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The Changeful Earth

THE address of Prof. W. W. Watts, F.R.S., this year's president of the British Association, appears in the supplement to the present number of NATURE. In the "Form, Drift, and Rhythm of the Continents", he has a very big subject, covering many topics that are debatable, for geology is a highly controversial subject when we get down to principles, and is likely to remain so for a long time to come.

Uniformitarianism is referred to briefly, and the help that Darwin admits he obtained from a consideration of this and kindred topics as set forth by Lyell is mentioned ; but is it not going too far to say that Lyell only just missed the discovery of organic evolution ? If he only just missed it, why was his recognition of its truth so tardy ? Is it permissible to attribute heroism to Lyell because in the long run, and very reluctantly, he admitted its truth ? In any event, the principle of uniformitarianism, while no doubt essentially sound, should be applied with some caution ; for it is not difficult to believe that dynamic agencies acted much more impetuously on the earth's crust during the early stages of its history than they did during later times, and even during later times there are some results the explanation of which seem to call for an occasional display of impetuous dynamic agencies. Later on in his address, in the portion dealing with the nature of the interior of the earth, Prof. Watts acknowledges this, and arrives at a view which "is neither strictly uniformitarian nor strictly catastrophic, but takes the best from each hypothesis". The important fact to note is, however, as he points out, that taking the earth as a whole "the chain of life has never snapped", and organic evolution has proceeded continuously throughout the traceable history of the earth's crust.

In a brief outline of the geological story of the earth, the idea of rhythm is developed, involving the alternation of periods of land growth with periods of marine transgression, as advocated by Suess. To account for this rhythm, Prof. Watts refers to the theory of the earth's contraction by loss of heat, and he seems to regard this as the factor of prime importance in the explanation of mountain growth and rock folding. He points out, however, that some geologists have found this theory inadequate, because in their opinion it is unable to account for the large amount of compression involved in mountain building.

A consideration of the age of the earth gives Prof. Watts an opportunity of emphasising the importance of radioactivity in the earth's crust as a hidden reserve from which it replenishes the supply of heat it requires to make good the losses sustained by radiation, and of remarking on the ample sufficiency of this reserve to explain the great age of the earth. Here he states Joly's view that, as a result of radioactivity, dissipation of the earth's energy, although continuous, proceeds by a process of pulsation, and that this furnishes the explanation required to account for the rhythmic alternation of land growth and marine transgression already referred to. Prof. Watts is apparently a strong supporter of this view, for he assures us that, "As Darwin found the missing word for Lyell, so Joly in his theory of thermal cycles has indicated the direction of search for a mechanism to actuate the rhythm of Suess". Here we are in some difficulty, for in connexion with

this view it is suggested that continental masses are embedded in a substratum of denser rock matter, in which they float as do icebergs on water ; and whether we believe this or not, we may reasonably doubt if it can be harmonised with the theory that rock folding and mountain building are the outcome of tangential compression due to loss of heat and consequent contraction of the earth's mass.

The portions of Prof. Watts's address dealing with the Atlantic and Pacific Oceans, and with continental drift, will be read with much interest by geologists, as this subject has been widely discussed in recent years. In dealing with it, Prof. Watts contents himself with a recital of published pros and cons, showing on the whole an affectionate regard for the pros, while leaving us with the impression that he has not quite made up his mind. He points out the structural contrasts between the shore lands of the Atlantic and those of the Pacific. He further mentions the rough parallelism between the two coast lines of the Atlantic, the close resemblances between the structure, rocks and fossils in the land areas bordering the two coasts, and various other features that have been brought into the account to support the hypothesis of continental drift, which Wegener did so much to popularise some years ago, and which on that account usually carries his name. According to this hypothesis, the above-mentioned Atlantic features are to be explained partly by the view already mentioned as supported by Joly, that continental masses float in a denser substratum like icebergs on water ; and partly by the view that the Atlantic margins represent one of many fractures which dissected what was formerly one vast continental mass, and that the separate masses thus defined by fractures have since drifted apart as a result of differential rotation or some other cause. To satisfy those who have difficulty in accounting for the Western Cordilleras of the Americas, the advocates of continental drift explain that these are due to the piling up of rock masses against obstacles which have arrested the drifting movement, and the same rather shabby explanation is applied to the origin of the Himalaya and some other mountain masses.

Prof. Watts no doubt sees many difficulties in the way of accepting this hypothesis, although, from the support he gives to Joly's views, one would expect him to be an out-and-out supporter of it. He realises, however, that its basis is purely speculative, for he tells us that the only way to settle it is by making more exact and longer-period measurements of longitude and latitude than have hitherto been possible. Unfortunately, however, such variations as have been recorded are, we are told, well within the limits of error involved in the observations. Indeed, pending the establishment of a stronger groundwork of fact for this hypothesis, the older theory of foundering subsidence for the origin of the Atlantic, and ordinary tangential compression for the origin of mountains, seems decidedly preferable.

In a concluding section on the evolution of life on the earth, reference is made to changing physical and biological influences as quickening or checking competition, and thus affecting the rate of evolution. The case of the grasses receives special mention. The geological date for the appearance of this important group of plants is given as early Tertiary (probably late Eocene) times. Not only is this group of plants important as a source of wheat and many other foodstuffs on which mankind depends directly ; they are also of importance indirectly as nourishers of numerous kinds of animals that serve as human food. The appearance of these grasses was a factor of immense importance during Tertiary and later times in stimulating the evolution of the vertebrates, including man, whose brain, Prof. Watts tells us, is of all the wonders of the known universe the most wonderful, "the most intricate and efficient mechanism ever devised, . . . capable of inspiring and ruling great masses of mankind".

A lofty note is struck in the last paragraph of this interesting address, which spreads before us such a varied feast of scientific thought concerning the earth on which we live. In the concluding six words of this last paragraph, Prof. Watts speaks of "the golden ages that have gone". He almost persuades us to think, however, that "the best is yet to be, the last of things for which the first was made" ; for he assures us that we are still far from the end of the mighty purpose that shows itself in the evolution of life on the earth, and that we can look forward with confidence to a further advance. Fortified by this assurance, we may reasonably hope that *Homo sapiens*, the wonder-brained creature that proudly labels itself "heir of all the ages, in the foremost files of time", will, in the coming years if not in the immediate future, show by wise governance in world affairs that it is worthy of the great earthly heritage into which it has entered. T. C.

Man Conquers the Desert

The Desert Fayum

By G. Caton-Thompson and E. W. Gardner. Vol. 1. Pp. xiv+167. Vol. 2. Pp. vii+114 plates. (London: Royal Anthropological Institute of Great Britain and Ireland, 1934.) 30*s*. net.

THESE two handsome volumes present with a wealth of detailed evidence the results of three seasons' pioneer work in the arid desert of the Fayum depression. Regions, previously traversed only by camels or donkeys, had to be opened up to motor-cars; water had to be supplied to gangs of native excavators encamped twenty-five or more miles from the nearest spring; the intrigues of other expeditions had to be circumvented. In the face of these obstacles the authors completed a contoured map of 100 square miles within the depression, and an archæological and geological survey of a much wider area.

The geological conclusions of the expedition have been published already in specialist journals. The present book merely notes the subsequent confirmation by the Geological Survey of Egypt of Miss Gardner's figure for the maximum level of the Pleistocene lake and of the existence of a rock sill across the Hawara channel that finally disposes of a rival theory of the origin of the lake: otherwise, ignoring controversy, the conclusions are just restated here. In Pleistocene times a great lake filled the depression to 115 ft. above sea-level; it then dried up almost completely, to be succeeded after an indefinite interval by a Neolithic lake with its highest beach at 59 ft.; the second lake contracted by stages until its strand lay 7 ft. below sea-level in Old Kingdom times and afterwards shrank even faster towards the present Birket Qarun. The pauses in the contraction of the lake must be due to increased rainfall, but nothing like a 'pluvial period' is admitted in holocene times. Maps and tables show how the archæological remains must be correlated with the several stages in the contraction of the Neolithic lake. Thus the laborious levelling and plotting, epitomised in these charts, serve to establish the relative ages of the human cultures to the description of which the bulk of the text is devoted.

The co-operation of several sciences secured to the expedition three outstanding triumphs. First, it provided the solution to the problem which first attracted Miss Caton-Thompson to the Fayum—the classification of the remarkable flint tools collected there and the determination of their relative age and cultural status. The makers of the oldest—Neolithic *A*—flints lived along the shores of a lake, 180 ft. above the modern lake-shore, and were allied to, and probably contemporary with, the oldest neolithic peoples discovered (after the first seasons' work in the Fayum) in the Nile Valley at Tasa and on the edge of the Delta at Merimde. With the discovery of their makers' actual settlements, silos, grains and household equipment, the long-familiar flints can be seen as marks of what is perhaps the oldest food-producing community yet known to archæology. Meticulous excavation, followed here by exhaustive publication, has yielded a vivid picture of this early phase of civilised life, while its scientific value is enhanced by expert reports on grains, animal bones and other materials.

To British prehistorians, the Fayum culture should appeal particularly, since Menghin has shown that our oldest neolithic culture is ultimately sprung from the same stock. On its origins the authors are wisely non-committal. (One reason for their reluctance to admit an eastern origin will have been removed by Mallowan's discovery of emmer nearly as early in Assyria.) In any event, though the Fayum *A* culture is the best illustration of a critical stage in man's progress, it is not the starting point of the new economy; the barley from the neolithic granaries, for example, is almost as far removed from its wild ancestor as is that grown in Egypt to-day. The primary stages in the plant's domestication must therefore be sought in a still remoter past.

Nor does the Fayum reveal any development of its oldest culture. The next phase, when the lake had sunk 20 ft., witnesses rather a degeneration. To it belong microlithic tools which on old typologies would have been classed as 'pre-neolithic'. The first advance comes with the Egyptians of the Old Kingdom. The expedition discovered gypsum and dolerite quarries of that age and forgotten roads leading across the desert to the Pyramids—a triumph nearly as dramatic as the recognition of the older neolithic culture. It adds materially to our appreciation of the industrial organisation of the Old Kingdom. The authors found a village of more than two hundred hut-circles (quite like those so familiar in Britain) in which the gypsum workers were housed, no less than 3,233 unfinished vases and piles of flint-nodules—the raw material for quarryman's picks. The collection and transportation of these heavy flints from a considerable distance must itself have employed a multitude of labourers. The discovery in the village of a rope

of undoubted camel hair and of horn-cores belonging probably to *Bos brachyceros* should be noted by zoologists, since both animals are reputedly foreign to the early holocene of Africa.

The expedition's third triumph was the identification of a Ptolemaic irrigation system. The canals had been completely masked by sand, but were revealed to Miss Caton-Thompson's expert vision by seedlings that, after a shower, sprouted most luxuriantly along the line of the old channels. Excavation defined the character of the channels, fixed their date and showed that they had rendered possible the cultivation of vines and date-palms on this now treeless waste. In this instance, archæology may prove to have a positive economic value.

V. GORDON CHILDE.

Philosophy of Modern Physics

(1) Science and the Human Temperament
By Prof. Erwin Schrödinger. Translated, and with a Biographical Introduction, by James Murphy. Pp. 154. (London: George Allen and Unwin, Ltd., 1935.) 7*s*. 6*d*. net.

(2) Science and the Human Temperament
By Prof. Erwin Schrödinger. Translated by Dr. James Murphy and W. H. Johnston. Pp. 192. (New York: W. W. Norton and Co., Inc., 1935.) 2.50 dollars.

THESE two books are identical but that the one published in America has an error on the title page, where the author is wrongly described as "formerly" professor in Berlin.

The essays here published together were produced at various times for various occasions, but they are all philosophical discussions of modern physical theory designed for the general public more than for the professional physicist. The essays are all most readable and written in a lively and even provocative manner. The last of them is Prof. Schrödinger's Nobel Prize lecture and contains a simple account of the ideas underlying his well-known, if little understood, wave theory of matter. The author explains that, just as light for some purposes can be treated as consisting of rays moving in straight lines, for others it can be treated as a system of transverse waves, which can spread round obstacles; so also the electron for some purposes can be treated as a particle, for others as a wave system. The difficulties underlying the theory are essentially those that arise when we try to translate concepts that have been developed to deal with the familiar large-scale operations of Nature into terms which are applicable to operations on the smallest scale of the elementary units. The older physicists assumed that no translating was needed and that their concepts applied through and through, although they were anthropomorphic in the sense of being derived from the ordinary mechanical arts.

The other essays deal in the main with two other difficulties of a similar kind. One of these has now been apparent for a long time, ever since it was realised that the laws which are found by observation to describe the behaviour of gases, the transfer of heat, the progress of chemical reactions, and so on, are based upon complete chaos of the individual particles making up the things that are actually handled experimentally. The regularities appear only because the individual particles are handled in very large numbers, just as insurance companies remain solvent because large numbers of people take out policies. The other is the more novel Uncertainty Principle of Heisenberg: the assertion that there is necessarily a rigid limit to the accuracy of observation, a limit determined by a natural constant. Hitherto it had been assumed that—in principle at any rate—observations could be made with any degree of accuracy; though now, after the event, it is easy to see that the assumption never had a leg to stand on. Prof. Schrödinger points out that even if this principle introduces a new sort of indeterminism, classical theory was not so strictly deterministic as has been popularly supposed. You can never specify more about the motion of an object than that at t_0 it is at p_0, and after a finite interval, at t_1 it is at p_1, and so on. At least two observations are needed, and all observations are limited by the fact that the scales of instruments have a finite number of divisions at finite intervals.

The writings of Eddington and Jeans have popularised the notion that modern physical theory leads inevitably to some kind of 'Idealism' similar to that of Berkeley. Prof. Schrödinger's treatment provides no warrant for this view, and on this point we would emphatically contradict the suggestion Mr. Murphy makes in his introduction. Mr. Murphy and the other translator have, however, done their translating very well; there is none of the awkwardness so often apparent.

A. D. R.

Physiology and Pathology of Internal Secretion

The Diseases of the Endocrine Glands

By Dr. Hermann Zondek. Third edition, revised and enlarged, translated by Dr. Carl Prausnitz. Pp. xi+492. (London: Edward Arnold and Co., 1935.) 40*s*. net.

THE addition of yet another volume to works on diseases of the endocrine glands can only fill the expert reader with dismay, unless such a work has outstanding characters. The work at present under review, from the theoretical point of view, has everything against it; for it deals mainly with the pathology of the endocrine glands, is written by an author well known for very strong personal views, and it is a translation from the German. It may be stated at the outset that despite these difficulties the work forms a most valuable addition to the literature of this subject. Dr. Hermann Zondek is well known as a member of the distinguished scientific family of which his brother, Prof. Bernard Zondek, has contributed perhaps some of the most striking developments of modern endocrinology.

The volume is divided into two parts, part one being concerned with the general physiological and biochemical principles of the glands and internal secretions, and part two solely with the pathological changes. A good historical review is given in part one, the functions of the hormones, their mode of action and the question of specificity are carefully considered and the site of action in the body briefly discussed.

The section dealing with the actual chemistry and physiology of the hormones is rather disappointing. Thus, a more detailed description of the reasons for the adoption of the Harington formula for thyroxine should have been given. The summary of the present position of our knowledge of the hormones of the anterior and posterior lobes of the pituitary gland is very good, but one would have liked more details of the chemical properties of these substances. Again, it is unfortunate that Dr. Zondek has not gone more fully into the question of the chemistry of the male and female sex hormones. For example, the very important recent developments whereby sex hormones may be obtained as degradation products of certain sterols is not made at all clear. It is, of course, difficult for the author of such a volume to know what to include, since the subject is so vast; but for future editions we would suggest that more chemical details are given, since these are the basic facts of our knowledge of the endocrine glands.

In the special part of this work, Chapter xii is concerned with Graves' disease, and is a very good summary of our present position. There can be no doubt that the greater part of this description will be new to chemical and clinical readers. The whole subject of hyper- and hypo-thyroidism is considered from a hormonal aspect. The description of the treatment of hyper-thyroidism is particularly interesting, although all will not agree with some of Dr. Zondek's remarks; for example, on p. 169 he implies that there is no use whatsoever for digitalis in Graves' disease. Other chapters deal adequately with the subjects of myxodæma, cretinism and endemic goitre.

There is an excellent chapter on obesity. Dr. Zondek very wisely points out that the fundamental consideration in the problem of obesity is the excess of intake over output. The endocrine glands can only accentuate or diminish this fundamental consideration. Many writers on endocrinology tend to give the impression that even the first law of thermodynamics can be defied. Various types of obesity are dealt with, such as Frölich's syndrome, Dercums' disease and similar conditions.

The work is undoubtedly one of very great value. One may perhaps be irritated by the writer's emphasis of his opinion, but perhaps it is this factor that gives the book that freshness which is absent from most works of this kind. It is to be hoped that it will be read extensively by physicians and particularly by gynæcologists and obstetricians, who seem to be unmoved by the truly amazing progress made in their subject by endocrinologists. They have been presented with gift after gift, such for example as the Aschheim-Zondek reaction, but they appear to pay little attention to this branch of their work.

The book is well produced, with good and well-selected illustrations. The work differs from most translations in that the casual reader would not realise it is a translation, and this is perhaps the greatest compliment one could pay to Dr. Prausnitz. Some of his translations are extremely apposite; for example, "Mastfettsucht" is translated simply as "overfeeding", whereas "Luxuskonsumption" is "alimentary extravagance". Dr. Zondek is to be congratulated on producing one of the best books on the subject and Dr. Prausnitz on supplying the perfect translation.

Sir Ray Lankester as Archæologist

Prehistoric Archæology and Sir Ray Lankester
By J. Reid Moir. Pp. viii+160. (Ipswich: Norman Adlard and Co., Ltd., 1935.) 7*s*. 6*d*.

SIR RAY LANKESTER was one of the most versatile and inspiring scientific men of his generation. His own researches in biology and geology were remarkably varied, but his active interest in the work of others was still more comprehensive. He watched each new development and did not hesitate to form his own opinions on the evidence produced. He frequently entered discussions on problems outside his immediate sphere, and helped to illuminate them by his keen appreciation of their nature and possible mode of treatment.

Among other problems which interested Lankester were those of prehistoric archæology. As a young man he visited Abbeville and Boucher de Perthes, who gave him examples of the palæolithic flint implements which were then being discovered in the valley of the Somme. In his later years, from 1910 onwards, he followed with close attention the researches of Mr. J. Reid Moir, who was finding still older and more primitive flint implements in the bone bed at the base of the Pliocene "Red Crag" in Suffolk. In 1911 he described Mr. Reid Moir's new implements in a paper read before the Royal Society, and gave to them the now familiar name of 'rostro-carinates'. In subsequent years he continued to make further contributions to the subject.

From 1910 until his death in 1929, Sir Ray Lankester wrote many letters to Mr. Reid Moir during the progress of his researches and publications. They are full of characteristic comments and helpful suggestions, and the most important parts of them are now printed with a connecting narrative by Mr. Reid Moir in the small volume before us. Some relate to the Red Crag and its basement bed, which Lankester studied and described so long ago as the years 1865–70. Some give hints for the study of the fracture and patination of flints; others offer excellent advice on the writing of scientific papers. Some deal with current researches on fossil man and his handiwork outside East Anglia. They tell a most interesting story, which we commend both to archæologists and to all who wish to see science in the making.

A. S. W.

Tables of the Complete and Incomplete Elliptic Integrals
Reissued from Tome 2 of Legendre's "Traité des Fonctions Elliptiques", Paris 1825. With an Introduction by Karl Pearson. Pp. xliii+94. (London: *Biometrika* Office, University College, 1934.) 12*s*. 6*d*. net.

COPIES of Legendre's classical work, "Traité des Fonctions Elliptiques", published in Paris in 1825, have now become very scarce, with a consequent rise in price. To the mathematician, this has considerably diminished the accessibility of the fundamental tables of the complete and incomplete elliptic integrals E and F, which were contained in Volume 2 of the treatise. By means of the photographic process, however, it has now been possible to republish the tables, and the present volume is the result. Not the least valuable part of the book is the excellent introduction written by Prof. Karl Pearson. Here we have 39 pages devoted to a lucid explanation of the tables and their use. Several interesting diagrams are shown and a beautiful autographed portrait of Legendre is included. As the tables are a photographic reproduction, the book is larger than usual, but all those whose work necessitates the use of the tables will be grateful to the *Biometrika* Office for issuing such a valuable work of reference at so reasonable a price.

Gasentladungstabellen:
Tabellen, Formeln und Kurven zur Physik und Technik der Elektronen und Ionen. Von M. Knoll, F. Ollendorff und R. Rompe. Unter Mitarbeit von A. Roggendorf. Pp. x+171. (Berlin: Julius Springer, 1935.) 29 gold marks.

A VERY considerable proportion of modern physics is concerned with electrical phenomena in more or less evacuated vessels. The worker in this general field, whether his special interest be in thermionics, in light-sources for spectroscopy, or in any other of its many branches, needs at one time or another information about the properties of a vast number of things. He may require the ionisation potential of cæsium, the vapour pressure of cadmium at 100° C., the specific resistance of molybdenum at 1,000° C., or the relative rates of sputtering of aluminium and iron cathodes in a hydrogen discharge. All these data, and hundreds more, can be found in this very useful book, which contains in graphical or tabular form an immense amount of quantitative information of value to workers on electrical discharges.

The authors have been commendably careful in making clear the units in which the various quantities are measured, and the sources from which the information has been obtained. The index, which is of the greatest importance in a book of this kind, seems to be quite adequate.

A Bibliography of Sir Oliver Lodge, F.R.S.

Compiled by Theodore Besterman. Pp. xiv+220. (London : Oxford University Press, 1935.) 21*s*. net.

SIR OLIVER LODGE has for many years been a clear and prolific writer on many subjects, and Mr. Besterman has collected a list of 1,156 books, pamphlets, articles, letters, notes, etc., in scientific, technical and other journals and books written by Sir Oliver in the past sixty years. Of these, 247 relate to electricity and wireless communication, 54 to questions concerning the ether, 289 to other scientific subjects, 70 to psychical research in general, 73 to survival after death, 64 to education, 170 to philosophy and religion, 118 are biographical or are reviews of or prefaces to books by other authors and 71 are on miscellaneous subjects. An index of 23 pages, which distinguishes typographically between books and pamphlets on one hand and contributions to periodicals on the other, facilitates reference to the book.

In the preface, Sir Oliver has added some further information as to his early demonstration of wireless signalling at the meeting of the British Association at Oxford in 1894, and the developments which followed. The book is well printed, and the portrait of Sir Oliver which forms the frontispiece is very good and shows him in a characteristic attitude. An absence of cross references throughout the book makes it difficult to follow the course of discussions on psychical or religious subjects between Sir Oliver and his critics. Sometimes a reply is tabulated without the criticism, at others the criticism without a reply, as for example, Sir Herbert Stephen's criticism of "Raymond" on p. 111. No hint is given that Prof. Armstrong's article, xxi p. 191, entitled "Sir Oliver Lodge, Intolerant, Infallible", is the fourth member of a quartette, the others being Sir Oliver dcvi p. 102, Sir Ray Lankester xxix p. 191, Sir Oliver dcxi, p. 103. The roman numerals for articles throughout the book, as for example, "Science and Psychical Research dccccxlviii", instead of 948, p. 215, of the index, detract considerably from the ease of reference to the Bibliography.

The Origins of Religion

By Prof. Rafael Karsten. Pp. viii+328. (London : Kegan Paul and Co., Ltd., 1935.) 12*s*. 6*d*. net.

PROF. KARSTEN, in formulating his theories of the origins of primitive religion, is in a position to draw upon an extensive acquaintance with the beliefs of backward peoples, especially in South America, at first hand. He is thus able to meet the more serious critics of the comparative method in the study of religion on their own ground, when they impute neglect or ignorance of the context as a fatal flaw in the argument. On the other hand, although he himself maintains the predominance of animism and ancestor worship as formative influences in the religious side of man's cultural development, he points out that those who have followed Tylor and Spencer have frequently been entirely uncritical in the use of authorities upon whose evidence they have based the evolutionary view of the growth of religion.

