dr. L. Hogben: Relation of Electrolytes to Invertebrate Muscle.—H. W. Harvey: Some Variable Properties of Sea-water.—W. E. Garner: Molecular Orientation in relation to Muscle Contraction and Nervous Conduction.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Industry Club), at 8.15.—Annual General Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Henry Newbolt: Scenery in the Pastoral Poets.

SATURDAY, MAY 30.

SOCIETY FOR EXPERIMENTAL BIOLOGY (at King's College), at 10 A.M.—R. Chambers and P. Reznikoff: Studies on the Plasma Membrane and Physical State of Protoplasm by Micro-dissection and Micro-injection.—C. Shearer: Child's Hypothesis.—J. S. Huxley: Some Problems of Differential Growth.—Dr. W. H. Pearsall: Rates of Growth and Plant Form.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. Dr. E. M. Walker: Democracy in the Ancient World (II.).

FREE PUBLIC LECTURES.

MONDAY, MAY 25.

IMPERIAL COLLEGE OF SCIENCE—ROYAL SCHOOL OF MINES, at 5.15.—Prof. F. A. F. C. Went: Modern Conceptions of Light Stimuli in Plants.

ROYAL SOCIETY OF MEDICINE, at 5.15.—Prof. E. Brumpt: How to conduct an Anti-Malarial Campaign (Chadwick Lecture).

THURSDAY, MAY 28.

ST. MARY'S HOSPITAL (Institute of Pathology and Research), at 5.—Dr. W. E. Gye: The Filterable Viruses.

FRIDAY, MAY 29.

ROYAL SOCIETY OF ARTS, at 5.15.—Prof. E. Brumpt: The Prophylaxis of Sleeping Sickness (Chadwick Lecture).