Prof. Karsten is to be regarded as in the main an evolutionist, though he is no upholder of the crude view of a unilateral line of development. On the other hand, he is ready to recognise that diffusion and *kulturkreise* are not to be ruled out, and that they, too, have played their part. Preanimism or animatism, however, finds no favour as a precedent to animism, and is regarded as late and sophisticated.

The book is an excellent and well-balanced review of current theory and reinterpretation of the evidence in the light of personal first-hand knowledge. Its value is enhanced by the use the author has made of evidence afforded by the beliefs of Finno-Ugrian peoples which, owing to difficulties of language, are not generally accessible.

Terrains, roches et fossiles de la Belgique

Par Eug. Maillieux. Deuxième édition, revue et augmentée. Pp. 217. (Bruxelles : Musée royal d'Histoire naturelle de Belgique, 1933.) 6 belgas.

THIS work is an excellent summary of the present state of knowledge of the stratigraphical geology and palæontology of Belgium, and while invaluable to geologists, sufficient explanatory matter is given to make the book of use to readers with only a small knowledge of the subject. With the exception of the Cambrian system, the range of formations is almost as extensive as in the British Isles, and the deposits, in the main, resemble those of these islands. The palæontological record really starts with the Tremadocian, there being no definite evidence to show whether earlier formations are of Cambrian or pre-Cambrian age. Three maps show the outcrops of Palæozoic, Mesozoic and Tertiary formations respectively, from which it is seen that the Mesozoic deposits occupy a relatively small area, the Palæozoic form most of the southern part of the country, and the Tertiary the northern part. Intrusive and extrusive igneous rocks are of little importance.

The palæontology of each system and its divisions are lucidly described and illustrated by numerous figures. Interest is given to the stratigraphical facts by an account of the conditions under which the deposits were formed and of the geographical changes which took place during each period. A new section across the Ardennes by Prof. F. Kaisin is welcome.

Opera hactenus inedita Rogeri Baconi

Fasc. 12 : Questiones supra librum de Causis. Nunc primum edidit Robert Steele, collaborante Ferdinand M. Delorme. Accedit Liber de Causis a Roberto Steele. Pp. xxiv+196. (Oxford : Clarendon Press ; London : Oxford University Press, 1935.) 17*s*. 6*d*. net.

THIS excellent edition of Bacon's commentary on the "Liber de Causis" brings nearer to completion the publication of the works of the erudite Franciscan friar of the Middle Ages. The thesis and the commentary are printed separately, following the method used by medieval writers. The history of the MSS. used for this edition is given by Mr. Steele in a comprehensive introduction. The work deals with some fundamental points of ontology, such as being, substance, cause and the intellect. T. G.

Robert Hooke and his Contemporaries

"DR. ROBERT HOOKE is generally allowed to have been one of the greatest promoters of Experimental Natural Knowledge, as well as Ornaments of the seventeenth century, so fruitful of great genius." With suchlike words Richard Waller begins his introduction to the "Posthumous Works", and the judgment still holds good. Nevertheless, our information as to Hooke's life and character has hitherto been comparatively meagre, for Ward's "Life", and most of what has besides been written of him, derives from Waller's account, and Waller apparently had little personal knowledge of Hooke or his intimates, since he states that his main authorities are Hooke's brief biographical notes and the "Journals" of the Royal Society. It is typical that Hooke is one of the few great men of science of whom no portrait is available—possibly the only one, for even of Cavendish we have the well-known sketch prefixed to George Wilson's "Life" and the "Scientific Papers". Hard judgments have been pronounced on him, without, perhaps, much trouble taken about that understanding which is said to lead to comprehensive pardon. The publication* of Hooke's diary for 1672–80, now in the possession of the Corporation of the City of London, at least affords us some direct evidence as to his character and mode of life.

This Diary covers the period of the "Cutlerian Lectures" and "Philosophical Collections". Hooke was thirty-seven years old when he started it, and had already published the "Micrographia" and made some of his most important improvements in instruments, including the first Gregorian telescope with a pierced objective mirror, but was still in his scientific prime. The diary consists of brief entries in staccato style, as can best be shown by a typical entry.

"Monday June 15th Rose at 4. Mr. Amhurst desired a meeting this day at 3. Tryd helioscope by reflection. Hurt my eye much—prosecuted Hevelius. Was at Lord Mayors and coffee house with Sir Ch. Wren. Lord pleased with accounts. Oliver a Rascall. Dean of Paules angry. At Garaways. Met Mr. Amhurst, 1 Guinny. View in Fleet Street 10sh. At Mr. Tompions".

It might be thought that this kind of thing would soon pall, but one reader at least has found it fascinating. The "Cutlerian Lectures", the "Philosophical Collection", and Birch's "History of the Royal Society" go far to elucidate obscurities and amplify allusions, while the Diary makes the formal records extraordinarily vivid and personal.

For general interest this Diary does not, of course, challenge comparison with Pepys, but we must respectfully dissent from the judgment implied in the charming words of introduction by the honoured president of the Royal Society, Sir Frederick Gowland Hopkins, that the difference in style is partly attributable to the fact that Hooke's diary was meant for himself alone, while Pepys had his eye on eventual readers. Surely the fact that Pepys, who used a special secret shorthand, was essentially a gossip and a man about town, while Hooke was a man whose interests were concentrated on pure and applied science, and who had no interest in public affairs and society, as distinct from The Society, supplies a sufficient reason. It is much to be regretted that the two diaries do not overlap in time, Pepys's concluding three years before Hooke's starts, but it is amusing to note that the two men, of such different temperaments, met and liked one another. There are several references to Hooke in Pepys, the first speaking of "Mr. Hooke, who is the most, and promises the least, of any man in the world that ever I saw". Elsewhere we read:

"Discoursed with Mr. Hooke about the nature of sounds and he did make me understand the nature of musicall sounds made by strings, mighty prettily; and he told me that having come to a certain number of vibrations proper to make any tone, he is able to tell how many strokes a fly makes with her wings (those flies that hum in their flying) by the note that it answers to in musique, during their flying. That, I suppose, is a little too much refined; but his discourse in general of sound was mighty fine".

Thus the president-to-be (1684–86) of the Royal Society. On the other hand Hooke, in his briefer style, writes: "I was twise with Mr. Pepys who was very civil and kind", and even if he says later "Mr. Pepys master of the Trinity House made a long speech to no great purpose", it is only his way of stating that it was a "little too much refined".

What does the Diary tell us? We premise that it is obviously a truthful personal record, written without any thought of possible readers. Hooke sets down with a symbol every passage—and at one time they were frequent—with his mistress Nell Young and with her successors, and a host of pitiful details of his troubled health. Entries like

* The Diary of Robert Hooke, M.A., M.D., F.R.S., 1672–1680. Transcribed from the Original in the possession of the Corporation of the City of London (Guildhall Library). Edited by Henry W. Robinson and Walter Adams. Pp. xxviii + 527 + 8 plates. (London: Taylor and Francis, 1935.) 25s.

"Drunk. Promised to pay whatever I signed to be paid" show that he spared himself no less than others in his directness. The first thing that stands out clearly is that Hooke was a sick man, trying all the time with medicine and diet to win a little ease. He was troubled constantly with what appears to have been a form of catarrh in his nose, with terrible headaches, with vomiting, with giddiness, with sleeplessness, with indigestion in various forms, and with fearful dreams—possibly also with worms, for he frequently took what he calls hagiox, which is probably hagiospermum, that is, santonin, which nowadays, at any rate, is only used for that trouble. Nevertheless, only occasionally was he too ill to work—"Ill all day, miserere mei deus". When anything agreed with him, or he slept, he thought it worth noting. "Eat nuts and brandy. Agreed well, and slept". "Slept well. Deo Gratias". The medicines which he took almost daily make a formidable list.*

There is some excuse, then, for Hooke's reputed ill-temper. Not only, however, was he without ease and sleep ; it is clear that he was prodigiously overworked. "The indefatigable Hooke", Weld may well call him. What is sometimes forgotten is that Hooke was a considerable architect, so much so that the College of Physicians in Warwick Lane has been attributed to Wren, although it appears that it was Hooke's. In any event, he was the architect for Bethlehem Hospital, to which very many entries refer, and he appears to have been responsible for the urn on the Monument, which gave some trouble. He designed private houses for many individuals mentioned in the Diary. He had been appointed City Surveyor in 1666, in which capacity he was assisting Sir Christopher Wren all through the period of the Diary, so that there is scarcely a page on which Sir Christopher is not mentioned. There are frequent records of his being with Sir Christopher and, incidentally, with Robert Boyle, Sir J. Hoskins, and other famous men, a circumstance to be noted in connexion with Thomas Molyneux's accusation that Hooke was "the most ill-natured, conceited man in the world, hated and despised by most of the Royal Society". Strange that he should afterwards have become secretary of the Society! The truth is probably that he was impatient with fools, and ill-tempered at times, especially when he thought himself slighted. As, however, he seems to have been on good terms with most of the first-class intellects of the time —Wren, Boyle, Ent, Glisson, Petty, Aubrey and a host of others—and throughout the Diary we find him playing chess with Haak, and in the company of Abraham Hill, Daniel Whistler, Halley, and many others whose names occur over and over again as his coffee-house companions, he cannot have been so difficult as it pleased his enemies to make out. Sydenham invited Hooke to stay with him for six weeks.

If it is clear that Hooke was sharp-tempered, it is equally clear that in most cases he bore no malice. He discharged Nell Young from his service in 1673, but she continued to make his clothes and they visited one another, and although there was a quarrel in 1676, "Paid Nell for suit 6s8d besides the full of her bill 16s6d never more to do with her", within a few weeks we find "At Nell's", which thereafter occurs at intervals, as usual. Occasionally he rails at Tompion, who appears to have been slow and often behind his time, "a slug", "a rascall", but they continue to work together through the Diary, and no doubt knew one another's worth and idiosyncracies perfectly well. Even in the case of Oldenburg there is no unkind entry at his death, and Hevelius's fire is referred to sympathetically.

The people whom Hooke consistently stigmatises as rogues—Oldenburg ("a lying dog", "treacherous and a villain") and Sir John Cutler ("a villain", "a cheating knave", "Sir Stingy"—I presume that this is Sir John) appear to have done much to earn his just indignation. Oldenburg first incurs censure for not registering things brought into the Society, and there are references to his not entering experiments long before the controversy over the application of the spiral spring to the balance wheel of watches. This dispute over the balance wheel seems to have upset Hooke more than any of his other troubles. We find the entry "Saw the Lying Dog Oldenburg's *Transactions*. Resolved to quit all employments and to seek my health". (Oldenburg was responsible for the *Transactions*, which were in a sense his property, as he received all profits on the sales.) It is often held that Hooke was in the wrong, and that Oldenburg was a harmless and devoted servant of the Society, as, indeed, he induced the Society to say. It is, however, recorded of him that he "had a peculiar temper, which prevented him agreeing well with others", while at the same time he had had an early training in diplomacy which possibly rendered his approach to the truth somewhat less direct than Hooke's.

When it is remembered that Oldenburg had a financial interest in Huygens' watch, since Huygens had assigned him the patent rights, and his petition for a patent is on record, it is, perhaps, possible to believe that he was not completely unprejudiced. His statement that none of Hooke's early watches had succeeded seems to go beyond what he could have known, and it was distinctly in his own interest to make it. Hooke's account of his early

* Sir D'Arcy Power, to whom I referred this passage, very kindly tells me that there is no doubt that Hooke's headaches were due to a chronic inflammation of his frontal sinuses.

invention is true where we can check it, and it seems quite likely, in view of what we know, that he had, as he says, dropped the matter because of a very reasonable objection of his to a clause in the proposed agreement, to take it up again when he heard what Huygens had done. Thomas Thomson, in his "History of the Royal Society", refers to Hooke's character in the most censorious terms, and yet says in connexion with the balance spring, "Huygens has been considered as the author of this happy invention; but there is complete proof that Hooke anticipated him by about 14 years". Anyhow, Hooke's accusation that Oldenburg was "a traffiker in intelligence" seems absolutely justified. The Newton-Leibnitz controversy throws doubt on Oldenburg's discretion, and, in spite of his plaintive protests, when he was committed to the Tower, there are letters on record to show that he did meddle with political matters in them, as well as with scientific news. Sydenham, "universally recognised" according to the "Dictionary of National Biography", "as noble, modest and sincere" liked him as little as did Hooke, and I, for one, have the impression that he was an oblique, intriguing and toadying individual, jealous of Hooke's fame and earnings.

Sir John Cutler undoubtedly promised Hooke a yearly salary for lectures, which Hooke amply earned, and yet Sir John constantly evaded all attempts to make him pay it. He seems to have had a bad reputation. "Sir W. Petty" (a shrewd man if ever there was one) "told me that Sir J. Cutler would never pay me". Finally Hooke brought a Chancery suit against Sir John's heirs, in which he was successful. Waller quotes from a diary, no doubt the one in the British Museum, "In July 1696, being his Birth Day, his Chancery Suit for Sir John Cutler's salary, was determin'd for him, to his great satisfaction, which had made him very uneasy for several Years". It is not greatly to Hooke's discredit that he strongly resented this arrant attempt to bilk him, especially after his lectures had appeared in print with a handsome acknowledgment, in advance, of Sir John's bounty.

Another matter in which Hooke has incurred blame is the controversy with Hevelius about telescopic sights. Here there is no doubt that he was, objectively, in the right in every particular, and his estimate of the resolving power of the human eye, which he was the first to treat scientifically, is a very good one. All that he claims as advantages of telescopic sights has long since been established, and his defence against the strictures of Wallis and Molyneux is correct in manner and faultless in exposition and matter. What Waller says, that in his original "Animadversions", "he chanc'd to let slip some Expressions which, tho' possibly strictly true, could yet never be digested by Hevelius", is the most that can be urged against him. Hevelius, however, had slighted Hooke's original reasoned suggestion that he should use telescopic sights, so that a little warmth on Hooke's part is understandable. When the controversy was revived by Hevelius publishing "Annus Climactericus" in 1685, Hooke, at the Royal Society, "showed his experiments to prove the excellency of telescopic sights above plain ones, by comparing a direction by the eye with a radius of ten feet, with that of a telescope of eight inches; and it appeared to the satisfaction of all present that there was a very great advantage in the telescope".

Let us see, however, if we can find any direct contradiction of the popular view of Hooke's character in the Diary. Among other faults with which we find him charged is "extreme parsimoniousness" (Weld). On the other hand, the Diary shows him spending freely. He is always buying books, often at prices round about 25*s*., a large sum in those days. His gifts to his niece Grace were generous: "This morning I gave Grace, Axes Stone Ring and speckled silk stockings and Ruby pendule" is but one of many entries. There are frequent records of small gifts to servants and messengers and of loans, which do not seem to have been repaid. He made extensive purchases of silks, and cloth, of wine and of brandy, and seems to have been always buying shoes. Incidentally, his use of the old term 'portoport' for port wine, of which he seems to have been fond, is much earlier than any given in the "New Oxford Dictionary". He frequented all the best taverns and coffee-houses and drank tea (the price of which was 15*s*. to 50*s*. a pound),* coffee and chocolate. He made gifts of tea and wine. One day he ate a pineapple "queen pine 2/-". He bought a hobby horse for Wren's son. He gave away copies of his books freely. These are only trifles, it may be said, but they are not rare. The general impression is that of a man who did not mind spending money on his friends and on himself—at the least the Diary makes it impossible to maintain that he was miserly.

Let us take another example. Baron Ernouf, author of the life of Denis Papin, says of his subject that he could not come to see Hooke, whom he terms "un de ces savants atrabilaires et soupçonneux dont l'espèce n'est pas perdue". Whether there was an occasion on which Hooke would not see Papin we cannot, of course, determine, but the Diary is full of entries of occasions on which he did, both when Papin visited him, and he visited Papin, so much so that under the name Papin in the index appears

* On January 16, 1679/80, Hooke "paid Chamberlain for tea, 25sh". A pound?

Passim. In July 1679, for example, they met almost daily. He seems to have done his best for the unfortunate Frenchman: "I treated with Broom and Car for Pappin's book but they agreed not". The only disparagement, if it may be so called, anywhere set down, is "Pappin ungrateful". Incidentally, a younger brother of Papin's appears, who is new to me.

The interest of the Diary for the history of science is great. It is full of observations of importance, many of which, but not all, so far as I can trace, were published later. Hooke records the hollowness of the flame of a candle: the extinction of flame by "air generated by corrosion or fermentation", "and how saturated air did the same thing", as well as many other interesting experiments on combustion: how a glass can vibrate in four, six or eight segments as shown by the movement of water in it.* We find the record of his experiment with the falling bullet, but not of his letter to Newton on the subject, though some of his important letters to Newton are noted. A curious entry refers to "the way to make aparition on the Stage by a concave cylinder", evidently a very early form of 'Pepper's ghost', and another example of Hooke's extraordinary inventiveness. Another anticipation is his observation of the curious forms sometimes shown by the rising sun—"saw the sun rise very elliptical the under side much flatter than the upper", with a drawing, and, just a year later, "the sun rose very ovall, red and indented". The earliest observations on this subject quoted by Pernter in his "Meteorologische Optik" are considerably later, namely from an unpublished manuscript of the younger Cassini, who was born in 1667.

All this time, Hooke was polishing mirrors, seeing Tompion about watches, and making instruments. There are references to the scotoscope, of which Pepys mentions an example:

"There comes also Mr. Reeve with a microscope and scotoscope. For the first I did give him £5-10, a great price, but a most curious bauble it is, and he says, as good, nay, the best he knows in England, and he makes out the best in the world. The other he gives me, and is of value; and a curious curiosity it is to look objects in a dark room with."

and to the otheometer, which I cannot find mentioned elsewhere, but which is evidently a name given to one of the many forms of barometer which Hooke invented. A matter of biographical interest is that in two separate instances there are records of Hooke giving away in the autumn copies of books which are dated the following year. There are also records of gilt copies, which must be very rare.

Reluctantly we must cease to quote from this book of manifold interests. One last note—for Mr. Dunne. On more than one occasion Hooke, who dreamt so much, speaks of prophetic dreams, as, for example, "Dreamt several things which came to pass the Day following", and again "Dream strangely fulfilled in Powis".

To produce this book has evidently been a labour of love for the editors, who have added an annotated list of the taverns and coffee-houses (some hundred and fifty of them!) mentioned by Hooke, and an excellent biographical index of getting on for two thousand names quoted in the Diary, nearly all of whom are Hooke's contemporaries. The transcription is, on the whole, excellent, but there are a few obvious errors, some of them amusing. "Eat candle, which agreed well" is not so surprising, if we suppose the word to have been "caudle"; and "cured by a felon in the neck" may well be a 'seton', if we remember the long esses.* "I wrote *myopitius gunamen*" is unlikely, if we remember that Hooke wrote a little tract called "myopibus juvamen". The "homocercle tadpoles in seed" are no doubt "homuncule", a term freely used for spermatozoa. Many of the authors and titles of foreign books and other foreign words have gone wrong: "Sutta anglicance" should clearly be "gutta anglicana": the "forces monantes" of Pardies' book should be "mouvantes" (possibly written "movantes" by Hooke) and I suspect that "Brooks' *Mathematical Jewell*" should be Blagrave's, for there is a book of this title by the latter author, of which a second version appeared in 1658, but have never heard of one by Brooks. Chizzell, in the index, should be Chiswell, who published most of the "Philosophical Collections". Slips like these, and others not quoted, are probably inevitable in a work of this length, and a few of them give the reader pleasant exercise in tracking them down. A word of praise must be spoken for the admirable illustrations, especially those of buildings planned by Hooke.

The publication of this Diary in a worthy form is an event for the history of science, and we hope that the encouragement shown by the Royal Society to its learned librarian, Mr. H. W. Robinson, upon whom the labour of the work has chiefly fallen, will incite him to further researches into the early history of the Society.

E. N. DA C. ANDRADE.

* See Waller: "Life". Hooke noted that to each figure corresponded "their particular and distinct Sounds or Notes", "the 4 and 8 were octaves and the 6 and 4 were fifths", observations which Tyndall assigns to Chladni.

* Felon was, of course, used as a term for a sore, Cf. Herrick.

"Where others love and praise my verses, still
Thy long black thumbnail marks them out for ill,
A felon take it, or some whitflaw come
For to unslate or to untile that thumb".

Nevertheless, a deliberately produced felon is unlikely.

Characteristics of Violin Tone

THE scientific explanation of certain qualities of violin tone is still an unsolved problem of great complexity. When a copy of an old Italian violin has not the tone qualities of the original, it is very difficult to find in what details the unfaithfulness of the copy lies. No new scientific technique remains long unapplied to the problem, and the most recent results were included in Major C. E. S. Phillips' discourse bearing the above title delivered at the Royal Institution on May 31.

Some X-ray work done in America has indicated the importance of using, for the backs of violins, material in which the speed of sound is the same in all directions. A violin was shown in which the back was replaced with copper, which somewhat muted the tone, and another with a bakelite back in which the tone was almost unaffected by the change. A 'cello with a body made entirely of copper had a pleasant, woody tone.

A small microphone used as a searching device shows that the whole violin is thrown into vibration when the strings are bowed. Although it has been supposed that the chief function of the sound post is to convey vibrations from the front to the back plate, it has been found that if this post is removed and external pressure brought to bear upon the top plate above where the sound post

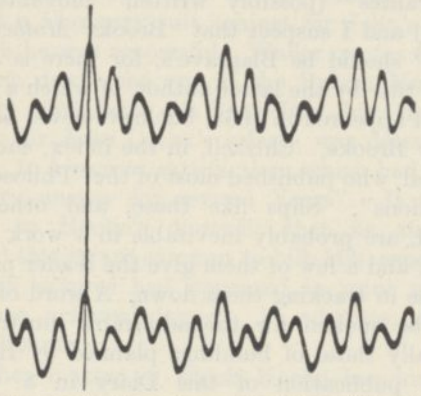

FIG. 1. Oscillograph records of tone of bowed *E* string of two Stradivari violins made in the same year, 1699. The lower record is from a 'long' pattern.

presses against it, the result is practically as good. Transillumination of two Stradivari violins shows that one with a higher arched front and back plate has been thinned more than one with a flatter front and back. The flatter top plate vibrates more easily under the pressure of the bridge than the one that is convex. The note heard on blowing across an 'f' hole of any Stradivari violin has a frequency of 256 vibrations per second.

Scientific examination of the varnish question may prevent much more of the haphazard mixing of all manner of gums and lacs dissolved in oil in attempts to make varnishes with magical qualities. Molecular size is an important factor

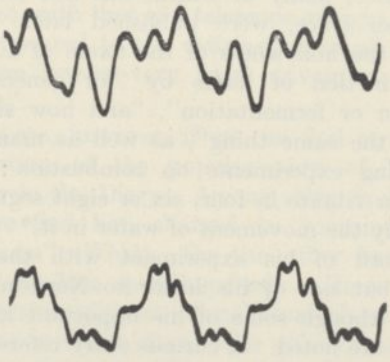

FIG. 2. Oscillograph records of tone of bowed *E* string without (above) and with mute (below).

affecting the penetration of the body of a varnish through the closely packed semi-permeable membranous cells of wood. If a varnish made by dissolving celluloid in acetone be applied to pine, the solvent will rapidly soak into the wood, leaving the celluloid behind. The early Cremona varnish as used by Stradivari or Guarneri entered the wood. Penetration would be helped by using a solvent of low surface tension on carefully dried wood, with thorough cleaning and special treatment of the surface to reduce the contact angle. The manner of application may be specially favourable under the atmospheric conditions of Italy. Terpenes obtained from the distillation of larch would have been known to Stradivari, and may have helped penetration when used to 'wet' the clean wood in a warm dry air before the application of a thin coat of an amber varnish.

An unvarnished violin soon loses some of its sonorous qualities, which are regained on varnishing. The tone of a newly varnished instrument is dull until the varnish dries thoroughly and hardens. The inside of a violin is seldom coated, and is free to absorb moisture from the air. Such absorption, which may amount to 30 gm., tends to stiffen the plate and may affect the tone. It is possible that the improvement of clearness of tone of violins with age may be explained by supposing that the small molecules of the body of the varnish slowly build themselves into larger groups, assuming a more closely-packed structure with increased rigidity. Examination by means of ultra-violet light serves to distinguish between

spirit and oil varnishes. Oil is present in all the 'Strads' so far examined by this means.

Since a violin is made up of seventy distinct parts, it would be surprising if the function of each were perfectly understood. For example, the tone of a violin without its back was found to preserve its main characteristic features. The result of the experimental removal of the sound post has been given already. The cuts and fretting of the bridge are not merely decorative. The rocking motion of the bridge in its own plane about the right foot as centre is important for fullness and quality of tone, which are but little affected when the effect of the rocking parallel to the strings is eliminated by reducing the feet to knife edges. Experiments in which the orientation of tiny steel rollers placed under the feet of the bridge was varied, were used to study this rocking motion of the bridge.

The latest attempt at the substitution of manufactured for grown fibres is in the use of artificial silk for horsehair of the violin bow. The viscose fibre retains the resin better than does the fine metal wire which is also in use for bows.

Microphone and cathode ray oscillograph have been used to obtain records of violin tone, and two examples are given in Figs. 1 and 2. During the discourse the famous 'Messie' Strad of 1760 was exhibited, and the intention of Mr. Arthur and Mr. Alfred Hill to present this unique instrument to the nation was announced. If, therefore, current scientific technique fails to solve all the problems of violin tone, future generations will have the problems handed to them in practical form.

Obituary

Prof. F. A. F. C. Went, For.Mem.R.S.

ON July 24 Prof. F. A. F. C. Went died at Wassenaar, near the Hague. He was born at Amsterdam on June 18, 1863, where he was also educated. He went to the University of Amsterdam in 1880, and worked under Hugo de Vries and also came in contact with Van 't Hoff and Van der Waals. After taking his doctorate in 1886 with a thesis entitled "De jongste toestanden der vacuolen" (The Youngest Stages of Vacuoles), Went spent some time in the laboratories of E. Strasburger (Bonn) and Ph. Van Tieghem (Paris), and then he made his first visit to Java as a fellow of the Buitenzorg Foundation.

Deeply impressed both by Nature in the tropics and also by the work and organisation of Melchior Treub, Went shortly after his return received a call to the Java sugar industry. For five years (1891–96) he was director of the West Java Sugar Experimental Station at Kagok. In this capacity, working with the late Dr. J. H. Wakker, he did very important work on the diseases of sugar cane. The results of their studies were published in their well-known book "De ziekten van het Suikerriet op Java" (The Diseases of Sugar Cane in Java, 1898). He also studied photosynthesis in the sugar cane and the formation of sucrose and other carbohydrates. Went, therefore, may be regarded as one of the pioneers of experimental stations in the Dutch East Indies, which later achieved a great reputation. His experience in Java also considerably influenced his later work. He inspired his students by his conviction that development of the Dutch Colonies should be based on scientific knowledge and a thorough investigation of the natural resources of the tropics.

Went succeeded Prof. N. W. P. Rauwenhoff in 1896 as professor of botany in the State University of Utrecht. In the first decade, he still taught the entire field of botany, but later special chairs were provided for taxonomy and plant geography, phytopathology and genetics. At first there were only a few students in biology, but gradually he attracted a large number of students. This involved much heavy teaching for a devoted and conscientious teacher such as he was, and it left him little time for his own researches. His investigations were restricted to some work on enzymes and the curious family *Podostemonaceae*. He founded, however, a school of plant physiology, which is now well-known throughout the world.

In the beginning, Went directed his attention mainly to microbiological and mycological problems. Later on, however, systematic research was directed along two lines—one of them inspired by F. F. Blackman's theory of limiting factors and the temperature-reaction velocity ratio in vital phenomena, and the other on the nature of plant movements, where Pfeffer's conceptions were fundamentally attacked. A number of papers were issued in course of time on the influence of the temperature and limiting factors on the rate of germination, growth, respiration, carbon assimilation, protoplasmic streaming and also on the perception and reaction to 'stimuli' by plants.

The name of Went, however, is most closely connected with the problem of plant movements and especially with that of tropisms and growth. The nature of the problem was formulated in Blaauw's thesis (1909). The dependence of the phototropic response on the *quantity* of light (Blaauw), analogous relations in geotropism (Mrs. Rutten-Pekelharing) and finally the correlation between quantity of light and the phototropic curvatures (Arisz, 1914), suggested an exact quantitative analysis of tropisms. These investigations received a fresh impetus from Blaauw's

theory that phototropism represents a special case of photo-growth reactions (1913). The succeeding period was devoted to exact measurements of growth, especially in *Avena* coleoptiles, as influenced by illumination and gravity (1919–26). Although a large amount of data was collected, it did not help much in visualising an internal mechanism of growth and tropisms.

The whole aspect and technique of the problem were changed, however, by the isolation of the growth substance (auxin) by Went's elder son (F. W. Went, 1927), and by his successful attempts to elaborate a physiological method of quantitative analysis of this growth substance. A large number of papers was published in the succeeding years on the relation of auxin to phototropism and geotropism, its distribution and transport, its formation in the root and its influence on the plasticity of the cell wall. Further, the chemical nature of auxin was revealed by Kögl and his collaborators (Haagen Smit, Miss Erxleben), also at Utrecht in the University Chemical Laboratory.

It was not in biology alone that Went was a man of outstanding importance. A member of the Royal Academy of Sciences, Amsterdam, since 1898, he was elected president in 1921. In this capacity he succeeded Lorentz, who strove after the War to bring together again scientific men of different nations. Went followed the example of his great predecessor with the same idealism, and finally succeeded in getting international scientific relations re-established to a large extent. Went thus played an important part in international scientific congresses.

Went was at the height of his scientific importance and international fame when he died. He retired from the chair of botany in Utrecht in July, 1934, and took an active part, until his death, in the preparations for the International Botanical Congress, of which he was president-elect. On several occasions during his life, for the last time on the occasion of his seventieth birthday, appreciation of his work was shown: in 1930 he was given the honorary degree of doctor of science of the University of Cambridge; in 1931 he was elected a foreign member of the Linnean Society of London, and in 1933 of the Royal Society. In Went we have lost a man of great qualities: his death will be deplored far beyond the boundaries of his own country.

Miss Nina F. Layard

WE regret to record the death of Nina Frances Layard, archæologist, which took place after an operation at the age of eighty-two years. She was a daughter of the Rev. C. C. Layard, rector of Combe Hay, Bath, and a niece of Sir Austen Layard, the excavator of Nineveh.

Miss Layard was not only the first woman to be elected a fellow of the Society of Antiquaries, but she was also one of the first of those women who took up seriously and earned distinction in the scientific study of archæology in the field. She was for long one of the most prominent of the students of East Anglian archæology, especially in the neighbourhood of Ipswich, holding that position almost as much by her success in stimulating the enthusiasm of others as by her own researches. These, however, especially in her studies of the industries of the palæolithic period, brought her no small reputation outside local circles, and on more than one occasion her work received the public commendation of Sir John Evans.

In addition to her finds of the palæolithic period, of which she submitted accounts to the British Association or published in the *Journal of the Royal Anthropological Institute* and other archæological publications, Miss Layard made an interesting and unusual discovery of what she held to be a prehistoric communal kitchen and a neolithic mining area, and superintended the excavation of an Anglo-Saxon cemetery, the relics from which are to be found in the Ipswich Museum. She also did much work on the investigation of remains of the Roman and medieval periods. In addition to her contributions to the *Journal of the Royal Anthropological Institute*, the *Proceedings of the Prehistoric Society of East Anglia* and other publications, Miss Layard was the author of a history of Ipswich School, of "Seventeen Suffolk Martyrs", and of two volumes of verse.

Dr. C. F. Marbut

SOIL investigators all over the world will learn with deep regret of the death of Dr. C. F. Marbut at Harbin. Early in August, he had attended the International Congress of Soil Science at Oxford, and had presided over the Section of Soil Classification and Mapping. He did not accompany the members on their excursion around Great Britain, but left instead for China, where he was to spend a year studying the soils and advising generally in regard to their mapping. Afterwards he was to go to Rome to work at the International Institute of Agriculture on the preparation of a map of the world's soils. But he was struck down by pneumonia on his voyage and died at Harbin.

Marbut began his career as a teacher in Nebraska, then became professor of geology in the Missouri University. He joined the Bureau of Chemistry and Soils of the United States Department of Agriculture at Washington and by 1912 he was appointed chief of the Division of Soil Survey: it was here that his best work was done.

Up to the time that Marbut took charge, the American soil surveys had been mainly based on the mechanical analyses of the surface soils. Marbut was essentially a field man, and discarded this analytical basis for a study of the characteristics of the soil as revealed by direct examination of the profile. This was, of course, accompanied by chemical and mechanical examinations, but the perspective was different: the interest lay in the morphology of the soil rather than in the units out of which it was made. This was in accordance with the developments of the subject being made in Russia by Glinka and others, the importance of which he recognised by translating into English the German edition

of Glinka's classical work "The Great Soil Groups of the World".

A little later Marbut had the opportunity of testing the new ideas by constructing a soil map of Africa. The actual task of making vegetation observations and collecting soil samples was carried out by Dr. Schantz in a rapid journey round the continent: the samples were very few, yet so firm was Marbut's faith in the new generalisations that he did not hesitate to construct the map, which was published in 1923 in "The Vegetation and Soils of Africa" and still serves a useful purpose.

In 1927 Marbut was in charge of the party of soil workers who travelled round the United States after the First International Soil Congress at Washington, and won great respect from his colleagues for his wide knowledge of American soils. He also visited Russia in 1930 for the second Congress, and studied the great soil groups of that country.

Marbut's great work was the organisation of the United States' soil survey, the first to be completed on modern lines. To the credit of the Department, his services were retained after he had passed the retiring age so that he might remain in charge to the end. The map was completed a few months ago.

Marbut was not merely a shrewd observer, but also a man of great personal charm, and had a singular power of capturing the affections of his colleagues. Tall, spare of build, alert and very active, with finely moulded features, he was a striking figure in the various scientific conferences he attended, and he never failed to attract and hold the attention of his audiences. His work will long survive to influence the activities of his successors.

News and Views

Norfolk Woodhenge

As stated in the preliminary announcement of the arrangements for the Norwich meeting of the British Association this year, the Norwich Research Committee has undertaken the excavation of the remarkable example of the type of monument, known to archæologists as 'Woodhenge', in the parish of Arminghall in the south-eastern outskirts of the city. The generic term 'Woodhenge' was first used by Mrs. M. E. Cunnington to describe the circle near Amesbury with wooden uprights in place of stone, which she excavated in 1926 and 1928. The Norfolk Woodhenge, which was discovered from the air in 1929, was known from air photographs to be a striking example of the type, consisting of two concentric rings, in the inner and broader of which was a gap giving access to the central space, around which were nine dark patches, presumed to be the post holes of the uprights of the circle. The completion of the work of excavation, which has been carried out under the direction of Mr. J. G. D. Clark, will enable members of the British Association, who have not previously had the opportunity, to form an idea at first hand of this striking development in the history of prehistoric monuments. In a preliminary report of the results of the excavation communicated to *The Times* of September 3, it is stated that excavation has confirmed the surface indications of a diameter for the outer circle of 262 ft. and for the central area within the smaller circle of 87 ft. The outer circle was found to be a ditch 12 ft. wide and 4 ft. 8 in. deep, the inner circle a ditch 28 ft. wide and 7 ft. 8 in. deep. As anticipated, the dark patches of the photographs are post-holes with ramps. The posts were found to consist of oak trunks some 3 ft. in diameter, set to a depth of 7 ft., after charring for preservation. It was evident that they had been dragged into position before the construction of the great inner ditch. No trace of burial was found in the enclosure, though there is evidence of burials nearby. Pottery of the Beaker type dates the structure at 1800–1500 B.C.

Cotswold Long Barrow

EXCAVATION of a long barrow near Notgrove in the Cotswolds has revealed an interior structure of a remarkable and, in certain respects, unusual character. The barrow is situated on a side road off the Cheltenham – Stow-on-the-Wold road, near the Notgrove G.W.R. station. It is being excavated by Mrs. E. M. Clifford with the assistance of a party of Cambridge students. The chamber, according to a report of the excavation which appears in *The Times* of September 2, is of the double cruciform type, which is rare in England, only about half a dozen examples being known. It has a horned entrance in dry stone walling —that is, the sides are prolonged to enclose partially a space at the entrance—and on the north side is a revetment wall in an excellent state of preservation. The south side, and also part of the north side, have been found to be enclosed by a rampart built of stone. The extent of this structure is being traced by further excavation. The most unusual feature, however, is a 'rotunda', a circular structure of large stones surrounded by a dry wall at the west end of the chambers—a form of structure of the greatest rarity, of which the purpose is unknown. These unusual features, which tempt comparisons that would be hazardous without plans and photographs, press for early publication of full details.

Celsius, Linnæus and the Centigrade Thermometer

THE history of the centigrade thermometer is discussed by Dr. N. V. Nordenmark (*Svenska Linné-Sällskap. Årsskrift*, **18**, 124; 1935). He points out that the thermometer of Anders Celsius used the scale of de l'Isle, the freezing point being at 100°,

the boiling point at 0°. Celsius's diaries are preserved at the Observatory of Uppsala, and show the development of his experiments with thermometers. The centigrade scale with freezing point at zero and boiling point at 100° appeared in 1747 on a thermometer bearing the name of its maker, the optician Ekström. It was constructed by Linnæus. In 1745, Linnæus had demonstrated to the Senate of the University his new thermometer, which in a letter to Sauvage he describes: "Ego primus fui, qui parare constitui thermometra nostra, ubi functum congelationis 0 et gradus coquentis aquae 100". It is strange that this centigrade thermometer of Linnæus, soon in universal use, and known at first as "the Swedish thermometer", should ever have become associated with the name of Celsius. But perhaps it was a casual association suggested by the C. for centigrade, together with the fact that Celsius was known to have experimented with thermometers.

Public Relations Work

In a pamphlet entitled "Whither Public Relations Work?" Dr. William A. Hamor, of the Mellon Institute of Industrial Research, Pittsburgh, emphasises the need of accumulations of facts about the social structure upon which public relations work rests, in order that the principles evolved will not crumble through faulty foundation work and therefore discourage this highly important managemental aid of the future. The development of such a science as sociology, especially for application in the province of public relations, requires investigators who are willing to achieve a thoroughly disinterested point of view toward the whole life of society for the purposes of their work. It is to be hoped that the day will soon come when an organisation may be established in which far-sighted social science research of a type corresponding in importance to physical science investigation may be carried forward extensively with the co-operation of management. When sociology has reached that plane of development, much of the guess-work that is now necessary—much of that costly element of chance—will gradually be eliminated from management as a whole as well as from the direction of public relations activities.

Re-awakening of Geysir at Hawkdale, Iceland

After a sleep of nineteen years, Geysir, the hot spring in Iceland from the name of which the term 'geyser' was derived, has been awakened to renewed activity by three research workers, Trausti Einarsson, Jón Jónsson of Lang (Bath) and Gudmundur Gislason. The report of the revival of Geysir appeared in the *Morgunblad* of July 30, announcing the fact that magnificent jets were thrown up 40–50 metres high. Later, however, comes another account stating that Geysir spouted fifteen times on that day, that as of old the highest jets were delivered in the morning and about eleven o'clock at night. Eruptions are very sudden, preceded by bursts of steam, and, as it is dangerous to be near, sketches of these are more or less guess-work. Following the steam, water 'cascades' all around the crater, and the accompanying steam renders photographs or measurements useless. None of the jets has actually been measured. It was Dr. T. Einarsson who conceived the idea of awakening Geysir. He realised that the 'saucer' of the geysir was the most important factor concerned, providing a large surface of water from which heat was radiated as fast as it was supplied from below, thus preventing the accumulation of heat in the pipe below necessary to produce the outburst. Consequently a gap was made in the lip of the saucer to prevent the water spreading out. The experiment was justified, and Geysir continues its old activity. The road from Parliament Fields to Geysir, 118 kilometres in length, is to be improved, so that motor-cars may be able to undertake the journey.

Speed and Engineering

In his presidential address to the Sheffield section of the Junior Institution of Engineers, Mr. Allan J. Grant gave an interesting account of the development of speed in engineering. Up to the advent of railways, about 1830, a speed of about 30 miles an hour was the maximum. By the use of steam trains a speed of 100 miles an hour was made safe. In 1933 the motor-car *Bluebird* did 272 miles per hour. The motor-boat *Miss Britain III* recently attained a speed of 111 miles per hour. To attain this speed, 1,375 horse-power had to be transmitted through a shaft only $1\frac{1}{8}$ in. in diameter. At the outbreak of the War, the most advanced aeroplane engines developed about 100 brake horse-power, and weighed about 4 lb. per horse-power, and the average speed varied from 60 miles to 90 miles per hour. The modern 'sprint' engines run at more than 3,000 rev. per min. and weigh only $\frac{3}{8}$ lb. per b.h.p. The recent flight of Charles Ulm to Australia in 6 days 18 hours proves the capabilities of small aircraft. Jules Verne's speed in "Round the World in 80 Days" is no longer fantastic. In fact, velocities would only have to be slightly more than doubled to become 1,000 miles an hour. At this speed, it would be possible for an airman starting at the equator at sunrise and flying west to arrive in 24 hours at sunrise and have continuous sunrise all the way round. If he flew in the latitude of London he would only have to fly at 620 m.p.h. to obtain the same effect. At the present time, it would not be possible for him to carry sufficient fuel for the purpose.

Railway Electrification

In an address broadcast from Radio Paris on May 16 and published in *Le Genie Civil* for June 22, Prof. H. Parodi says that the problem of railway electrification has come to the forefront in all the countries of the world. Between 1927 and 1933 more than 6,800 miles were electrified throughout the world, more than 3,000 being in Europe. The electrification of the Paris–Orleans, Orleans–Tours and Vierzon–Brive railway is an excellent example of main-line electrification, as all the services, signals, illumination, etc., are carried out electrically. Every discovery in the realm of power-production accelerates

the spread of electrification. In electric power stations, lignite, oil, coke-oven and blast furnace gas are used as well as coal and water-power. In France, electrification is from certain points of view imperative as France has to purchase coal and oil from abroad whilst it possesses great internal water-power resources. The consumption of fuel by French railways amounts to 42 million tons, of which 30 millions has to be imported. At the present time, France utilises 8,000 million kilowatt hours of energy generated by water-power or about 20 per cent of its maximum potential water-power resources. In Italy the policy of exploiting the natural wealth of the country has been systematically pursued. More than 1,200 miles of Italian railways are electrified and 3,000 miles are in progress. Similar, but less far-reaching programmes, have been prepared and are being carried out in Switzerland, Sweden and Bavaria. The electrical machinery employed is almost entirely automatic and entails operation, maintenance and repair charges considerably lower than steam locomotives.

Centenary of the Great Western Railway

ON August 31, 1835, after an unduly protracted and very expensive Parliamentary struggle, the Royal Assent was given to the Bill authorising the construction of the railway between Bristol and London, to which two years earlier the name of the Great Western Railway had been given. Notable among British railways for many reasons, the Great Western Railway as it is to-day has a fine record of achievement, and last week the centenary of the passing of the Bill which brought it into being was commemorated in various ways. On the evening of August 30, the B.B.C. included in its programme an account of the railway and its many activities, while on August 31, *The Times* issued a Great Western Railway Centenary Number as a special supplement, of 28 full-sized pages. The forty articles in this supplement include not only sketches of the history of the line, a biography of Brunel and a review of locomotives and rolling stock, but also others dealing with co-operation in transport, speed, safety and comfort in travel and the organisation of a great railway. As is well known, when planning the Great Western line, Brunel adopted the 7 ft. or broad gauge, as compared with the 4 ft. 8½ in. or narrow gauge, as used by the Stephensons and others, and it was this that gave rise to the famous "battle of the gauges". When that battle was at its height, a Royal Commission reported that the broad gauge was superior for speed and steady running, and for the greater capacity of the engines, but as there were then 1900 miles of narrow gauge line in existence as compared with only 274 miles of broad gauge, the verdict was given in favour of the former. This and other matters are all dealt with in an interesting manner in *The Times* supplement, which will remain of permanent value to all students of transport.

International Commission of Agriculture

THE International Commission of Agriculture (International Union of Agricultural Associations) recently held its general assembly at Brussels and Gembloux (Belgium) under the chairmanship of the Marquis de Vogüé (France), president. Among the problems discussed were the organisation of agricultural production under planned economy, edible fats, limitation of pig breeding and fattening (with special reference to attempts made in Denmark and Holland). The assembly devoted special attention to the present condition of agriculture. It came to the conclusion that in spite of the fact that useful measures have been taken in several countries since 1932, conditions of agriculture have grown worse. The Commission is convinced that the two main problems to be solved in order to overcome the agricultural crisis are the wheat problem and the edible fats problem : on one hand the London Wheat Agreement (1933) should be prolonged and improved ; on the other, the older civilised countries should take measures or improve the existing measures in order to prevent consumption of tropical fats and whale oil, which handicaps the normal production and consumption of butter and lard. The Commission will hold its next meeting in 1936, in Oslo. It has been decided that the twelfth International Congress of Agriculture shall take place at The Hague in 1937.

Religious Motives in Medical Biology

IN the April issue of the *Bulletin of the Institute of the History of Medicine* Dr. Walter Pagel deals successively with the doctrines of Paracelsus, Hieronymus Hirnhaim, the alchemists of the seventeenth century and their adversaries, Marcus Marci, Robert Fludd, Mersenne and Robert Boyle, to illustrate the presence of religious motives in the medical biology of the seventeenth century. Dr. Pagel first shows that to Paracelsus and his religious view is due the modern conception of disease in the establishment of three new doctrines, namely : (1) the external cause is the essence of disease ; (2) the organ involved and the anatomical changes decide the nature of the disease ; and (3) disease consists of a complicated disturbance of organ metabolism which secondarily reflects upon the whole system. Hirnhaim, who regarded sympathy and antipathy as fundamental phenomena, adopted a pious scepticism which was the philosophical basis of idealistic biology and pathology. On the other hand, the pious conceptions of Nature and magic in the writings of the seventeenth century alchemists led to their embarking on a course of independent empirical research, their point of view being partly due to a positive appreciation of magic as a systematic imitation of Nature by means of arbitrary variation of the conditions of natural processes. After discussing the speculative embryology of Marcus Marci and his application of the physics of light to the explanation of life according to the principles of optics, Dr. Pagel gives an account of the "Medicina Catholica" of Robert Fludd, and shows at once the similarity of his conceptions with, and the fundamental differences from, the Romantic natural philosophy during the early nineteenth century. In conclusion, consideration is given to Robert Boyle and his theory of corpuscles as a scientific explanation of the mystery of specificity, forms and final causes.

Polish Science in the Middle Ages

THE principal contribution to vol. 20 (1935) of the annual publication, *Nauka Polska* (Polish Science), is a lengthy memoir, complete with index, by Prof. Stanisław Kot entitled "Anglo-Polonica". In it the author traces the contact between Polish men of culture and their fellow workers in Great Britain. It appears that from the Middle Ages onwards quite a number of Polish theologians and some men of science and arts visited London, Oxford and Cambridge, and some made protracted stays. It was natural that educated Protestant Poles should look to England for guidance in the troublous Middle Ages for, like Britain, Poland was an asylum for the persecuted. Thus Komenský (Comenius) and other Bohemian brethren settled at Leszno. These settlers are included in the article as Polish men of science. Polish alchemists, including the famous Sedziwój (Sendivogius), met their English confrères and exchanged books and possibly recipes with one another, and also engaged in polemics. The section on alchemy is probably the most purely scientific part of Prof. Kot's article. No fresh evidence is brought to light, however, to show that the Polish alchemists were any less of charlatans than those of other countries. One point does, however, emerge, and it is that the Polish language was very widely used in Medieval Europe along the Baltic coast and in other places where it has since been displaced by German. No less than eleven important English works on science are among the twenty books reviewed in this issue of *Nauka Polska*, which can almost be considered as an Anglo-Polish number.

International Federation of Eugenic Organizations

THE report of the eleventh assembly of the International Federation of Eugenic Organizations, held in Zurich, in July 1934, under the presidency of Prof. E. Rüdin, has just been issued as a pamphlet of eighty-four pages and contains a full account of the proceedings in English and German. Prof. R. J. A. Berry opened a discussion on the diagnosis and grading of oligophrenia, to which Dr. H. O. Wildenskov of Denmark, Dr. G. Rudolf, Dr. Lothar Loeffler (Kiel) and others made contributions. Dr. Mjöen (Oslo) demonstrated his methods of testing musical ability, Prof. C. Spearman discussed the psychological basis of personality and Dr. M. Steggerda (Cold Spring Harbor) gave an account of his methods of racial psychometry in Yucatan. Dr. F. von Verschuer (Berlin) described his methods of distinguishing monozygotic from dizygotic twins, with some new facts on tuberculosis in twins. Other contributions were made on the inheritance of various ocular abnormalities, by Dr. P. J. Waardenburg, and several pedigrees of chorea were explained by Dr. G. P. Frets. Dr. Ruttke and Dr. Astel gave an account of the working of the sterilisation law in Germany. Reports of progress in eugenics were received from representatives of Norway, Denmark, Holland, Poland, Austria, Czechoslovakia and the Dutch East Indies. The proposals of the Human Heredity Committee to establish in London a Central Bureau for Human Genetics, with affiliated bureaux in various countries, are given at length, the funds required for this purpose being about £2,000 annually for four or five years. Copies of this report can be obtained, price 3*s*. 6*d*., from the Hon. Secretary, Mrs. C. B. S. Hodson, 443 Fulham Road, London, S.W.10.

American Collecting Expeditions

DURING 1935 the Academy of Natural Sciences of Philadelphia, founded in 1812, the oldest institution of its kind in America, has sponsored twenty-four expeditions for collecting and field work in thirteen foreign countries and various parts of the United States. The most thrilling of these are perhaps the African expedition headed by George Vanderbilt, which has secured gorillas and okapis for new habitat groups and large collections of other mammals, birds, reptiles, fishes and insects; Brooke Dolan's expedition to western China and eastern Tibet; R. M. de Schauensee's collection of birds, fishes and orchids from the central highlands of Guatemala, and aquatic life from Lake Atitlan, 5,000 feet above sea-level. In Siam this collector-naturalist, after his third expedition there, organised a permanent field staff with headquarters in Bangkok which continues to gather much interesting material; and in Siberia Dr. E. B. Howard is searching for fossil remains of man which would link up with the earliest human arrivals on the American Continent. In America, expeditions are at work on the high plateau of Central Mexico, in the mountains of Panama, Cuba and the West Indies, Alaska, Wyoming, Bolivia, New Mexico and Louisiana.

The Strangeways Laboratory

IN their report for 1934, the trustees direct attention to the amount of work carried out at the Strangeways Research Laboratory, Cambridge, at very small expense, and appeal for further support. The increase in subscriptions and endowment has not kept pace with the increase in the work and the growing demand for funds to finance new work. The appeal is not for an extravagant scheme of expansion, since one of the advantages of the laboratory is that it is housed in a small building where the staff can work as a team with constant opportunities for discussion and co-operation, but for a sufficient income to enable the director, Dr. Honor Fell, and her colleagues to carry out their work this year with the apparatus and materials they need, and to plan next year's work with confidence that the funds required will be available. The trustees cannot count as a permanent source of income the grants from the Royal Society and Medical Research Council which have been provided for several years. As regards research work, steady progress has been made in fields which lie within the overlapping borders of general biology and medicine. The cultivation of living embryonic tissues in artificial media helps to reveal the factors which control normal growth, both of the individual cells and of the different tissues in relation to each

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Form, Drift, and Rhythm of the Continents*

By Prof. W. W. Watts, F.R.S.

President of the British Association

IT is now sixty-seven years since the British Association enjoyed the hospitality of the city of Norwich, a privilege which is being renewed under the most happy auspices.

At that meeting we find the scientific community was particularly interested in underground temperatures and tidal phenomena, in the application of the spectroscope to celestial objects, and in the discovery of the oldest Cambrian fossils and the earliest fossil mammals then known. Many papers were read on local natural history, including those on Norfolk farming and the drainage of the county and of the Fens.

In his address at the meeting the president, Sir Joseph D. Hooker, made special reference to the work of Charles Darwin: not to the "Origin of Species" which had been acrimoniously discussed by the Association on previous occasions, and notably at Oxford in 1860, but to some of the work that followed.

It should be remembered that Hooker was one of the three scientific men, representing botany, zoology and geology, whom Darwin had selected as judges with whose opinion on the soundness of his theory of the origin of species he would be content. The others were Huxley and Lyell; and of the three Lyell was the hardest to convince, chiefly because the record of life in the past then furnished by the rocks was manifestly so incomplete and unsatisfactory that its evidence was insufficient to warrant a definite verdict.

Uniformitarianism

Lyell had set out to "treat of such features of the economy of existing nature, animate and inanimate, as are illustrative of geology", and to make "an investigation of the permanent effects of causes now in action which may serve as records to after ages of the present condition of the earth and its inhabitants". By laborious study of the work of others, and by his own extensive travel and research, he had been able to enunciate, for the inorganic world, the principle of uniformitarianism, which in its original form we owe to Hutton. This principle involved that the history revealed by the rocks should be read as the effect of the slow but continuous operation of causes, most of them small, such as could be seen in action in some part or other of the world to-day. This was set in opposition to the opinion of the older geologists, who had postulated a succession of catastrophes which, by flood, fire and convulsion, had periodically wrecked the world and destroyed its inhabitants; each catastrophe necessitating a new creation to provide the succession of life on the earth as it then was known.

But in the organic world, Lyell, like Hutton, had failed to detect any analogous principle, and, as he rejected all the theories of transmutation of species then in vogue, he had to accept their absolute fixity; and to suppose that, as species became extinct one after another, replacement by special creations followed. Yet the reading to-day of the chapters devoted to this branch in the earlier editions of Lyell's great work produces the haunting feeling that a better explanation had only just eluded him. It was the story revealed in Lyell's work, Darwin tells us, the new conception that the earth had been in existence for vast æons of time, the proof that it had been continuously peopled by animals and plants, and that these had steadfastly advanced and improved throughout that time, which showed him the necessity for an explanation of the progression of life, and gave him the first hints of his theory.

* Presidential Address delivered at Norwich on September 4, 1935.

When he had enunciated this, he was enabled to repay his master with the principle of organic evolution, which brought changes in the animate world into harmony with those of the inanimate.

His "Antiquity of Man" shows that by 1863 Lyell had become a convert, and he afterwards rewrote much of the second volume of his "Principles" accepting the new point of view. This change earned from Hooker a testimonial in the 1868 address which, if not unique, must certainly be one of the most magnificent ever awarded to a scientific work :

"I know no brighter example of heroism, of its kind, than this, of an author thus abandoning, late in life, a theory which he had regarded as one of the foundation stones of a work that had given him the highest position attainable amongst contemporary scientific writers. Well may he be proud of a superstructure, raised on the foundation of an insecure doctrine, when he finds that he can underpin it and substitute a new foundation : and, after all is finished, survey his edifice, not only more secure, but more harmonious in proportions than before."

Although infinitely richer than when Darwin wrote, the geological record still is, and must from its very nature remain, imperfect. Every major group of animal life but the vertebrates is represented in the Cambrian fauna, and the scant relics that have been recovered from earlier rocks give very little idea of what had gone before, and no evidence whatever as to the beginnings of life. But, from Cambrian time onward the chain of life is continuous and unbroken. Type after type has arisen, flourished, and attained dominion. Some of them have met extinction in the heyday of their development ; others have slowly dwindled away ; others, again, have not finished their downhill journey, or are still advancing to their climax.

Study of the succession of rocks and the organisms contained in them, in every case in which evidence is sufficiently abundant and particularly among the vertebrates and in the later stages of geological history, has now revealed that the great majority of species show close affinities with those which preceded and with those which followed them ; that, indeed, they have been derived from their predecessors and gave origin to their successors. We may now fairly claim that palæontology has lifted the theory of evolution of organisms from the limbo of hypothesis into a fact completely demonstrated by the integral chain of life which links the animals and plants of to-day with the earliest of their forerunners of the most remote past.

Further, the rocks themselves yield proof of the geographical changes undergone by the earth during its physical history ; and indicate with perfect clearness that these changes have been so closely attendant on variation in life, and the incoming of new species, that it is impossible to deny a relation of cause and effect.

Indeed, when we realise the delicate adjustment of all life to the four elements of the ancients which environ it, air, water, earth and fire ; to their composition, interrelationships and circulation ; it is perhaps one of the most remarkable facts established by geology that, in spite of the physical changes which we know to have occurred, the chain of life has never snapped in all the hundreds of millions of years through which its history has been traced.

Rhythm of Sea and Land

The physical changes with which Lyell and his successors were most closely concerned were, first, the formation of stratified rocks on horizontal sea-floors, situated in what is now often the interior of continents, far removed from the oceans of the present day, and thus indicating important and repeated changes in the position of land and water ; and, secondly, the deformation of these flat deposits until they were rucked and ridged to build the mountain ranges.

Before and since Lyell's time, geologists have devoted themselves to working out the exact and detailed succession of these stratified rocks, translating their sequence into history and their characters into terms of geography ; the succession of physical conditions prevailing at the time of their formation. Further, although animals and plants migrate from place to place, the time occupied by the migrations of suitable forms is so negligible when compared with the length of the chapters of geological history that their fossil remains have proved to be the best means for correlating strata over broad stretches of the earth's surface. This correlation has converted the fragments of local history thus revealed into at least the outlines of the geological story of the world.

It was not until 1885, however, that the accumulation of data of this type was sufficient to enable the great geologist, Suess, an Austrian, but born in Great Britain, to assemble and correlate them, and to deduce from them further principles which have been the mainstay and inspiration of his successors. We owe to Hertha Sollas and her father the rendering of this great work, "The Face of the Earth", into English ; and to Emmanuel de Margerie and his colleagues a French translation enriched with a magnificent series of maps and sections such as could only have been brought together by one with the most remarkable bibliographic knowledge : a veritable recension of the original.

The nature and associations and the distribution in time and space of modern changes in the relative levels of land and sea, as detected at sea-margins and by altitude survey, and of older changes betrayed by such evidence as submerged forests and raised beaches, had convinced geologists that the unstable element was not the fickle and mobile sea, but the solid if elastic earth-crust. They naturally applied the same explanation to those encroachments of the sea in the past which had resulted in the formation of our stratified rocks. But while some investigators were content with one form of movement—that due to lateral pressure—to explain both the formation of mountains and the rise and fall of the land, others called in a different cause for the latter. Without entering into a discussion of causes, it may be well for us to distinguish the orogenic or mountain-forming from the epeirogenic or continental movement.

The evidence collected by Suess proved that these last great land and sea changes had occurred simultaneously over whole continents or even wider regions. Such great submergences as those to which the Cambrian Rocks, the Oxford Clay, and the Chalk are due were of this character; while, in between, there came times of broad expansions of continental land and regressions of the sea. These changes were in his view on far too grand a scale to be compared with, or explained by, the trivial upheavals and depressions of land margins of the present day, which he showed could mostly be correlated with volcanoes or earthquakes, or with such incidents as the imposition or relief of ice-sheets on an elastic crust in connexion with glacial conditions.

It became necessary for him to replace or supplement oscillations of the earth-crust by a world-wide periodic ebb and flow of the oceans, to and from the continents; positive movements of transgression carrying the sea and its deposits over the lands, drowning them and their features under tens or hundreds of fathoms of water; and negative movements or regressions when the oceans retreated to the deeps, leaving the continents bare or encrusted with recently formed sediments.

Although the facts cried out for this generalisation, Suess was at a loss to supply any mechanism competent to produce the wonderful rhythm. The problem was difficult because a liquid must maintain a horizontal, that is, an equipotential, surface. It was manifestly impossible to withdraw from the earth, and later to replace upon it, the vast quantity of water that would be required; and, though a shifted water-level, or even a varied water-surface relative to the continents, might be caused by polar ice-caps, by redistribution of the continents carrying their local effects on gravitation, by variations in the rate of the earth's rotation, or other far-reaching causes, none of these would supply an explanation that fitted all the facts. Regressions of the sea could be to some extent explained if Suess's main postulate, that the great ocean basins had been slowly sinking throughout geological time, were granted. But this explanation only rendered more impotent the raising of ocean levels by deposits of sediment, and this was almost the only valid cause for transgressions that he had been able to suggest.

Further, it is not possible to ignore the definite relationship that exists between the pulsation of the oceans and the raising of mountains by lateral or tangential stress. Periods of positive movement or advance of the seas were times of comparative tranquillity, when tangential pressure was in abeyance. Periods of negative movement and retreat were invariably marked by the operation of great stresses by which the earth's face was ridged and wrinkled in the throes of mountain-birth.

Mountain Ranges

The theory that continuous cooling and shrinkage of the interior of the earth afforded an explanation of mountain ranges and other rugosities on its surface was a legacy from the nebular hypothesis. In spite of the homely simile of a shrivelling apple, this explanation has never received a very enthusiastic welcome from geologists, though, in default of other resources, they had to make use of it. As knowledge has grown, the difficulties have become insurmountable to them.

First, there is its inadequacy to explain the vast amount of lateral movement required to account for the greater mountain ranges; their rocks, originally spread over a wider area, having been folded and crushed into a narrower width. The shortening of the earth-crust thus effected has been estimated in the case of the Rocky Mountains at 29 miles, of the Himalayas at 62, the Alps at 76, and the Appalachians at the large figure of 200 miles.

Then there is the periodicity of mountain growth. The great epochs of mountain building, such as the Caledonian, to which the chief Scottish and Welsh mountains are due, the Hercynian, responsible for the Pennine and South Wales, and the Alpine, which gave us "the wooded, dim, blue goodness of the Weald", were associated with vast continental development; and each was separated from the next by a period of relative inactivity lasting dozens of millions of years.

Further, there is the fact that the vigour of mountain building, of volcanoes, and of other manifestations of unrest, has shown no sign of

senility or lack of energy. The geologically recent Alpine-Himalayan range is as great, as lofty, and as complicated in structure as were any of its precursors. The active volcanoes of Kilauea, Krakatao, or St. Pierre, and those recently extinct in northern Ireland and the Scottish Isles, were as violent and efficient as any of those of the Palæozoic era. The earth is 'a lady of a certain age', but she has contrived to preserve her youth and energy as well as her beauty.

Age of the Earth

It was when Lord Kelvin's dictum struck from geology its grandest conception, time, that it became vital to re-examine the position. He had demonstrated that, if the earth had been continuously cooling down at its present rate, its surface must have been too hot for the existence of life upon it a limited number of million years ago. The concept of geological time, indicated by Hutton in his famous saying that in this inquiry "we find no vestige of a beginning—no prospect of an end", had been confirmed by data accumulated through the painstaking researches of a host of competent and devoted observers all over the world. To them, familiar with the tremendous changes, organic and inorganic, that the earth had passed through since Cambrian time, it was wholly impossible to compress the life-story of the earth, or the history of life upon it, into a paltry twenty or thirty million years. The slow growth and slow decay of mountain range after mountain range, each built out of, and in some cases upon, the ruins of its predecessor; the chain of slowly evolving organisms, vast in numbers and infinite in variety; told plainly of long æons of time. The duration of these æons can be dimly realised when it is recalled that, within a small fraction of the latest of them, man, with the most primitive of implements and the most rudimentary culture, has succeeded in penetrating to the uttermost corners of the world, and developed his innumerable languages and civilisations.

Huxley took up the challenge in his address to the Geological Society in 1869, and asked the pertinent question, "but is the earth nothing but a cooling mass 'like a hot water jar such as is used in carriages' or 'a globe of sandstone' ?" He was able to point out at least some agencies which might regenerate the earth's heat or delay its loss.

So it is only fitting that the great physicist, who imposed a narrow limit to geological time, should have prepared the way for those who have proved that the earth possesses in its radioactive substances a 'hidden reserve' capable of supplying a continuous recrudescence of the energy wasted by radiation, thus lengthening out the time required to complete its total loss. These later physicists have given us time without stint; and, though this time is the merest fraction of that envisaged by cosmogonists and astronomers, we are now so much richer than our original estimates that we are embarrassed by the wealth poured into our hands. So far from the last century's urge to 'hurry up our phenomena', we are almost at a loss for phenomena enough to fill up the time.

The far-sighted genius of Lord Rutherford and Lord Rayleigh first saw the bearing of the rate of disintegration of radioactive substances in the minerals of rocks on the age of the parts of the earth-crust built of them. The extension and supplementing of this work, by Joly, Holmes and others, has now enabled us to look to the disintegration of uranium, thorium and potassium, as the most promising of many methods that have been used in the endeavour to ascertain the age of those parts of the earth-crust that are accessible to observation. These methods also promise a means of dating the geological succession of Eras and Periods in terms of millions if not hundreds of thousands of years.

The Earth Pulse

The decline and early death to which Lord Kelvin's dictum had condemned the earth, according so little with the vigour displayed in its geological story, is now transformed into a history of prolonged though not perennial youth. It was for Joly, of whose work the extent, variety and fruitfulness are scarcely yet fully appreciated, to take the next step and see in the release of radioactive energy a mechanism which could drive the pulse that geologists had so long felt, and that Suess had so brilliantly diagnosed. As Darwin found the missing word for Lyell, so Joly in his theory of thermal cycles has indicated the direction of search for a mechanism to actuate the rhythm of Suess.

In Joly's conception, the running down of the earth's energy, though a continuous process, was, through the intervention of radioactivity, converted into a series of cycles, during each of which relative movements of sea and land must occur; downward movements of the continents, associated with positive encroachments of the sea; upward movements, with retreat of the sea, the formation of wide land masses, and the ridging of strata to form mountain ranges. Thus he forged a link that could unite the continental or epeirogenic movement with orogenic or mountain movement.

The visible parts of mountains and continents, as well as their lower and hidden portions, or 'roots', are made of comparatively light rocks. In order to stand up as they do, their roots must be

embedded in denser matter, in which they 'float' like icebergs in water. A far larger mass must exist below than is visible above, and the bigger the upstanding part the bigger the submerged root. Over the larger area of the ocean floor, on the other hand, the thickness of material of low density must be very slight, and the denser layer must come close to the surface.

Thermal Cycles

The study of earthquakes, to which the Seismology Committee of the British Association has made outstanding contributions, has yielded, from the times taken in transmission of vibrations through the earth, the best information as to the nature and state of the interior. It has proved that the dense layer is solid at the present time. It is probably no coincidence that the earth is also but just recovering from what is possibly the greatest period of mountain building, if not the greatest negative movement of ocean retreat, that it has ever experienced.

But solidity cannot be the permanent condition of the substratum. Heat is generated in it by its own radioactivity, but, according to the terms of the hypothesis, cannot escape, in consequence of the higher temperature generated in the continental rocks which cover it. It is therefore retained in the substratum and stored as latent heat of liquefaction, so that, within a period which has been calculated approximately in millions of years, complete melting of the sub-crust must ensue.

The resulting expansion of the liquefied stratum will have at least two effects of great importance to us. In the first place, the unexpanded superficial layers will be too small to fit the swelling interior. They will, therefore, suffer tension, greater on the ocean floor than on land, and cracking and rifting will occur, with intrusion and extrusion of molten rock. In the second place the continental masses, now truly floating in a substratum which has become fluid and less dense than before, will sink deeper into it, suffering displacement along the rift cracks or other planes of dislocation. As a result the ocean waters, unchanged in volume, must encroach on the edges of the continents, and spread farther and farther over their surfaces.

Thus we have the mechanism which Suess vainly sought, causing positive movements of the oceans, their waters spreading over wide stretches of what was formerly continental land, and laying down as sediment upon it the marine stratified rocks which are our chief witness of the rhythmic advances of the sea.

This condition, however, cannot be permanent, for by convection of the fluid basic substratum, supplemented by the influence of tides within it, and the slow westward tidal drag of the continental masses towards and over what had been ocean floor, there will now be dissipation of its heat, mainly into the ocean waters, at a rate much faster than it has been or could be accumulated. Resolidification ensues, and again there are two main consequences. First, the stratum embedding their roots having now become more dense, the continental masses rise, and as they do so the ocean waters retreat from their margins and epicontinental seas, leaving bare as new land, made of the recently deposited sediments, the areas previously drowned. Secondly, the expanded crust, left insufficiently supported by the withdrawal of shrunken substratum, will suffer from severe tangential stress, and, on yielding, will wrinkle like the skin of a withering apple. The wrinkles will be mountain ranges, formed along lines of weakness such as those at continental margins ; and they will be piled up and elevated, to suffer from the intense erosion due to water action upon their exposed and upraised rocks.

In this, again, we have a mechanism which supplies what was needed by Suess, and one, moreover, which secures the required relationship between continental and mountain movement, between the broader extensions of continental land and the growth of mountains with their volcanoes and earthquakes and the other concomitants of lateral thrust.

Thus a thermal cycle may run its full course from the solid substratum, through a period of liquefaction accompanied by crustal tension, back to solidification and an era of lateral stress : and the stage is set for a new cycle.

Prof. Arthur Holmes, in checking Joly's calculations, has concluded that the length of the cycles in a basic rock substratum should occupy 25–40 million years, a period much too short to fit the major periods of mountain movement, as determined by him from the radioactivity of minerals contained in the rocks. On this evidence the Alpine movement should date back 20–60 millions of years ago, the Hercynian 200–250 millions, and the Caledonian 350–375 million years.

In a preliminary attempt to modify Joly's hypothesis, Holmes postulated the occurrence of similar, but longer cycles (magmatic cycles) in a denser, ultra-basic layer underlying the basic one, the rhythm of which would be nearer to 150 million years. The shorter cycles due to the basic layer are held in part responsible for periods of minor disturbance, and also to account for the individual variations in effect, duration and intensity of the larger ones. Each of the later movements has also evidently been limited and conditioned by the results of foregoing ones, and especially by areas of

fracture and weakness on one hand, and by large stable masses composed of rocks intensely consolidated, or already closely packed, on the other.

More recently, Holmes has developed the possibility that the loss of heat is mainly due to convection in the liquid substrata, and that convection is the leading cause of the drifting and other movements of the crust, and the disturbances that have occurred in it. He says :

"Although the hypothesis involving sub-crustal convection currents cannot be regarded as established, it is encouraging to find that it is consistent with a wide range of geological and geophysical data. Moreover, it is by no means independent of the best features of the other hypotheses. It requires the local operation of thermal cycles within the crust, and it necessarily involves contraction in regions where crustal cooling takes place. It is sufficiently complex to match the astonishing complexities of geological history, and sufficiently startling to stimulate research in many directions".

The phenomena are difficult to disentangle as the number of operating causes has been so great and many of them are not fully understood. But, underlying them all there is unquestionably the pulse within pulse which Suess saw, and of which Joly pointed the way to explanation.

The view at which we have arrived is neither strictly uniformitarian nor strictly catastrophic, but takes the best from each hypothesis. As Lyell showed, most of the phenomena of geology can be matched somewhere and sometime on the earth of to-day ; but it would appear that they have varied in place, intensity, phase and time. And, as Lyell was driven to accept *evolution* to explain the history of life on the earth, so must we employ the same word to express the life-processes of the earth itself, as was suggested by Huxley in 1869 and strongly advocated by Sollas in 1883.

The Atlantic and Pacific Oceans

The contrast in outline and structure between the Atlantic and Pacific Oceans had long been noted when Suess formulated and used the differences as the basis of his classification.

The Pacific is bounded everywhere by steep slopes, rising abruptly from profound ocean depths to lofty lands crowned with mountain ranges, parallel to its shores and surrounding its whole area. On the American side the coast range is continued by the Andes. On the Asiatic side chains of mountainous peninsulas and islands, separated from the continent by shallow inland seas, extend in festoons from Kamchatka and Japan to the East Indies, eastern Australia and New Zealand. This mountain ring, as Charles Lapworth said, "is ablaze with volcanoes and creeping with earthquakes", testifying that it has been recently formed and is still unfinished.

The Atlantic Ocean, on the other hand, is not bordered with continuous ranges, but breaks across them all : the Scottish and Welsh ranges, the Armorican range, the continuation of the Pyrenees and Atlas ; and, on the American side, the uplands of Labrador, Newfoundland and the eastern States, and the hill ranges of Guiana and Brazil. The Atlantic is in disconformity with the grain of the land, while the Pacific conforms with it. The Pacific has the rock-folds of its ranges breaking like ocean waves towards it as though the land were being driven by pressure to advance upon it, while the Atlantic recalls the effects of fracture under tension.

The middle and southern edges of the Atlantic, however, agree to some extent with the Pacific type. The Caribbean Sea, with the Antilles and the rest of its border girdle, recalls the similar structure of the Mediterranean, as it stretches eastwards, with breaks, to the East Indian Archipelago ; while the Andes are continued to Antarctica in a sweeping curve of islands. The rest of the Indian Ocean is of Atlantic type, as seen in the shores of eastern Africa and western Australia.

Continental Drift

Another feature of the Atlantic is the parallelism of much of its eastern and western coasts, the meaning of which has often attracted the speculations of geologists and geographers. With a little stretch of the imagination, and some ingenuity and elasticity of adjustment, plans or maps of the opposite sides may be fitted fairly closely, particularly if we plot and assemble the real edges of the continents, the steep slopes which divide the 'shelves' on which they stand from the ocean depths. This has suggested the possibility that the two sides may once have been united, and have since broken and drifted apart until they are now separated by the ocean.

This view, outlined by others, has been emphasised by Wegener and dealt with by him in full detail in his work on "The Origin of Continents and Oceans", and it now plays a leading part in what is known as the Wegener theory of continental drift. The hypothesis is supported by the close resemblances in the rocks and fossils of many ages in western Europe and Britain to those of eastern North America ; by community of the structures by which these rocks are affected ; and

by the strong likeness exhibited by the living animals and plants on the two sides, so that they can only be referred to a single biological and distributional unit, the Palæarctic region.

The hypothesis, however, did not stop at this; and in the South Atlantic and certain other areas Wegener and his followers have also given good reasons for believing that continental masses, once continuous, have drifted apart.

Broad areas in southern Africa are built of rocks known as the Karroo Formation, of which the lower part, of late Carboniferous age, is characterised especially by species of the strange fern-like fossil plants *Glossopteris* and *Gangamopteris*. Associated with them are peculiar groups of fossil shells and fossil amphibia and reptiles. Similar rocks, with similar associations and contents, in Peninsular India have been named the Gondwana Formation. Comparable formations also occupy large regions in Australia, Tasmania and New Zealand, in Madagascar, in the Falkland Islands and Brazil, and in Antarctica.

The correspondence between these areas is so close that Suess supposed they must at that date have been connected together by lands, now sunk beneath the sea, and he named the continent thus formed Gondwanaland after the Indian occurrences. The break-up of this land can be followed from a study of the rocks, and it was a slow process, its steps occupying much of Mesozoic time. Dr. A. L. du Toit's comparison of South African rocks with those of Brazil and elsewhere in South America favours even a closer union than this between the units now scattered.

One of the most remarkable features shown by these rocks in all the areas mentioned, but to varying extents, is the presence of conglomerates made of far-travelled boulders, scratched like those borne by the modern ice-sheets of Greenland and the Antarctic, associated with other deposits of a glacial nature, and often resting upon typical glaciated surfaces. There is no possible escape from the conclusion that these areas, now situated in or near the tropics, suffered an intense glaciation. This was not a case of mere alpine glaciers, for the land was of low relief and not far removed from sea-level, but of extensive ice-sheets on a far larger scale than the glaciation of the northern parts of the New and Old Worlds in the Pleistocene Ice Age. I have never seen any geological evidence more impressive or convincing than that displayed at Nooitgedacht, near Kimberley; while the illustrations and other evidence published by David and Howchin from Australia are equally striking.

Du Toit's work on these glacial deposits brings out two remarkable facts; first, that the movement of the ice was southerly, pole-ward and away from the equator, the opposite to what would be expected and to the direction of the Pleistocene ice-movement; secondly, that the ice in Natal invaded the land from what is now sea to the north-east.

When it is realised that at this period there is no evidence of glacial action in northern Europe or America, but a climate in which grew the vegetation that formed the coal seams of our Coal Measures, it is clear that we are not dealing with any general refrigeration of the globe, even if that would produce such widespread glaciation: we are face to face with a special glaciation of Gondwanaland.

On both sides of the Atlantic these glacial episodes in Carboniferous times were followed by dry and desert climates in Triassic time, and these by violent volcanic outbursts. Nor are the rocks alike only in mode of formation: the structures by which they are traversed correspond; while even in details there is remarkable agreement, as in the peculiar manganese deposits, and the occurrence of diamonds in 'pipes' of igneous rock, both east and west of the Ocean.

Rather than face the difficulties presented by the subsidence of lands connecting the severed portions of Gondwanaland, as pictured by Suess, Wegener has preferred—and in this he is supported by Du Toit and many other geologists—to bring into contact these severed parts, which could be fitted together as nearly as might be expected, considering the dates of severance. Du Toit's map of the period places South America to the west and south of South Africa, Madagascar and India to the east, Antarctica to the south, and Australia farther to the south-east. Such a grouping would form a continent much less wide in extent than that envisaged by Suess, and would offer some explanation of the more remarkable features of the glaciation in the several areas, as well as the problems of the rocks, fossils and structures involved.

In its application to the geology of Gondwanaland the modified hypothesis of Wegener cuts a Gordian knot; but it still leaves a great climatal difficulty, unless we take his further step and conceive that at this date the terrestrial south pole was situated within Gondwanaland. No shift in the axis on which the earth rotates would, of course, be possible, nor is it postulated: only a drifting at that date of continental land across the pole.

If a hypothesis of drift be admitted for Gondwanaland, it would be illogical to deny its application to other regions, including the north Atlantic. I have already mentioned some facts in its favour. Others are the resemblances of all sedimentary rocks on the two sides from the Cambrian to the

Ordovician, and from the Devonian to the Trias ; the links between the structures of the land, as, for example, between Ireland and Newfoundland ; and the instance given by Prof. E. B. Bailey in his address to Section C in 1928. As Bailey then pointed out, the great Caledonian range which crosses Scotland, northern England and Wales from north-east to south-west on its course from Scandinavia is affected and displaced by the east to west Armorican (Hercynian) chain extending across from Brittany to South Wales. "The crossing of the chains, begun in the British Isles, is completed in New England" ; and from here the Armorican structure continues its westerly course. This is where it should cross if the continent of North America were brought back across the Atlantic and placed in the position which, according to Wegener, it would fit into in the European coast ! Can the Pilgrim Fathers have ever dreamed of such a link between the Old England and the New ?

The hypothesis of continental drift gave rich promise of solving so many difficult problems that it was hailed by many classes of investigators almost as a panacea. Geographers have seen in it an explanation of the forms of continents and the position of peninsulas, islands and mountains ; meteorologists have found it the solution of some of the problems of past climates and their anomalies of distribution over the world ; biologists hope to get help with the intense complexities in the distribution of forms of life and many strange facts in migration, and palæontologists with similar difficulties among the ancient faunas and floras as revealed by their fossil remains ; geodesists have welcomed escape from the rising and sinking of the crust, so difficult to reconcile with the demands of isostatic equilibrium ; and it has been already stated that drift forms a vital factor in Joly's thermal cycles.

But there has been no lack of criticism in all these directions. It has been assailed on one hand for the detail attempted in its geographical restorations, and on the other hand for its vagueness. Prof. Schuchert quotes Termier as saying that it is "a beautiful dream, the dream of a great poet. One tries to embrace it, and finds that he has in his arms but a little vapour or smoke : it is at the same time alluring and intangible". It has been objected that "no plausible explanation of the mechanics involved has been offered" ; that the continental connexions postulated present by no means so close a match, when fitted together, as has been claimed, in the structure or the nature of either igneous or sedimentary rocks ; that there is good evidence of extensive vertical movements in recent earthquakes, in the accumulation of tremendous thicknesses of sediment indicative of shallow-water from base to summit, and in the growth of coral reefs ; that Central America and the Mediterranean are a difficult obstacle ; and that the known distribution of the Karroo fossil reptiles is not by any means what the hypothesis demands.

If the idea of drift be accepted, it cannot be regarded as a royal road out of all our difficulties, nor can it be the only form of earth-movement to be reckoned with. The late J. W. Gregory, whose life was sacrificed to geological discovery, studied exhaustively the geological history of the Atlantic and Pacific Oceans, both as revealed by the sedimentary rocks and fossils on their borders, and by the distribution of life to-day. He found that, according to our present knowledge, in the two oceans, facilities for migration have fluctuated from time to time, periods of great community of organisms alternating with periods of diversity. Again, at some times connexion seems to have been established north of the equator, at others to the south ; and we cannot ignore the possibility of migration across polar lands or seas when terrestrial climates have differed from the present. The facts of life distribution are far too complex to be explained by any single period of connexion followed by a definite breaking apart, even if that took place by stages. Mrs. Reid, too, has pointed out that resemblances between the Tertiary floras of America and Europe actually increased at the time when the Atlantic should have been widening. Unless continental drift has been a more complicated process than anyone has yet conceived, it seems impossible to escape from some form of the 'land bridges' of the older naturalists :

> "Air-roads over islands lost—
> Ages since 'neath Ocean lost—"

We have no right to expect greater simplicity in the life of a planet than in that of an organism.

As the question of drift must in the last appeal be one of fact, it is not unnaturally expected that the real answer will come from measurements of longitude and latitude with greater exactness and over periods longer than has yet been possible. None of the measurements hitherto made has indicated variations greater than the limits of errors of observation. Two things, however, may militate against a definite answer from this source. Many parts of the crust, such as the shield-like masses of Archæan rock, may have completed their movement, or be now moving so slowly that the movement cannot be measured. Careful selection of locality is essential, and at present we have little guidance. Also, as the displacement of crust must be dependent on the condition of its substratum, it will be a periodic phenomenon and the

rate of movement may vary much in time. According to the theory of thermal cycles the sub-crust is at present solid, and may not permit of drift. Drift, according to Joly and Holmes, is a cyclical phenomenon ; if present-day observations were to give a negative result they would not necessarily disprove it.

The occurrence of recumbent rock-folds, and nearly horizontal slides or 'nappes' in mountain regions, gives positive proof that parts of the upper earth-crust have moved over the lower. In the North-west Highlands of Scotland, a sliding of at least ten miles was proved by Peach and Horne, and in Scandinavia it amounts to sixty miles. For mountain packing as a whole the figures already given are far larger, while in Asia, Argand has stated that packing of more than 2,000 miles has occurred. Thus, when all is said and done, movements on a colossal scale are established facts, and the question of the future is how far we shall accept the scheme of drift due to Wegener, or one or other of the modifications of it. It is for us to watch and test all the data under our own observation, feeling sure that we shall have to adapt to our own case Galileo's words "e pur si muove".

Rock Folding and Mountain Birth

Ever since it was realised that the inclination and folding of rocks must be attributed to lateral or tangential stress and not solely to uplift, shrinkage of the interior of the earth from its crust has been accepted as the prime mover, and whichever of the current theories we adopt, we cannot deny the efficacy of so powerful a cause.

The general course of events in the formation of a mountain range is fairly well known : the slow sinking of a downfold in the crust during long ages ; the filling of this with sediment *pari passu* with the sinking, and associated softening of the sub-crust due to accumulated heat ; the oncoming of lateral pressure causing wave-like folds in the sediments and the base on which they rest ; the crushing of folds together until, like water waves, they bend over and break by over-driving from above or, it may be, under-driving from below ; fracture of the compressed folds and the travelling forward for great distances of slivers or 'nappes' of rock, generally of small relative thickness but of great length and breadth, and sliding upon floors of crushed rock ; the outpouring and intrusion of igneous rocks, lubricating contacts and complicating the loading of the sediments ; metamorphism of many of the rocks by crystallisation at elevated temperatures and under stress, with the development of a new and elaborate system of planes of re-orientation and movement ; and elevation of the whole, either independently or by thickening with compression and piling up to bring about a fresh equilibrium.

Such a course of events would be brought about by lateral pressure developed during the consolidation phase of each of the thermal or magmatic cycles. At each period of their building, mountains have arisen along lines of weakness in the crust, especially coast lines and the steep slopes marking the limits between continents and ocean basins. This is consistent with Joly's theory that the thrust of ocean beds against land margins is the cause.

The advocates of continental drift point to the siting of ranges across the paths along which the drifting movement is supposed to have occurred, and they consider that the moving masses are responsible ; and indeed that the ridging and packing of the crust has in the end checked and stopped the movement. They note that the great western ranges of America occur in the path of any western drift of that continent, the Himalayas in the course of the postulated movement of India, the East Indies in front of Australia ; and that the Alpine ranges of Europe may be linked with the crushing of Africa towards the north.

The 'nappes' of rock, cut off from their origin and sliding for dozens of miles, are a constant source of wonder to all who have considered the mechanics of mountain formation. They are so thin as compared with their great length and breadth, that it seems impossible to imagine them moved by any force other than one which would make itself felt throughout their every particle. Such a force is gravitation, and it is of interest that some Alpine geologists and Dr. Harold Jeffreys have used it in explanation of them. Prof. R. A. Daly has also adopted gravitation on an even greater scale in his theory of continental sliding : and one cannot fail to notice the increasing use of the term 'crust-creep' by those working on earth-movement.

Is there no other force, comparable in its method of action to gravitation, but capable of producing movement of the earth-crust in a direction other than downhill ? Is it not possible, for example, that the tidal influence of the moon and sun, which is producing so much distortion of the solid earth that the ocean tides are less than they would be otherwise, and, dragging always in one direction, is slowing down the earth's rotation, may exert permanent distorting influence on the solid earth itself ? May it not be that such a stress, if not sufficiently powerful to produce the greater displacements of continental drift and mountain building, may yet take advantage of structures of weakness produced by other causes, and itself contribute to the formation of nappes and to other movements of a nature at present unexplained ?

Geological Surveying

Our knowledge of geology has been gained by the survey of the rocks, the study of their structures, and the delineation of both upon maps and sections. This work is being accomplished by geologists all over the world, and Great Britain and the Empire have contributed their full share. It is therefore opportune to note that there has just been celebrated the centenary of the Geological Survey of Britain and, with it, the opening of the new Geological Museum at South Kensington.

A century ago H. T. de la Beche, one of the devoted band of pioneer workers then studying the geology of the country, offered to "affix geological colours to the new maps of Devon and Cornwall" then in course of issue by the Ordnance Survey. His offer was accepted, and, at his own expense and on his own feet, he carried out a geological survey of some 4,000 square miles. In 1835 he was appointed to continue this task, with a small salary and a few assistants. Thus was started the first official geological survey, an example widely followed by other nations and dominions. De la Beche's conception included also a Museum of economic and practical geology, a Library, a Record of Mines, for which he secured support from a strong committee of the British Association in 1838, and a School of Mines for the scientific and technical education of those to be employed in the survey or exploitation of mineral resources. In these objects, and especially the last, he was warmly supported by the Prince Consort. He lived to see his visions all come true, as he collected round himself that wonderful band of surveyors, investigators, writers and teachers, which included such men as Playfair, Logan, Ramsay, Aveline, Jukes, Forbes, Percy, Hooker, and Huxley.

Some of the schemes planned by de la Beche have budded off and grown into large and important entities, rendering conspicuous service to scientific record, education, and research. But the main duties of the Geological Survey remained with it, and have been carried on for a century. These are to map the geology of the country on the largest practicable scale, to describe and interpret the structure of the land, to preserve the evidence on which conclusions have been founded, and to illustrate for students and other workers the geology of the country and its applications to economics and industry. The broad detail of the structure of the whole country is now known, but much new work must be done to keep abreast of or to lead geological thought. For example, the study of the cloak of 'superficial deposits', which often cover and conceal the structure of the more solid rocks below, is essential for the proper understanding of soils and agriculture; and a knowledge of the deep-seated geology of the country, which is often widely different from that nearer the surface and thus very difficult to interpret, is vital to the community for the successful location and working of coal and iron, and for tracing supplies of water and oil and other resources at depth.

Evolution of Life

Evolution of life on the earth has been by no means uniform; there have been periods of waxing and waning which may be attributed to geographical, climatological, and biological influences. The development of large land areas, ranged longitudinally or latitudinally, the invasion of epicontinental seas, the isolation of mediterraneans or inland seas, the splitting of continental areas into archipelagos or the reunion of islands into continuous land, the making of barriers by the rearing of mountain chains or the formation of straits or arms of the sea, the oncoming of desert or glacial climates; all such factors and many others have been of importance in quickening or checking competition, and in accelerating or retarding the evolution of life.

Probably, however, even greater effects have followed the interaction of groups of biological changes on one another. As an example I might recall Starkie Gardner's estimate of the results following upon the first appearance of grasses in the world. This seems to have been not earlier than Eocene, and probably late Eocene times. By the Oligocene they had made good their hold, peculiarities in their growth and structure enabling them to compete with the other vegetation that then existed; and gradually they spread over huge areas of the earth's surface, formerly occupied by marsh, scrub and forest. They have, as Ruskin says, "a very little strength . . . and a few delicate long lines meeting at a point . . . made, as it seems, only to be trodden on to-day, and to-morrow to be cast into the oven"; but, through their easy growth, their disregard of trampling and grazing, and by reason of the nourishment concentrated in their seeds, they provided an ideal and plentiful source of food.

On the establishment of the grasses, we find that groups of animals, which had previously browsed on shrubs and trees, adopted them, with consequent alterations and adaptations in their teeth and other bodily structures. To follow their food from over-grazed or sun-scorched regions they required to be able to migrate easily and quickly, and it was essential for them to discard sedentary defence and to flee from threatened danger. Such defence as was possible with heels, teeth or horns they retained; but the dominant modifications in

their organisation were in the direction of speed as their vital need.

Side by side with this development, and in answer to increasing numbers, came bigger, stronger and speedier carnivores, to feed on prey now so much more abundant, but more difficult to catch. The answer of the grass-feeders, with their specialised hoofs, teeth and bones, better suited to flight than fight, was to seek safety in numbers, and thus develop the herd instinct, with its necessity for leadership and discipline; but this, in turn, provoked a like rejoinder from some types of their enemies.

When it is remembered how much of the meat and drink and life of mankind is bound up with the grasses, including wheat, maize, millet and other grains, sugar-cane, rice and bamboo, we must realise how close is his link with the development just outlined. Practically his whole food supply is provided by them, either directly by the agriculturist who grows little else but grasses, or indirectly by the herdsman whose domestic animals are fed chiefly on the same food. Nor must we forget that almost every one of our domesticated animals has been derived from the gregarious types just mentioned, which have accepted the leadership of man in place of that of their own species.

It is perhaps not too much to say that the magnificent outburst of energy put out by the earth in the erection of the Alps, Andes and Himalayas in Tertiary times, was trivial in its influence for man's advent and his successful occupation of the earth in comparison with the gentle but insidious growth of "mere unconquerable grass" and its green carpet of "wise turf", which in some form clothes by far the greater part of the land of the globe.

Development of Brain

The kind of developmental reaction of which this is but a single example must clearly have had influence on bodily features other than bones and horns, teeth and claws, speed and strength; and one of the most striking has been on intellectual development and the size and shape of brain.

We do not, and perhaps can never, know the quality of the material of which the brains of fossil creatures was made, for we have no instrument to pierce the veil of time as the spectroscope has penetrated the abysm of space. But we are even now learning something about their shapes and convolutions, and more about their mass in its relation to the size of the bodies controlled; from the time of the earliest Ordovician fishes, through the history of the amphibia, reptiles, birds and mammals, up to man himself.

The brain of those gigantic if somewhat grotesque reptiles the dinosaurs, the tyrants of Mesozoic time, was relatively tiny. In *Diplodocus*, 80 feet in length and 20 tons in weight, the brain was about the size of a large hen's egg. It is true that there was a big supplementary sacral ganglion which may have taken chief charge of locomotion and helped to secure co-ordination throughout the hinder part of its huge length and bulk; but of true brain there was not more than a quarter of an ounce to control each ton of body and limb; and we begin to understand why they lost the lordship of creation.

The proportion of brain to body improved in those reptiles which took to flying, possibly in relation to their acquisition of warm blood, and in the birds evolved from reptiles; but it is only in mammals that a marked advance is seen. Here the brain of *Uintatherium*, a great rhinoceros-like animal of Eocene date, weighing 2 tons, was about the size of that of a dog. This proportion of half a pound of brain to each ton of body shows how far the mammals had gone, and still had to go. A twelve-stone man of the present day has about $3\frac{1}{2}$ pounds of brain—an amount not far short of half a hundredweight per ton.

Even though we can know nothing of its material, this steadfast growth in the guiding principle, through the millions of centuries that have gone to its development, is surely one of the most remarkable conclusions that we owe to geology. Of all the wonders of the universe of which we have present knowledge, from the electron to the atom, from the virus and bacillus to the oak and the elephant, from the tiniest meteor to the most magnificent nebula, surely there is nothing to surpass the brain of man. An instrument capable of controlling every thought and action of the human body, the most intricate and efficient piece of mechanism ever devised; of piercing the secrets and defining the laws of Nature; of recording and recalling every adventure of the individual from his cradle to his grave; of inspiring or of ruling great masses of mankind; of producing all the gems of speech and song, of poetry and art, that adorn the world, all the thoughts of philosophy and all the triumphs of imagination and insight: it is indeed the greatest marvel of all.

When we contemplate the time and energy, the sacrifice and devotion, that this evolution has cost, we must feel that we are still far from the end of this mighty purpose: that we can confidently look forward to the further advance which alone could justify the design and skill lavished on this great task throughout the golden ages that have gone.

Summaries of Addresses of Presidents of Sections*

The Story of Isotopes

IN his presidential address to Section A (Mathematical and Physical Sciences), Dr. F. W. Aston says that the isotope chapter in the history of science contains much to interest the philosopher and offers many illustrations of that interplay of theory and experiment by which advance takes place. The postulate of Dalton that atoms of the same element are equal in weight was practically undisputed for more than a hundred years. It was correctly preferred to the alternative hypothesis of Prout. Early objections to the postulate were founded upon inaccurate data, and it was only disproved after the discovery of radioactivity.

Soddy's hypothesis of 'isotopes' was at first strongly resisted. Satisfactory proof of it from radioactive evidence could only be obtained in the case of lead, and this was established by chemical results during the War. The possibility that it could be applied to elements in general was first suggested by the twin parabolas of neon, and was proved by the results of the mass-spectrograph. The first of these instruments showed that neon and chlorine each consisted of two isotopes, that krypton had six, and other elements even more. By its means the 'whole number rule' of atomic mass was established and some fifty elements analysed. The difficulties of obtaining the rays for analysis varies enormously from element to element, but during the past fifteen years, knowledge of the isotopic constitution of the elements has become very complete. A year ago, data on all but four had been obtained, and since then the rays of three of these, produced by a new method, have been analysed by Dempster. Iridium is the only one now left. In all, some 259 stable isotopes are known. Elements of odd atomic number do not in general have more than two components but even elements are not so limited, the most complex, tin, having eleven.

One of the most astonishing results is that for practically every natural number up to 210 a stable atom is known. The determination of the relative abundance of isotopes in an element enables its atomic weight to be calculated. This has been done for nearly all the elements, giving valuable checks on the results obtained by chemical means.

The most important work now going on in this field is the measurement of the 'isotopic weights' of atoms. In recent years the accuracy has approached 1 in 10,000, but for theoretical considerations of nuclear structure and artificial transmutation even greater accuracy is desired. The first value obtained for the isotopic weight of hydrogen and the subsequent discovery of the heavy isotopes of oxygen suggested that hydrogen had a heavy isotope. This was discovered by Urey and called deuterium. It cannot be treated as a normal isotope, for its exceptional difference in mass enables it to be separated in a pure state. It has recently been used in the mass-spectrograph to give a more direct and reliable measurement of the isotopic weight of ordinary hydrogen, with the paradoxical result of removing the very discrepancy which led to its discovery.

* The collected presidential addresses at Norwich are being published under the title, "The Advancement of Science, 1935". (Norwich: B.A. Reception Room. London: Burlington House.) 3*s.* 6*d.*

Molecular Structure of Carbohydrates

PROF. W. N. HAWORTH'S presidential address to Section B (Chemistry) deals with the molecular structure of carbohydrates. Ten years have elapsed since the structural model of glucose was first presented as the six-atom ring form, an observation communicated to NATURE in 1925. This model now can be regarded as the unit of the carbohydrates cellulose, starch and glycogen. At the outset it was essential to investigate the mode of union of pairs of glucose units which occur in cellobiose and maltose, the bioses to which cellulose and starch give rise by graded breakdown processes. This occurs through the groups at the first carbon atom in one residue and the fourth carbon atom in a second residue, which furnish the oxygen bond uniting two glucose units in these bioses. The spatial disposition of this bond provides the reason for the different identities of starch and cellulose. In other carbohydrates the linking follows a different choice.

Investigations have demonstrated how cellobiose units are united in a continuous chain in cellulose, and how maltose units are assembled in starch. The chain lengths of these and other representative carbohydrates have been determined by the chemical assay of one of the terminal groups in the fully methylated polysaccharides.

A distinction is drawn between the chemical molecule, representing the assembly of glucose units by principal valencies, and the physical aggregate, which has much larger dimensions. Starch has a molecular weight of about 4000–5000, but this

chemical unit is capable of undergoing very considerable molecular aggregation, and these physical aggregates are undoubtedly very complex. Probably the same kind of interpretation should be applied also to cellulose. The aggregation of the chemical unit consisting of about two hundred glucose units may proceed to very great lengths of chain by co-ordination, and there is no doubt that the physical unit of cellulose is dimensionally very large. In this connexion lichenin has been simultaneously studied and its chain length determined. Its relationship to cellulose is similar to that between glycogen and starch.

Glycogen has a chemical molecule represented by a chain of twelve to eighteen α-glucopyranose units. This is smaller than that of vegetable starch, and the tendency to undergo molecular aggregation is not nearly so marked. Investigation of many degraded forms of starch representing different chain lengths has proved of service in the study of this problem.

New carbohydrates prepared artificially by the aid of moulds acting on glucose have resulted in the discovery of new modes of linking of hexose units. The chain length of several of these representatives is short and corresponds to about ten hexose residues. A new polysaccharide from grass, a levan, is found to be composed of ten fructose members united through positions 2 and 6, whereas inulin consists of about thirty fructofuranose units united through the positions 1 and 2.

Considerable interest is attached to investigations on the constitution of gums. A derivative of gum arabic is shown to possess properties resembling the specific polysaccharide of type III pneumococcus serum. Nothing could be more important than the development of the more recent discoveries of polysaccharides possessing immunological functions. A knowledge of their composition, properties and intimate structure will be of immense service to medicine.

Geological Research on Coal

SPEAKING of the state of knowledge at the commencement of this century regarding the real nature of coal, Prof. H. G. A. Hickling in his presidential address to Section C (Geology) says that it was a remarkable example of the tendency of research to pass over 'common' things, and also a striking illustration of the limitations of mere description to convey effective impressions of unfamiliar objects. A review of the writings of various earlier investigators of the last century in the light of present-day knowledge shows that, in their attempts to examine the structure of coal under the microscope, they had seen many of the features which have been revealed by the work of the past thirty years; but, on account of lack of effective illustration, and as a result of their inability to give correct interpretations of much of what they saw, their observations bore little fruit. Coal was still regarded as essentially one substance, and there was no sound basis for a classification of the different varieties, the existence of which the coal-user had perforce to recognise.

Recent work has brought vividly to light the fact that every piece of coal is a complex agglomeration of many different types of plant material; of the residues of wood and cellulose and proteins; of resins, waxes, gums and other substances. The development of microscopic technique has made it possible to show that almost the whole of the coal consists of larger or smaller plant fragments the original component materials of which still exist as discrete masses retaining their original forms, however much or little their ultimate compositions may have been severally modified. The microscope reveals, further, that while every coal is an aggregate, the ingredients differ widely in character and in proportions in different seams, and in different portions of the same seam. Modern research makes it increasingly clear that the problem of the classification of coals is twofold; to divide up the coals according to the nature of the original aggregates of plant debris from which each was formed; and, secondly, to determine the nature and extent of the chemical alteration which the aggregate has suffered after its entombment in the earth. The former determines the *type* of coal; the latter, its *rank*. Its economic qualities depend on both.

Hitherto, chemical examination of coal has been almost entirely confined to analysis of the whole mass, so that variations of composition due to type and rank respectively have not been distinguished; and the order which emerges from comparison of the analyses results only from the fact that, in the more common coals, the general constitution of the aggregate of plant debris is comparatively constant. The outstanding differences are consequently those due to rank. Extended study of the distribution of rank in its relation to the relative depth of different seams, and of the changes of rank exhibited by the various seams as they are traced through the coalfields, is making it increasingly clear that these changes are the result of varying temperatures and pressures to which the coals have been subjected in the earth's crust. Coal is far more sensitive to such changes than any other rock, and may well come in future to serve as the most delicate earth thermometer. Not only for such applications to purely scientific ends, however,

but also equally to provide the knowledge on which we must base any sound practice for the most effective utilisation of coal, it is essential to undertake a far more fundamental study of this mineral, and in particular to investigate separately the many components of the coal aggregate.

The Species Problem

MAINLY from a study of the water-beetles, Prof. F. Balfour-Browne has come to some conclusions as to the origin of species by means of natural selection which he brings forward in his presidential address to Section D (Zoology). He points out that, although a struggle for existence undoubtedly occurs, choice also plays a part in the formation of different communities of water-beetles associated with different types of habitat, and that even localisation under particular climatic conditions is probably partly due to choice.

Choice of a particular food-plant by certain individuals of a species may give rise to biological races, such as are known to exist in Nature and can be produced artificially, and such races may be one source of origin of new species. In any group, species are variously related, some being very distinct while others form clusters and are difficult to distinguish. The clustered species are not usually members of the same community and may perhaps be accounted for on the assumption that they originated as biological races. As to these clusters, there seems to be no evidence that the distinctive characters are hereditary, and it seems possible that they are merely due to the effect of environment upon each succeeding generation.

The majority of the species-characters by which the water-beetles are separated are non-vital and cannot therefore have evolved through the action of natural selection. In some cases the structure is common to other groups but the function is different. The clubbed antennæ found in Hydrophilidæ have appeared several times in the Coleoptera, but if they had been wiped out in all these other groups before the Hydrophilidæ were first studied, we should doubtless be describing them as specially evolved in connexion with respiration in these beetles.

Among these species-characters it is possible to trace what might be called stages in their evolution running through whole groups or families, suggesting that, just as growth is a definite property of the organism, so evolution is an inherent property of the species. But the discoveries in connexion with chromosome control of characters suggest that possibly what has been described as orthogenesis may be the result of mutations caused by external stimuli or, if function can produce an alteration of structure, physiological activities may produce these lines of evolution on the assumption, still requiring proof, that acquired characters are inherited. The inheritance of acquired characters must also depend upon the ultimate effect of changes of habit, physiological activity and structure upon the germ-cell chromosomes, so that the real struggle for existence seems to be in these latter, the first function of which is to see that like produces like, while external influences are perpetually endeavouring to prevent them carrying out their duty.

Polar Research

IN his presidential address to Section E (Geography) Prof. F. Debenham discusses "Some Aspects of the Polar Regions". In spite of an extensive literature on the exploration of the polar regions, there are few sources for a general appreciation of their value to man. The economic aspect is perhaps the best known, since most expeditions of the past have been prompted to some extent by hopes of making discoveries which would ultimately return a profit. Several of the earlier resources, however, were speedily exhausted by the spirit of competition which ruled amongst the different nations. The disappearance of the arctic whale and the reduction in numbers of the fur seal are two instances of this.

Among the potential values that yet remain to be exploited in the polar regions, there is the prospect of using them for air routes. Prof. Debenham urges caution as to acceptance of the exaggerated accounts of possible mineral wealth, especially in the Antarctic. Although by analogy with other parts of the world there are doubtless valuable deposits of precious metals, the almost universal covering of ice prevents prospecting and would hinder mining operations.

The economic aspects of the lands in high latitudes naturally lead to the subject of the national ownership of polar lands and the unusual conditions in which claims have to be made. In the Antarctic, in particular, there can be no occupation, and it seems that its place as a reason for territorial rights will have to be taken by exploration and investigation.

The polar regions are of interest as a field for adventure, and also, in the more accessible parts, as a resort for holidays. So far as Europe is concerned, however, the field is narrowed down to little more of the Arctic than the Svalbard (Spitsbergen) group of islands. Associated with this aspect is another which may yet prove to be of greater value than any other. The polar regions

are, so far as disease is concerned, the most healthy segments of the earth's surface. This is due to the simple fact that most of the disease-bearing organisms cannot live throughout the year in the low temperatures typical of those regions. It is reasonable to suppose that residence in those latitudes should be able to effect a cure for many of those diseases which depend on germs or are spread by infection. There have been some remarkable cases of complete cures from pulmonary affections in the case of members of expeditions. How far this would be true in the cases of actual patients remains to be proved. Medical faculties and foundations such as that of the Rockefeller Institute, whose business is the study of remedial medicine, are urged to endow and carry out research into these possibilities. There seems to be difficulty in securing endowment for such an investigation, which might be of permanent benefit to the sufferers of temperate lands, although there has been heavy expenditure of money on recent flights to the poles.

Examining the value to science of research in the polar regions, Prof. Debenham is of opinion that probably the science of meteorology has most to gain from a continuance of such co-operative work as was carried out in 1882 and 1932, and he commends the natural inclination of young men to visit the polar regions in search of either adventure or results of scientific interest.

Economic Nationalism and International Trade

THE presidential address to Section F (Economics and Statistics) by Prof. J. G. Smith discusses the problems created in the field of international trade by the great accentuation of economic nationalism which has taken place throughout the world owing to the trade depression in the past five or six years. He points out that this policy of economic self-sufficiency is not a new one and that there may be something to be said for a moderate dose of it, especially in countries the history of whose economic development is different from that of Great Britain.

There are two sets of broad influences to be considered which make for economic nationalism or autarchy: those due to the War and to the economic upheaval resulting from the War, and those due to what may be called long-term changes consequent on progress and on scientific invention applied to industry and to commerce. Among the latter are improvements in agricultural technique, which have removed the fears of food scarcity in industrial areas that were once a dominant factor making for freedom of trade, and the development of intricate machine tools, growth of technical education and wide distribution of electrical power, which enable new industries to be set up with equal prospects of success almost anywhere. Again, the vulnerability of modern large-scale rationalised industries causes a struggle for markets (in which Governments are necessarily involved) and high protection for the home market, which is the only one capable of effective control. Further, nationalism which originally had merely political aims has now changed its character and become largely an economic movement. Government control of the whole of economic activity exists already in the three totalitarian States of Europe; and Government regulation is growing rapidly even in such liberal States as France and Great Britain; while recent experience in the United States of America is very significant.

The short-term influences due to the War and to the depression have reinforced powerfully these longer-term movements. Undue concern about the balance of trade, the exact significance of which is frequently misconceived, has led to curious consequences. Quotas, control of foreign exchange, prohibitions of imports, originally designed with one object, have been developed for other purposes. The general result has been a diminution in the volume of international trade which is felt especially severely by a country in the position of Great Britain. It is probable that the desire on the part of Governments to exercise quantitative detailed control over foreign trade may disappear when the depression passes and that these short-term influences making for economic nationalism will lose their force; but it is unlikely that freedom of international exchange will soon return.

Prof. Smith considers the general policy most likely to help in the eradication of these more extreme influences and comes to the conclusion that, as they are due very largely to the instability of currencies and the unforeseen and violent movements of prices which always accompany unstable standards of value, the remedy is to be found in currency stabilisation. This, he considers, can only be attained by a return to a gold standard of some form or other. On the whole, he favours an early decision to link again with gold; for the refusal to act soon will tend to accentuate the difficulties which will be encountered when postponement can no longer be avoided.

Stability in Engineering

IN his presidential address to Section G (Engineering), Mr. J. S. Wilson, a practising civil engineer, has chosen to discuss a branch of engineering to which he has devoted much of his

time. The word stability as applied to a structure means, in a general sense, strength and endurance to resist the loads and forces to which the structure may be subjected. The loads and thrusts combined with the dead weight of the structure induce stresses and strains in the material of which it is built. The determination of these stresses and strains in the various members is a matter of calculation or applied mechanics. The maximum stresses allowed in the members must be chosen to suit the characteristics of the material used.

Thus there are two sides to all problems in stability. Great advances in both have been made during the last hundred years by the more extended use of mathematics or applied mechanics on one side and in the testing and improvement of materials and methods of construction on the other.

Three interesting episodes in the history of the subject are recalled. The first of these relates to the arch. Our knowledge of the stability of this form of structure was in a state of confusion up to the middle of the nineteenth century, when efforts to advance appear to have been more a matter of dialectics than of science or experiment. The sharp differences of opinion on principles of design on the part of those who wrote with authority on the subject led engineers and architects who actually built arches to take extraordinary precautions to ensure their stability. Reference is made to Dr. Johnson's views on the relative strengths of semicircular and elliptical arches.

The feeling of uncertainty regarding the stability of masonry dams which arose at the beginning of the century and the re-establishment of confidence in the methods of calculation previously accepted form the second episode. Experimental investigations with the aid of india-rubber models on the distribution of stress in dams, which were carried out by the late Mr. William Gore and Mr. Wilson, helped to clear up the uncertainty.

The third relates to suspension bridges and the introduction, in 1836, of Dredge's patent taper chain principle of design. Designs on the new principle were very economical in the amount of iron needed and those who advocated the adoption of the principle were powerful. The principle was fundamentally unsound and although it was criticised, engineers and applied mathematicians of the day were too uncertain, or commanded too little support, to be able to shake confidence in it, and a large number of bridges were built in Great Britain and in India. The first ones had some margin of stability by good luck rather than design, but the later ones failed either before completion or soon after.

These three episodes reflect on the advances made in our knowledge on the applied mechanics side of the problem of stability. With regard to the permissible or working stress side, on which the more economical use of material depends, progress has not been so rapid.

The Birthplace of Man

SIR ARTHUR SMITH WOODWARD'S presidential address to Section H (Anthropology) is an account of recent progress in the study of early man. Palæontology and geology contribute much to our understanding of prehistoric archæology. It has long been recognised that the earliest men of which traces have been found in Europe did not originate on this continent but were immigrants from some other region. It is therefore important to examine the numerous associated mammals to ascertain whence they came ; for most of these mammals seem also to have been immigrants to Europe just before or during the Pleistocene period when man began to live here, and they may give a clue to his origins. These mammals show that when they flourished in Europe, the only direct land communication with the rest of the world was through Asia. The supposed connexions with Africa by way of Sicily and Malta and by Gibraltar have now been disproved. New discoveries of fossil mammals in the caves of Palestine and Syria show that during the early half of the Pleistocene period, Asia and North Africa were much more closely connected than they have been since. The explanation of the partial identity between the Pleistocene mammals of Africa and Europe is probably, therefore, that they had a common source in Asia.

Although the succession of stone implements in Pleistocene deposits in Africa is nearly the same as that in Europe, there is no evidence so far that the oldest types were made by the same primitive men. It is, however, now very doubtful whether the earliest tools in Kenya Colony were made by a modern race of men, as claimed by Dr. L. S. B. Leakey. The only fossil remains of man hitherto found in Africa seem to be related either to the surviving South African bushman or to the Australians.

The only known fossil which suggests that Africa may have produced man is the immature skull of an ape from Taungs in Bechuanaland, which was named *Australopithecus* by Prof. Raymond Dart. Numerous teeth and jaws of apes related to the chimpanzee are now being found in the Miocene of south-east Africa ; but

teeth and jaws of apes, with perhaps still more human characters, are abundant in the Mio-Pliocene deposits of northern India. Indeed, the theory that man arose in central Asia from ground apes, which had been driven from the forests by the upheaval of the Himalayas, is still the best which has been proposed.

Man had reached the stage of *Homo sapiens* before he crossed the narrow seas from Asia to Australia. The fossils *H. wadjakensis* and *H. soloensis* from Java, and some fossil skulls from South Africa seem to represent his forerunners on the mainland.

H. sapiens, who had already learned the art of trimming stone by pressure flaking, seems to have been the first human immigrant to America by way of Bering Straits. Late palæolithic stone implements like those found in the Gobi desert were discovered last year in Alaska. Implements much like those of the Solutrean stage in Europe have now been found in several localities in the southern United States in association with extinct mammals of Pleistocene age. Human remains were first found directly associated with extinct mammals in South American caves by the Danish naturalist, P. W. Lund, whose centenary has just been celebrated by the scientific men of Brazil in Minas Geraes.

The Pituitary Gland

THE anatomical and physiological connexion between the pituitary and diencephalon form the subject of Prof. P. T. Herring's presidential address to Section I (Physiology). The diencephalon itself is the site of integration of nervous impulses concerned in the regulation of many of the fundamental processes of life. The pituitary body is the only one of the diverse structures of the diencephalon which receives an accession of epithelium from an outside source—the buccal epithelium. These epithelial elements of the pituitary form one of the most important structures of the diencephalon.

The pituitary body provides the brain with an armamentarium of hormones, which are secreted in several ways. Quite a large number of hormones are now allocated to the pituitary, and more may be discovered. Some of these exert their actions directly upon peripheral tissues through the blood stream ; others act locally upon nervous mechanisms in the hypothalamus. All are under the control of this part of the brain.

From the anterior lobe are secreted hormones which stimulate growth and exercise a controlling influence over the gonads, thyroid, parathyroids, thymus, cortex of the suprarenals and the mammary glands. Some also influence metabolism, especially of carbohydrate and fat.

Pituitrin, an extract of the posterior lobe, has so far been separated into two fractions. One has a pressor effect. There are, however, anomalies in its action. It is also considered that the secretion of the posterior lobe is essential for the preservation of capillary tone. The other portion of pituitrin acts upon uterine muscle. The relationship of the secretion of the posterior lobe to the metabolism of carbohydrate and of fat is still obscure. Many other activities of the posterior lobe have been described and postulated, but one may well question if all be normal functions.

Nevertheless, one is compelled to conclude that the active principles of the pituitary are such as are necessary for the regulation of common and fundamental processes in the life of the animal. The diencephalon and pituitary body form a working unit, and have far-reaching importance in the control of fundamental physiological processes. It is probable that the pineal body is another part of the same mechanism, but its functions are still to be discovered.

Personality and Age

IN his presidential address to Section J (Psychology) on this subject, Dr. Ll. Wynn Jones directs attention to recent investigations with adult subjects. Most of the psychological measurements of the present century have been concerned with the mental traits of the child or the adolescent. Until recently, the later decades of human life had not been systematically studied. Adult populations are relatively inaccessible, the selection of samples presents statistical difficulties, and it is not easy to differentiate between what is largely native and what is largely acquired. Nevertheless, by the use of questionnaires, introspections, biographies, as well as various psychological tests, there has recently accumulated a mass of objective data concerning adults, resulting from the work of such investigators as Profs. Charlotte Bühler, Giese, Catherine and Walter R. Miles, Edward K. Strong, Terman, and Thorndike.

In brief, the effect of age, as such, on the ability to learn and, indeed, on most psychological abilities, is much less than has been generally supposed, not only up to middle age but even up to old age. It is true that elderly individuals, who still consider their powers to be at their zenith, may be objects of pity, but still more so, it would seem, are those who consider their abilities to have deteriorated long before that is actually the

case. Thorndike concluded that, in general, nobody under forty-five years of age should restrain himself from trying to learn anything because of a belief that he is too old to be able to learn it. For example, the facts are in flat contradiction to the doctrine that childhood is the period when it is easiest to learn to read, write or understand the hearing of a language. Similarly, objective tests of various sensory and motor and also of the more intellectual abilities show that the differences between old and young are small in comparison with the differences within either group.

Such findings have obvious applications to schemes of adult education or to the training of the unemployed. Ancient customs and opinions which had little scientific backing have in the past made it difficult for many of the unemployed to embark on any training for a new career. In industry it is especially important to obtain objective information regarding the handicaps of older workers. Age alone as a criterion for displacement or retirement is in many cases quite inadequate.

The question of age also arises in athletics. The ability of a sprint runner, which demands maximum expenditure of energy per second, is probably at its best at about twenty-three or twenty-four years of age. The half-miler must also learn economy of effort and its proper distribution, and his ability is at its maximum a year or two later. Much later are the maxima in sports requiring not only economy of effort but also the technique which only comes after long experience. Thus the median age of batsmen who have exceeded 3,000 runs in a season is 34·5 years; and the forty golfers who headed the Open Championship list in 1934 show a median of thirty-five years.

There are certain theoretical implications of these observations. Now that factorial analysis is proving so potent a method in psychology, it becomes necessary to study age in relation to personality more systematically. This will determine the relative importance of the various unitary traits at different stages of life, and this, in turn, will lead to a fuller psychological interpretation of the traits themselves.

Plant Pathology

MR. F. T. BROOKS'S presidential address to Section K (Botany) discusses certain aspects of recent investigations on disease in plants. With the discovery of the Mendelian inheritance of disease resistance, a potent weapon was placed in the hands of geneticists and pathologists for the control of plant diseases. Although sometimes very successful, the breeding of disease-resistant varieties cannot be looked upon as a panacea for the elimination of disease: great difficulties are sometimes experienced in building up these types, especially on account of the several diseases to which most crop plants are liable and the close linkage which often exists between a valuable quality and susceptibility to a particular disease; furthermore, progress along these lines with arborescent plants is necessarily slow. On the other hand, certain diseases can be effectively controlled either by paying due attention to environmental conditions which favour the host at the expense of the parasite, by the eradication of the sources of infection in accordance with the principles of plant sanitation, or by fungicidal treatment.

The influence of environment on the establishment of disease in plants is of outstanding importance. Environmental conditions which are most beneficial to the host frequently prevent attack by weak parasites. With fungi such as the rusts and downy mildews, however, optimum conditions for the host are often equally favourable to the parasite.

Much progress has recently been made in the study of the epidemiology of certain parasitic diseases, that is, the distribution in space and time of the causative micro-organisms which develop epidemically under favourable conditions. For example, in North America, Australia and India, an almost complete explanation is now available of the manner in which epidemics of black rust of cereals (*Puccinia graminis*) arise.

There are many physiologic or biologic forms within single species of parasitic fungi, especially in the rusts, a state of affairs which may greatly complicate the task of producing disease-resistant varieties. How these forms with different parasitic proclivities have arisen is an intriguing problem. It is known that sexual interactions between diverse forms may be the means of adding to their number, but it is suggested that gene mutation has also been a potent factor in their development. Although, in general, these physiologic forms are stable entities, their capacity for evolutionary change must not be forgotten.

Another active branch of plant pathology is that concerning the influence of one micro-organism on another in the establishment of disease. A host attacked by one fungus may thereby be rendered more susceptible to another, and a plant permeated by a complex of two viruses may exhibit symptoms unlike those induced by either virus acting separately. On the other hand, the effect of micro-organisms on one another may be one of antagonism. Of particular interest and of great importance is the antagonism shown by certain saprophytes to pathogenic fungi which invade the

underground parts of their hosts : indeed it is not too much to say that a new chapter in soil microbiology has been opened with the recognition of this factor of biological antagonism. The pathogenicity of fungi which cause foot-rot of cereals may be completely suppressed by the antagonistic influence of soil saprophytes, either through the secretion of some toxic substance or perhaps by the stress of competition. When more is known about the antagonism of other micro-organisms to pathogenic fungi in the soil, it may be possible to devise methods of biological control, such, for example, as altering soil conditions so as to favour the antagonistic action of other members of the micro-flora.

The Schools and Citizenship

DR. A. W. PICKARD-CAMBRIDGE has chosen "Education and Freedom" as the title of his presidential address to Section L (Educational Science). In Germany, Italy and Russia the suppression of freedom is largely carried out by the control of education, of which the aim is to teach the individual not to think. If freedom is to be maintained, it can only be by an education designed to teach the young to think freely and accurately, and to act as responsible citizens of democracy. The ideal community will be one which allows all to take a share in the formation of public opinion (and trains them to do so), and in which no one is simply a means to the ends of others, but each is free to realise the highest values and able to make his contribution to the common good. In the individual life, freedom, which is at first possessed only in a small measure, cannot usually be acquired without discipline and the presentation of the higher values by authority, and one function of education is to give the young a chance of appreciating these higher values, both by suggestion and example, and also in school work, for example, in the study of literature and history and the much-neglected study of the Bible.

Another function is to produce the habit of clear and accurate thinking. For this a citizen needs in later life access to the facts about which he is to form judgments, and this (as the popular Press is at present) is hard to obtain. In his education he should have practice in forming judgments upon evidence, and in all his work there should be insistence on individual thinking, not on mere absorption of lessons or rules-of-thumb. In many of the secondary schools of Great Britain—which are the key to the situation, since from them will come most of the teachers of the mass of the people and the leaders of opinion in most of the smaller circles in which public opinion is made—more practice might be given to the pupils in the management of their own affairs out of school, and in activities which encourage self-expression.

Examinations as at present treated in schools, largely owing to the excessive stress laid upon them by education authorities and employers, are serious obstacles to the acquisition of freedom and independence of mind, and here serious reforms are necessary. Other reforms, such as the prolonging of the time of education and the reduction of the size of classes, are urgently required, if the young citizens' capacity for freedom and for the citizenship of a free State are to be developed. All educational institutions and methods must be tested at every point by their tendency to produce or to hinder such freedom, and everything eliminated that makes for the standardisation of individuality or is hostile to ultimate independence of judgment, while at the same time the higher values (which make for good life and good citizenship) are so presented to the young that they may have the chance of freely making them their own.

State Control in Agriculture

IN his presidential address to Section M (Agriculture), Dr. J. A. Venn discusses the "Financial and Economic Results of State Control in Agriculture". A rather full criticism is made of agricultural economics and organisation from the end of the Napoleonic wars, until the beginning of the Great War—including that "period of rural depression of the 'nineties . . ." which finally passed "without affecting either the National outlook or the National purse".

The War years were a period of rigid control, and are therefore not considered. The present period began in 1922. The cost to the State of reliefs and disbursements are estimated. For example, the subsidising of sugar and molasses derived from home-grown sugar beet has been, during eleven years, slightly more than £47,000,000. The Forestry Commission will, in fifteen years, have expended £6,000,000. Non-returnable State contribution to the Milk Marketing Board amounted in 1934–35 to £1,600,000, and within a year £2,924,000 have been expended on the beef subsidy. Reliefs from rating must represent some £15,000,000 annually.

Recent tendencies involve a slight increase in output of the soil, a decline in arable area, a transference from production of feeding-stuffs to

that of sale crops, a reduction in number of workers, and a redistribution between the different classes of livestock. Of the expenditure that these results have involved, landowners have directly received little, and continued to deteriorate. Tenant-farmers have partly bridged a gap to save them from impotence as producers; while rural workers have received an increase of 75 per cent in wages. Recent 'planned' agriculture gives a figure of £40,000,000 in annual benefits derived from grants, remissions and augmented prices. It is arguable to what extent the middlemen's returns have been affected; but it may concern intimately the consumer. The direct tax-payer has gained a measure of respite, at the expense of the indirect.

A vast change has occurred in the problems of agriculture during the past hundred years, and consideration has ousted severity, and preferential treatment superseded laissez-faire. Agriculturists are faced with the twin problems of over-production and under-consumption. The most recent proposals involve a movement from quotas to levies, with a modicum of Dominion preference. Nevertheless, British agriculture has gained a protective covering to shield it from the worst economic shocks. But this may actually hamper it when progressing over the smoother terrain of normality which it is hoped lies ahead. Possibly the near future will witness some relaxation from control and some restoration of individual liberty of action.

Preservation of Sites of Scientific Interest

PROF. P. G. H. BOSWELL'S presidential address to the Conference of Delegates of Corresponding Societies deals with the preservation of sites of scientific interest in relation to town and country planning. One of the most enlightened enactments placed upon the Statute Book for a long time is the Town and Country Planning Act of 1932, wherein it is laid down that a local authority or joint committee must obtain the approval of the Ministry of Health before it can implement any resolution relating to a scheme of planning. Among the objects of such a scheme, as cited in Section 1 of the Act, are "preserving existing buildings or other objects of architectural, historic and artistic interest, and places of natural interest or beauty, and generally of protecting existing amenities whether in urban or rural portions of the area".

Formerly, the success of efforts directed to the preservation of sites and objects of scientific interest was due to the enthusiasm of advocates, and the broadmindedness and public spirit of landowners and benefactors. While this good work will, it is hoped, still continue, much more power is now in the hands of the people. But, as ever, knowledge is a prerequisite of useful action. How can the British Association, and in particular the Corresponding Societies, inform the people and assist them to safeguard their natural heritage?

Judging from the frequency of references to this and to cognate subjects in the columns of the daily Press, there can be no doubt as to the public awareness of the desirability and necessity for preserving sites and objects of scientific interest and natural beauty. The Ministry of Health has given opportunity to the Association to advise as to when action ought to be taken—that is, to conserve, concentrate and direct energy which might otherwise be dissipated in isolated action or unprofitable controversy. The areas in which planning schemes are proposed are notified to the British Association, a body admittedly well-fitted to advise the Ministry, by its aims and constitution, by its liaison with the Corresponding Societies, and by the call it can make upon scientific experts within and without its ranks.

Obviously, before the Association can act effectively, the requisite information regarding the existence of objects and sites worthy of preservation must be available. So far as botany and zoology are concerned, no systematic attempt to compile a list appears to have been made, but in the case of geology an inquiry was instituted some years ago by the Geological Society among local geologists and learned societies, with the result that a valuable though incomplete list was drawn up. In order to make the list as complete as possible, the Association is in a position to call to its assistance (*a*) its Corresponding Societies and their delegates; (*b*) the specialist learned societies; (*c*) officials of local museums and libraries; and (*d*) teachers in universities, colleges, and in public, grammar, secondary and technical schools. The reference list which may thus be compiled will be available for consultation as each scheme of planning is notified; and where there is doubt as to the best policy to pursue, the advice of experts on the panel already drawn up for the purpose by the Council can be sought.

Details are given of sites of scientific interest which should be preserved (*a*) in the area of Darwin's home at Downe, now held in trust by the British Association, and (*b*) in East Anglia.

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other. It helps also in the search for methods to control abnormal growth : the action of radium on a tissue culture can show how it may be used most effectively in the treatment of cancer. The director's Report gives brief abstracts of the different researches at present in progress.

Imperial Agricultural Bureaux

THE fifth annual report (1933–34) of the Executive Council of the Imperial Agricultural Bureaux has now been published (London : H.M. Stationery Office, 4*s*. net). Consequent on the recommendations of the Imperial Committee on Economic Consultation and Co-operation (1933), the Council, in addition to its previous duties, has taken over the administration and financial control of the Imperial Institute of Entomology and of the Imperial Mycological Institute. Special prominence is given in this year's report to the work of these Institutes, and the degree of their activity may be judged by the fact that, on an average, more than 2,000 specimens a week have been received for identification by the former, and material has been forwarded from thirty-five Dominions and Colonies to the latter Institute during the year under review. The parasite laboratory at Farnham Royal, started by the Empire Marketing Board, has also passed under the control of the Council, and now draws common financial support. The work of the eight original bureaux continues to develop, and increased use is being made of the information services available by research institutes and research workers throughout the Empire.

Madras Fisheries

DR. B. SUNDARA RAJ, director of fisheries, Madras, in his administration report for the year 1933–34 (Madras Fisheries Department), 1934, shows that the outstanding event of the year, which has brought back some measure of prosperity to the fishing industry of the west coast, was the return of the oil sardine in unexpected abundance after an absence almost complete for an unusually long series of years. The oil sardine (*Sardinella longiceps*) is the most important economic fish of the west coast, and its absence had reduced the fishermen to extreme poverty. Its return was just in time to save the industry from extinction, though advantage could not be taken of the abundance of the fish owing to the prevailing economic depression. Samples were examined twice a week and studied in detail. Research in all directions is progressing, an important result being the success obtained in keeping live pearl oysters under artificial conditions at the Krusadai Biological Station. This points to the possibility of establishing an oyster park which is one of the principal aims of this station. Oysterlings of 30–40 mm. have lived in cages well over a year, during which several have grown to almost adult size (50–65 mm.). There is evidence of the larger oysters in the cages having spawned in captivity. Spawn has been found in the cages, and a pycnogonid found swarming in them had young microscopic oyster spat attached to the lateral processes. Special attention is being given to determination of age and rate of growth. Other investigations are in progress including a systematic survey of deep-sea fishing grounds by the trawler, plankton investigations, fish eggs and larvæ, daily collection of food fishes and hydrographical records, whilst technological research is not neglected. The whole report is exceedingly interesting and instructive, showing much activity in all directions.

Literature of Food Investigation

THE first number of vol. 6 of the "Index to the Literature of Food Investigation" reviews the developments during the years 1932–33 (Department of Scientific and Industrial Research : Index to the Literature of Food Investigation : Vol. 6, No. 1, March 1934. Compiled by Agnes Elisabeth Glennie, assisted by Owen Davies. London : H.M. Stationery Office, 1935. Pp. 309+v. 5*s*. net). One of the most important is the application of gas storage to meat : by increasing the amount of carbon dioxide in the atmosphere to 10–12 per cent, it is possible to keep chilled meat in good condition for about seven weeks, so that chilled, instead of frozen, meat can be brought to Great Britain from so far away as New Zealand. Among other problems relating to animal products to which attention is directed are the onset of rancidity in stored food and the production and use of fish oils, which has assumed increasing importance with the development of our knowledge of the value of vitamins A and D as dietary factors.

HALIBUT liver oil is a rich source of vitamin A, often 50–100 times as rich as cod liver oil : the liver oil of the ling cod may contain about eight times as much vitamin D as cod liver oil : the latter is not present in the liver oils of cartilaginous fish or in the liver fat of whales and other mammals. In the case of milk and milk products, reference is made to the pasteurisation of milk, the effect of processes of manufacture on the solubility of the protein of milk powders and the keeping qualities of butter. Interest continues to be shown in methods of freezing animal and vegetable tissues. Quick freezing has no advantage over slow freezing, so far as the palatability of meat is concerned, nor has it any advantage in the preservation of peaches, strawberries or apple cider. Freezing orange and grapefruit juices does not usually affect the vitamin C potency. The importance of research into the problems of the storage and transport of fruit is shown by the fact that in 1932 more than 100,000 tons of oranges and 7 million bunches of bananas were brought to Great Britain in refrigerated ships, and emphasis is laid on the fact that the most satisfactory method of ascertaining the best storage temperatures for ocean transport is to make precisely controlled storage trials in the country of origin of the fruit.

New 'House Number' Lamps

THE names of the streets round London are usually placed in a conspicuous position and are well lit by some neighbouring lamp, but in some of the side

streets and avenues it is difficult to identify the number of the house. The illumination of these numbers would often be a great boon. In the August number of *Helios*—the German export journal for the electric industry—it is stated that in many newly built suburbs 'number lamps' have been installed over the front doors or in other convenient spots. Several of the older streets also are being equipped with these lamps. Electricity supply companies are encouraging their use by giving the consumer energy for illuminating the lamps at a specially low rate. The number lamps illustrated in the journal are prismatic in shape, three of the edges being vertical and the top and base being horizontal. Expensive shades in opal glass are sometimes used, but owing to the risk of breakage, most people use a cheaper form. Simple panes of glass are put in a cast iron frame. They can be easily removed for cleaning and in the event of an accident the pane can be easily replaced. The transparent number panes are placed in a black frame and the triangular base of the lamp is provided with an opal glass pane which lights up the entrance to the house.

Physics Research at Harvard

Contributions from the Physical Laboratories of Harvard University, vol. 22, is a collection of separate copies of 29 papers which have been issued by the Laboratory during the years 1932–33, bound together and provided with a table of contents. It extends to about five hundred pages, but the pagination of the original memoirs is retained. More than half of the volume is occupied by papers written by Prof. P. W. Bridgman or by workers in his laboratory. They add considerably to our knowledge of the properties of substances under great pressures. A paper by Prof. Bridgman puts forward serious criticisms of some of the methods of proof used in the current theory of groups (*mengenlehre*). Several of the remaining papers issue from the laboratory of Prof. W. Duane, and deal with investigations of atomic and molecular properties, while others dealing with spectroscopic investigations originate in Prof. T. Lyman's laboratory. Two others deal with vapour pressures and entropy, one with the magnetic properties of certain iron alloys, and another with the large changes of ionisation of the atmosphere which are produced by solar eclipses. Readers of these contributions will be struck by the importance of the work which is being done by 'National Research Fellows'.

The Fish and the Ring

THE city of Glasgow bears in its coat of arms a fish with a ring in its mouth, and the incident so commemorated involved a lady's honour in the days of St. Kentigeon. But since rubber rings were invented, the association between fish and ring has become a matter of solid fact. In the *Australian Museum Magazine* of April, G. P. Whitley has collected accounts of curious cases where fishes have become involved in rings, and the examples range from garfish and mackerel with rubber rings surrounding and even partly embedded in their bodies, to a shark, captured at Havana, Cuba (recorded by Dr. Gudger), and adorned by a motor-car tyre which encircled its body and was prevented from slipping over the tail by the dorsal fin and from slipping over the head by the pectorals.

Land Speed Record

SIR MALCOLM CAMPBELL made a new world land-speed record on September 3 by driving his *Bluebird* car on the Bonneville salt flats in Utah at a mean average speed of 301·337 miles per hour. In the first run, he was stated to have covered the measured mile in 11·83 sec., which works out at 304·311 m.p.h. The second run was stated to have been covered in 12·18 sec., giving a speed of 295·566 m.p.h. His average speed was therefore given as 299·875 m.p.h. Later it was announced that there had been a miscalculation of the time, and the average speed was corrected to 301·337 m.p.h.

Announcements

THE autumn meeting of the Institute of Metals will be held at Newcastle-upon-Tyne on September 9–12. The proceedings will begin in the evening with the delivery by Dr. H. W. Brownsdon of the fourteenth annual Autumn Lecture on "Metal Melting: its Effect on Quality". Following the lecture, a general discussion will take place on several different phases of the lecturer's subject. No tickets are required for admission to the lecture, which will be given in the King's Hall, Armstrong College, at 7.15. Visitors are admitted to the business sessions, beginning each morning at 10 a.m., on signing the visitor's book in the New Mining Lecture Theatre, Armstrong College.

A VOLUME of collected researches published from the Wards and Laboratories of the London Hospital during 1934 has been issued (London: H. K. Lewis and Co., Ltd. 7*s*. 6*d*. net). The papers included extend over a wide range of subjects, and mostly embody original observations of importance for the diagnosis, prognosis and treatment of disease.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

An assistant (Grade II) and a junior assistant in radiological research, a junior assistant and two assistants (Grade II) in ballistics research, and an assistant (Grade I), an assistant (Grade II) and a junior assistant in explosives research, in the Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich, S.E.18 (Sept. 14).

A junior scientific officer in the Admiralty Scientific Pool—The Secretary of the Admiralty (C.E. Branch), Whitehall, S.W.1 (Sept. 21).

An assistant curator of the Museums in Leeds—The Town Clerk, Room 57, Civic Hall, Leeds, 1 (Oct. 7).

A lecturer in mathematics in the University of Tasmania—The Agent-General for Tasmania, Australia House, Strand, London, W.C.1.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 398.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Charles Darwin and the Galapagos Islands

IT seemed possible that an examination of some of the unpublished Darwin manuscripts dealing with material collected during the weeks spent on the Galapagos Islands might bring fresh light to bear on the much discussed manner of growth of his evolutionary outlook. At what period during the *Beagle* voyage did his views crystallise ?

We know that in 1837 Darwin opened his first notebook on the transmutation of species, and made especial tribute to the Galapagos species as the origin of all his views, together with the South American fossils. But little sign of such a revolution found its way on to paper at the time. I have therefore been fortunate in finding among the contemporary ornithological notes a passage bearing directly on the subject, where the significant phrase "for such facts would undermine the stability of species" occurs. Here we have the earliest date yet obtained, I think, for an admitted upheaval of his thoughts along evolutionary lines. The ferment had already begun to work in September 1835.

As the passage in the manuscript differs widely from what was printed, both in the "Voyage of the *Beagle*" (1870, pp. 394–5), and in the "Birds of the Voyage" (Part 3, "Zoology of the Voyage", 1841, 4to) it may be worth quoting it at greater length.

"*Thenca.* [Mimus Thenca.] These birds are closely allied in appearance to the Thenca of Chile. They are lively, inquisitive, active, *run fast*, frequent houses to pick the meat of the tortoise which is hung up,—sing tolerably well,—are said to build a simple open nest,—are *very* tame, a character in common with other birds. I *imagined*, however, its note or cry was rather different from the Thenca of Chile— ? Are very abundant over the whole Island ; are chiefly tempted up into the high and damp parts by the houses and cleared ground.

"I have specimens from four of the larger Islands ; the specimens from Chatham and Albemarle Isd. appear to be the same, but the other two are different. In each Isd. each kind is *exclusively* found ; habits of all are indistinguishable.

"When I recollect the fact, that from the form of the body, shape of scales and general size, the Spaniards can at once pronounce from which Isd. any tortoise may have been brought :—when I see these Islands in sight of each other and possessed of but a scanty stock of animals, tenanted by these birds but slightly differing in structure and filling the same place in Nature, I must suspect they are only varieties. The only fact of a similar kind of which I am aware is the constant asserted difference between the wolf-like Fox of East and West Falkland Isds.— If there is the slightest foundation for these remarks, the Zoology of Archipelagoes will be well worth examining ; for such facts would undermine the stability of species."

Yet this profound change of view is scarcely discernible in the different editions of "Voyage of the *Beagle*". Even in the second edition of 1845, the words "creation" and "creative force" are used in the Galapagos discussion in the traditional sense. Darwin took no pleasure in overthrowing preconceived doctrines ; he entered the new road cautiously, determined to pave it with solid accumulated evidence. Probably a certain deference to Capt. FitzRoy's views, emphatically creationist, helped to delay the unfolding of Darwin's divergent opinions.

In this respect, FitzRoy's description of the birds of the Archipelago is in interesting contrast to the quotation from Darwin. "All the birds that live on these lava-covered islands have short beaks, very thick at the base, like that of a bull-finch. This appears to be one of those admirable provisions of Infinite Wisdom by which each created thing is adapted to the place for which it was intended. In picking up insects or seeds which lie on hard iron-like lava, the superiority of such beaks over delicate ones, cannot, I think, be doubted. . . ."

It is sad to learn from Ecuadorian sources that the Galapagos Archipelago is no more ; it is now the Archipielago de Colón. Moreover, Chatham Island has become San Cristobal, Hood and Charles are Española and Santa Maria Floreana, whilst Albemarle is Isabella. Perhaps in all truth as fitting a collection of names for the Pacific Ocean as our old ones of British kings, admirals and statesmen ; but saddening to insular tradition.

NORA BARLOW.

Boswells,
Wendover,
Bucks.

X-Ray Examination of the Effect of Removing Non-Cellulosic Constituents from Vegetable Fibres

THE cellulose of the cell-wall and fibres of most plants contains closely associated polysaccharide material which is generally a xylan. The cotton hair is unique in being free from xylan, but manilla hemp, jute and sisal, for example, may contain as much as 15–20 per cent. The view has been put forward tentatively that the xylan molecules in such fibres participate in the micelles and are oriented in the same direction as the cellulose chains[1] : the period along the fibre-axis of xylose residues in oriented xylan would be very much the same as that of the glucose residues in cellulose, and their presence should make no fundamental difference to the X-ray photograph. In support of this view there is the well-known fact that actually no such difference is observed in the ordinary way.

In carrying out a more serious test of the hypothesis, we have recently, among other things, examined by X-rays the effect of removing progressively the xylan (initially 19·8 per cent) of cellulose fibres from manilla hemp, using an apparatus specially designed for taking strictly comparable photographs on one and the same film[2]. By this means very accurate comparisons were possible, but again no really fundamental change was revealed. Briefly, it may be said that removing xylan from fibres of high xylan content merely makes their X-ray photographs more like those of fibres of low xylan content! The point of this apparently pointless verdict is that the X-ray photographs of fibres of low xylan content—ramie and Italian hemp, for example—show certain diffraction features typical of a more perfect state of crystallisation. The result of these experiments is therefore definitely in favour of the view that the incorporation of xylan is a sort of mixed crystallisation.

A number of common fibres were also purified by removal of lignin and encrusting hemicelluloses. As would be expected, the effect of this treatment was in general to clarify the X-ray photograph, and in most cases to lead to improved definition through a sharpening of the crystallite orientation. Otherwise, nothing of any great significance was observed. Much depends on the care with which the chemical pre-treatment is carried out, for it is possible to injure the crystallite orientation instead of improving it. Miles Thomas and Hewitt[3] report a diminished *intensity* in photographs of purified fibres; but we have not observed such an effect.

The photographs and experimental details of the work will be published in due course. In the meantime attempts are being made to obtain an X-ray pattern from xylan alone.

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Aug. 16.

[1] Norman, *Science Progress*, **27**, 299; 1933.
[2] Cf. Astbury and Woods, *Phil. Trans. Roy. Soc.*, A, **232**, 333; 1933.
[3] NATURE, **136**, 69, July 13, 1935.

Sub-Boundaries in a Crystal Grown by the Bridgman Method

INTEREST in irregularities observable in single crystals has arisen through the large discrepancies between the results of experimental studies of some of the physical properties of crystals and theoretical studies based on the idea of a single uniform lattice extending throughout each single crystal.

An observable irregularity has been found in working with a single crystal of copper grown by the Bridgman method. In trying to get an undistorted section parallel to the 311 planes for use as an X-ray polariser[1] many surfaces had to be cut, etched and examined under the microscope. The appearance of one such section, shown in the photomicrograph (Fig. 1), suggests that the crystal had broken down into a large number of small ones, the outlines of which are seen as the curved lines. The etching had been done with nitric acid, which develops the cube planes, so that the whole surface was covered by tiny cubes each having one corner projecting.

It was noticed that, as nearly as could be judged by eye, not only were the whole of the cubes similarly orientated, as would be expected in a single crystal, but also some of the individual cubes actually crossed the curved boundary lines. Both effects were easily seen distributed over the whole 7 mm. of crystal and they are detectable in the photomicrograph. The arrow is parallel to a cube face. The grinding marks are parallel to the two edges of the page. X-ray photographs showed that if the crystal had broken up into smaller ones, their orientation was unchanged within the limits of the experimental accuracy.

FIG. 1. Etched section of a single crystal copper rod cut parallel to (311) planes showing, to left of arrow, sub-boundaries crossed by cube edges. (× 30.)

Sir Harold Carpenter kindly pointed out that the markings are similar to the 'sub-boundary' or 'veined' structures observed in many metals. In the literature, these have been studied in the individual grains (crystals) of polycrystalline material but their nature is apparently not understood yet. Smithells and Rooksby[2] suggest that the sub-boundaries are formed under the influence of stresses set up during the rapid cooling of the metal (tungsten). Such a hypothesis would be untenable for copper as the observations here reported were made upon a crystal cooled very slowly. Furthermore, Northcott[3] was able to suppress veining in polycrystalline copper by quenching from 1,000° C. The etching which is favourable for revealing sub-boundaries is not always favourable for showing the crystal orientation. In preparing the specimen illustrated, the acid was applied to the clean dry surface held by the side of a running tap, so that the action could be stopped quickly after about one second.

Since these sub-boundaries can be found in single crystals, it is evident that their possible influence upon some physical properties can be studied in types of experiment not possible with polycrystalline material where they have been observed hitherto.

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The University, (Royal Society Sorby
Sheffield. Research Fellow).
Aug. 1.

[1] George, NATURE, **136**, 180, Aug. 3, 1935.
[2] Smithells and Rooksby, NATURE, **120**, 226; 1927.
[3] Northcott, *J. Iron and Steel Inst.*, **126**, 274; 1932.

Change of Magnetic Susceptibility of Metals during Melting and Allotropic Transformation

THE change of magnetic susceptibility during allotropic transformation or melting of metals was first observed by one of the present writers[1] about twenty-five years ago, in his measurement of the magnetic susceptibility of pure metals at temperatures ranging from room temperature up to 1,000°. In that paper the remarkable fact was mentioned that the magnetic susceptibility of tin changes its sign twice as the temperature rises. That is, the change of grey tin, which is a strongly diamagnetic substance, into white tin at 18°, is accompanied by an abrupt increase of susceptibility, which becomes thus paramagnetic, and afterwards this susceptibility remains constant up to 232°, at which temperature it resumes its diamagnetic properties on melting. In order to obtain a more accurate value of the susceptibility change during allotropic transformation or melting, we have recently measured the susceptibility in vacuum, and have succeeded in explaining the phenomenon in a quantitative way by applying our former theory[2] which has been proposed to explain the change of susceptibility in metals caused by cold working.

This note contains a preliminary report regarding metals such as tin, copper, silver and gold that show the above phenomenon.

In our theory, we assume that the magnetic susceptibility is affected by the volume change caused by an allotropic change or melting in two different ways: (1) the change of paramagnetic susceptibility due to the diminution of free electrons caused by the expansion; (2) the change of diamagnetic susceptibility due to the increase of bound electrons caused by the expansion. In the case of contraction, the free electrons increase at the cost of bound electrons, and hence the changes due to (1) and (2) are exactly opposite.

Now, according to W. Pauli, L. Landau and L. Posener[3], the first change of susceptibility is given by

$$d\chi_1 = +\frac{2}{9}\frac{CL^{\frac{1}{3}}\alpha_0^{\frac{1}{3}}}{W^{\frac{1}{3}}\rho_0^{\frac{2}{3}}}\left\{-2+\frac{A}{3\alpha_0}\left(\frac{4\pi}{3M}\rho_0\right)^{0\cdot488}\right\}\frac{d\rho}{\rho_0},$$

where $C = 2\cdot21 \times 10^{-14}$, L = Loschmidt's number per mol, W = atomic weight, ρ = density, α = number of free electrons per atom, $A = 2\cdot261 \times 10^{-12} Z^{0\cdot513}$, Z = the atomic number and M = mass of the atom.

According to Sommerfeld[4] and T. Hironé[5], the second change of susceptibility is given by

$$d\chi_2 = -\frac{4\cdot13 \times 10^{-7} Z^{-\frac{1}{3}} \alpha_0 x_0}{a\ W}\left(\frac{3M}{4\pi}\right)^{\frac{1}{3}}\cdot\rho^{-\frac{1}{3}}\cdot\frac{d\rho}{\rho_0}+$$

$$\left\{2\cdot06\times10^{-7}x_0^2Z^{-\frac{2}{3}}+0\cdot662\times10^{-5}\alpha_0^{-\frac{2}{3}}\right\}\frac{A}{W}\left(\frac{4\pi}{3M}\rho_0\right)^{0\cdot488}\frac{d\rho}{\rho_0};$$

where $x = \frac{r}{a}$, $a = \frac{0\cdot4676}{Z^{\frac{1}{3}}} \times 10^{-8}$, $r = \sqrt[3]{\frac{3M}{4\pi\rho}}$.

Hence, $d\chi = d\chi_1 + d\chi_2$.

ρ, $d\rho$ and α[6] being known from the experimental data, all the quantities found in the expression for $d\chi$ will be known, and $d\chi$, therefore, can be calculated.

The result of the calculation by the above method and also the observed change of magnetic susceptibility for tin, copper, silver and gold are given in the accompanying table:

Phase change	a_0	ϱ_0	$\frac{d\varrho}{\varrho_0}$	$d\chi_1 \times 10^6$	$d\chi_2 \times 10^6$	$d\chi \times 10^6$ (theor.)	$d\chi \times 10^6$ (obs.)
Allotropic change, white tin → grey tin	0·06	7·29	− 0·20	− 0·031	− 0·273	− 0·31	− 0·32
Melting of tin	0·043	7·18	− 0·028	− 0·006	− 0·047	− 0·052	− 0·061
,, ,, copper	0·036	8·38	− 0·041	− 0·011	− 0·153	− 0·164	− 0·120
,, ,, silver	0·044	9·86	− 0·050	− 0·009	− 0·105	− 0·114	− 0·097
,, ,, gold	0·043	18·39	− 0·052	− 0·007	− 0·080	− 0·087	− 0·071

Thus the very interesting phenomenon mentioned above in the case of tin can be explained by our theory. As is seen from the table, the observed change of susceptibility from white tin ($\chi = +0\cdot027 \times 10^{-6}$) to grey tin ($\chi = -0\cdot29 \times 10^{-6}$) is $-0\cdot32 \times 10^{-6}$, while the theoretical value is $-0\cdot31 \times 10^{-6}$; and the observed change in susceptibility of tin during melting from paramagnetic to diamagnetic is $-0\cdot061 \times 10^{-6}$, while the theoretical value is $-0\cdot052 \times 10^{-6}$. A similar comparison between the observed change of the susceptibility during melting and its calculated value in the case of copper, silver and gold shows also good agreement between these two values.

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July 8.

[1] K. Honda, *Ann. phys.*, **32**, 1027; 1910.
[2] K. Honda and Y. Shimizu, NATURE, **132**, 565; 1933. Y. Shimizu, *Sci. Rep.*, **22**, 916; 1933.
[3] *Z. Phys.*, **41**, 99; 1927. **64**, 629; 1930. **75**, 809; 1932.
[4] A. Sommerfeld, *Z. Phys.*, **78**, 283; 1932.
[5] T. Hironé, to be published in near future.
[6] K. Honda, T. Nishina und T. Hironé, *Z. Phys.*, **76**, 80; 1932.

Production of Electron Pairs

DIRAC's theory of electrons gives us the possibility of calculating the production of electronic pairs by collisions between electrons and nuclei. This process may be described as a second order effect of the perturbation of plane electron waves due to the nuclear field, and to the interaction between the incident electron and the electron which originates the pair in the transition from a negative to a positive energy state (rising electron).

If we regard the nuclear field as acting only on the rising electron, and if we assume Møller's[1] primitive electron interaction, we obtain as the cross-section for the production of a pair, of energy between ε and $\varepsilon + d\varepsilon$, by an electron of energy w_0 in field of a nucleus Ze,

$$d\sigma_0 = \frac{56}{9\pi}\alpha^2Z^2\left(\frac{e^2}{mc^2}\right)^2\log\frac{2\varepsilon}{mc^2}\cdot\log\frac{w_0}{\varepsilon}\cdot\frac{d\varepsilon}{\varepsilon}, \quad \ldots \quad (1)$$

if $w_0 \gg \varepsilon \gg mc^2$, in harmony with the results of Landau and Lifshitz[2] and of Williams[3].

Møller's primitive interaction is only available,

however, for first order processes: for second order processes it must be modified by an appropriate generalisation of the Bethe and Fermi method[4]. If we introduce this correction, which is equivalent to computing the reaction of the process on the incident electron, we obtain as cross-section

$$d\sigma_1 = \frac{14}{9\pi}\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\frac{d\varepsilon}{\varepsilon} \quad . \quad . \quad . \quad (2)$$

Even this cross-section is incorrect, because it neglects the action of the nuclear field on the incident electron, while on the other hand we may suppose that the excess impulse is given to the nucleus by this electron rather than by the rising one. If we calculate the process only with this last nuclear action, we obtain as cross-section

$$d\sigma_2 = \frac{8}{9\pi}\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\frac{d\varepsilon}{\varepsilon} \quad . \quad . \quad . \quad . \quad (3)$$

(If we assume Møller's primitive interaction without modifications, $d\sigma_2$ would be small in comparison to $d\sigma_0$ and $d\sigma_1$.)

To obtain the right expression for the cross-section, it suffices to sum $d\sigma_1$ and $d\sigma_2$, because the product of the matrix elements due to the two nuclear actions is antisymmetrical as regards the electron and positron, and vanishes with the integration. We have then

$$d\sigma = \frac{22}{9\pi}\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^2 \frac{2\varepsilon}{mc^2}\frac{d\varepsilon}{\varepsilon}, \quad . \quad . \quad . \quad (4)$$

and integrating,

$$\sigma = \frac{22}{27\pi}\alpha^2 Z^2 \left(\frac{e^2}{mc^2}\right)^2 \log^3 \frac{2w_0}{mc^2} \quad . \quad . \quad . \quad . \quad (5)$$

We see then that even in this approximation, we must neither neglect the reaction of the process on the incident electron, nor the interaction between this electron and the nucleus.

A fuller calculation and discussion of this problem will shortly be published.

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July 27.

[1] C. Møller, *Z. Phys.*, **70**, 686; 1931.
[2] L. Landau und E. Lifshitz, *Sow. Phys.*, **6**, 244; 1934.
[3] E. J. Williams, NATURE, **135**, 66; 1935.
[4] H. Bethe und E. Fermi, *Z. Phys.*, **77**, 296; 1932. See also W. Heitler et L. Nordheim, *J. Phys.*, **5**, 449; 1934.

Registration of the Ionisation Curve of a Single α-Particle

IN a recent letter[1], Dr. Alfvén of Uppsala has described a method for measuring the ionisation along the track of individual α-particles. Some years ago, an almost identical method was developed in this laboratory[2] (Fig. 1) and has been used for the investigation of the α-rays from radium and polonium[3]. The main difference between this method and that developed in Uppsala appears to be that, thanks to the oblique direction of the α-rays to the field, with the former method complications from different saturation are largely eliminated. Also the loss of ions to the grid is avoided by the application of a suitable potential. We have, however, of late abandoned this method for others giving more accurate results; namely, for the counting of α-particles and H-particles the "Doppel Röhrenelektrometer"[4], and for exact measurements of the

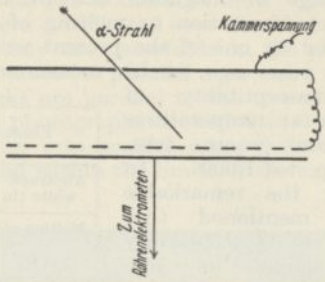

FIG. 1. From *Phys. Z.*, **33**, 294; 1932.

specific ionisation along individual α-tracks the method recently published by G. Stetter and W. Jentschke[5], also using a twofold registration.

GEORG STETTER.

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Universität, Wien.

[1] NATURE, **136**, 60, July 13, 1935.
[2] G. Stetter, *Phys. Z.*, **33**, 294; 1932.
[3] H. Dannbauer, Dissertation, Universität Wien.
[4] G. Stetter u. J. Schintlmeister, *Wien. Ber.*, **142**, 427; 1933. *Mitt. Rad.-Inst.*, No. 322.
[5] G. Stetter u. W. Jentschke, *Phys. Z.*, **36**, 441; 1935.

I AM sorry that I overlooked the papers cited by Prof. Stetter. In excuse I may state that the first paper is published under the title "Eine neue Methode zur Messung der Ionenbeweglichkeit", the second is unobtainable here, the third is published in a journal not very much read, and the fourth was published after my letter was sent to NATURE.

In any event, I do not agree with Prof. Stetter, that my experiment is a copy of his. The main features of the former are:

(1) The ions move with *constant* velocity to a special chamber where they cause a current which is amplified. In some experiments in 1929 I tried to move the ions by a slow air current, but with bad results. In the experiment described in my letter, it is made with a *homogeneous* electrical field. As the grid and the chamber have the same potential in Prof. Stetter's experiment, the field (deriving from the "Durchgriff" only) is not homogeneous. Then the ions do *not* move with a constant velocity and there is no possibility of constructing the ionisation curve from the current to the amplifier.

(2) The amplifier is constructed in such a way that the *current* to the first grid (not its integral) is registered by the oscillograph. Then the ionisation curve is *directly* registered on the oscillogram. In Prof. Stetter's experiment, the registered curve must be differentiated to give the current to the amplifier. In the registrations he has published it seems to be impossible to differentiate the curve with any degree of accuracy.

As regards complications from different saturation and the loss of ions to the grid, I do not think that these are of much importance in an experiment which in any event gives only an approximate picture of the ionisation curve.

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Aug. 21.

The Fundamental Paradox of the Quantum Theory

THE question of the logical consistency of quantum mechanics has recently been discussed by Prof. G. Temple[1] and by Dr. H. Fröhlich and Dr. E. Guth[2]. Temple arrives at an apparent contradiction, starting from principles which he states to be an essential part of quantum theory. From these principles contradictory results follow, as Temple shows by a perfectly rigorous deduction. (The existence of this deduction seems to have been ignored by Fröhlich and Guth.)

The main assumption used by Temple is that to every function of the classical variables of motion (momentum, co-ordinate, etc.) there corresponds one unambiguously defined operator which may be taken as the representative of this function in quantum mechanics. Although this assumption can be found quite frequently in papers discussing the principles of quantum theory, and even in some text-books, I would like to emphasise that it is not at all necessary and—as one can see from Temple's argument—not even possible in quantum mechanics.

Quantum mechanics requires operators as representatives of physical variables for two purposes: to connect wave functions with experiments, actual or possible, and to calculate the time dependence of the wave function. In order to be able to apply quantum mechanics unambiguously to actual problems, one must, therefore, know (*a*) the operator representing the quantity measured by any given apparatus, and (*b*) the energy operator for any given physical system. Properly speaking, (*a*) is a special case of (*b*), for the properties of a measuring apparatus can always be analysed if its interaction energy with the object in question is known.

If, then, we had an apparatus built in such a way as to measure, say, qp^2q (p denoting the momentum, q the co-ordinate of a particle), this apparatus would be *different* from an apparatus measuring $\frac{1}{2}(p^2q^2 + q^2p^2)$, although in the limiting case of classical mechanics, where quantum effects are negligible, both would measure the same quantity.

Before applying such an apparatus (assuming, for the sake of argument, that it exists although it probably does not) one would have to make sure, either by experimental investigation or by applying quantum mechanics to its working mechanism, which operator actually is to be associated with it. In other words, an apparatus which is quite suitable for measuring a certain quantity in the classical limit may not satisfy our requirements if we rebuild it on a smaller scale, because then quantum effects will have to be taken into consideration.

That one never meets with any difficulty about the order of factors in the usual applications of quantum theory is due to the fact that only very simple operators occur in practice. The most typical of them is the energy of an electron in a field of force, $p^2/2m + V(q)$ (m = mass, V = potential energy). One generally assumes that the function in this exact form, without quantum corrections, has to be taken as the energy operator of a particle the energy of which would be given by the same expression in classical mechanics. This assumption seems very *natural*, but it cannot be *proved* on mere theoretical grounds. All one can say is that this expression is the *most plausible* amongst a variety of different expressions, which all become equal in the classical limit but differ by terms like, for example, $pV - Vp = (h/2\pi i)\text{grad } V$ (h = Planck's constant). It is for the experiment to show that the most plausible choice corresponds to reality and that such correction terms are absent.

That the absence of these correction terms cannot be inferred from mere theoretical considerations is proved by the fact that when relativity and spin corrections are taken into account, such terms actually *do occur*.

R. PEIERLS.

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Aug. 5.

[1] NATURE, **135**, 957, June 8, 1935.
[2] NATURE, **136**, 179, Aug. 3, 1935.

Uncertainty Principle and the Zero-Point Energy of the Harmonic Oscillator

ACCORDING to quantum mechanics, an oscillator possesses a definite zero-point energy of vibration, and an attempt has been made to express this result *directly* in terms of some general principle. It has been found that the result may be deduced from the uncertainty principle, in view of the particular relation between position, momentum and energy in a simple harmonic field.

In a state of zero energy the vibrating particle would be at rest at the centre of the field, and its position and momentum would both be known accurately. But this would contradict the uncertainty principle, and the state is therefore not possible. The value of the minimum energy may be calculated from the uncertainty relation $\Delta p\, \Delta q \geqslant h/2\pi$. The linear harmonic oscillator is defined by the energy equation

$$W = \tfrac{1}{2}\mu\omega^2q^2 + \tfrac{1}{2}p^2/\mu = \text{constant}.$$

If we interpret

amplitude of q = Δq = uncertainty in position,
amplitude of p = Δp = uncertainty in momentum,

then $W = \tfrac{1}{2}\mu\omega^2(\Delta q)^2 = \tfrac{1}{2}(\Delta p)^2/\mu$,
giving $\mu\omega\, \Delta q = \pm\, \Delta p$.

For real Δp the positive sign must be taken, and from the uncertainty relation, $(\Delta p)^2 \geqslant h\mu\omega/2\pi$, and therefore $W \geqslant \frac{1}{2}h\omega/2\pi$. Taking the equality sign for the least value of the energy, it follows that the zero-point energy is $\frac{1}{2}h\omega/2\pi$.

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June 22.

The Problem of a Plant Virus Infection

IN a recent publication[1] an account was given of a new virus disease which occurred spontaneously in tobacco plants growing under insect-proof conditions in sterilised soil and sand. It was shown that the cowpea (*Vigna sinensis*), on account of its extreme sensitivity to the virus, was a valuable experimental plant. In continuing studies upon this disease, some observations have been made which will be of interest to virus workers.

It has been found by inoculation tests that a high percentage of healthy tobacco plants of the variety White Burley carry the virus in the roots. These plants are absolutely normal in appearance and under the present conditions of light and temperature in

the glasshouses remain normal until mature. Careful tests have failed to demonstrate the presence of the virus in the stems and leaves of young tobacco plants which are carrying the virus in the roots. The virus has, however, been isolated on one or two occasions from the stems of old, apparently normal, tobacco plants.

It therefore appears that a large proportion of tobacco plants of the White Burley variety normally carry a potential virus disease within them, and it is thus possible to inoculate a perfectly healthy plant from its own roots and to produce thereby severe, though localised, virus symptoms. Visible disease symptoms develop naturally in tobacco seedlings in the glasshouses from November until April, but have not been observed during the summer.

Further, and this is the most interesting point, there is a good deal of evidence that the same young tobacco plants which, by available inoculation methods, have been shown to be virus-free, yet contain the virus in the roots in quite large quantities some five or six weeks later.

The following experiment illustrates this. Seed from a White Burley tobacco plant grown in the insect-proof glasshouse was sown in sterilised sand in a 'cellophane' cage in the glasshouse. From the resulting seedlings a number of small plants were chosen and all the roots cut off except that one root was left on each plant. The roots of each plant, thus removed, were ground up and the resulting paste inoculated separately to three or four cowpeas. The tobacco plants were then repotted in sterilised soil and allowed to grow on; from this number twenty-four plants, the roots of which had given no reaction on the cowpeas, were selected for a second test. This was made, again to cowpeas, five weeks after the first test. The plants were by this time about eight inches across with a well-developed root system and showed no unusual symptoms. Of these twenty-four plants, on the second test, the roots of only five were found to be virus-free. The roots of the others gave a virus reaction ranging from twenty-five lesions, on five cowpeas out of five inoculated, down to a single virus lesion.

In considering these results, certain other facts should be borne in mind; exhaustive tests make the possibility of outside infection by seed-, soil-, or water-transmission unlikely, though seed transmission in some form cannot be definitely excluded. The virus is not insect borne. Further, it should be emphasised that natural infections of the virus have not occurred on any plant other than the tobacco, *Nicotiana tabacum*, and, occasionally, on *Nicotiana glutinosa*. Plants like cowpea, *Datura* and tomato have never once in five years become naturally infected in the glasshouse, although growing alongside virus-containing tobacco plants. Yet these species, especially the cowpea, are very susceptible to artificial inoculation with the virus.

Other properties of the virus which may have a bearing on the problem are its lack of resistance—it only remains viable in extracted sap for about 20 days—its low dilution end-point of 1 : 10,000 and its inability to withstand desiccation. The virus is of very small size; the average particle diameter is only 20–30 mμ as measured by the Elford process of ultra-filtration. Finally, there is the tendency of the virus to remain localised in the host whether the infection is natural or artificial and whatever the species of host plant. This fact also militates against the probability of seed transmission of the virus.

There seem to be three possible explanations of this problem. First, it may be assumed that the virus is present all the time in the stem, but present either in a non-virulent form which requires to gain virulence by concentration in particular cells of the roots or else in a dilution too great to give a positive reaction on inoculation. This theory, of course, involves seed transmission of the virus in undetectable form or quantity. The second possible explanation is that the virus is arising spontaneously within the plant. The third possibility, and perhaps the least likely, is the existence of a mode of virus transmission quite unknown to plant virus workers.

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[1] Smith and Bald, *Parasitology*, **27**, 2; 1935.

Non-identity of Vitamin D_2 (Irradiated Ergosterol, Calciferol) and the Natural Vitamin D from Cod Liver Oil

As will be known from numerous papers, these two forms of vitamin D have different biological actions. In children and in chicks, one rat unit of the natural vitamin D of cod liver oil is about a hundred times as potent against rickets as one rat unit of irradiated ergosterol. Hence Steenbock[1] has concluded that the two substances are not identical. Chemical and physical proofs of the difference between the two substances have been advanced by Ender[2], who showed that vitamin D_2 differed from the natural vitamin D in its reaction with phthalic anhydride, its ultra-violet spectrum and its rotation of polarised light. As basic material, Ender used the liver fat of the tunny (*Thunnus Thynnus*) on the assumption that the vitamin D in various fishes is the same. However, Bills, Massengale and Imboden[3] have found that one rat unit of Blue-fin tunny liver oil in chicks has only 15 per cent of the antirachitic effect of one rat unit of cod liver oil, whence they conclude that the two forms of vitamin D are different.

We have therefore made comparisons between the vitamin D from cod liver oil and irradiated ergosterol (D_2). The former was concentrated by the methods described by Rygh[4] and Weidemann[5]. The vitamin A was eliminated by the method of Dalmer, v. Werder and Moll[6]. 200 kgm. of cod liver oil yielded 8 gm. of a concentrate containing 3×10^6 international units vitamin D per gram. The original oil contained 150 international D-units per gram; the vitamin D had thus been concentrated about 20,000 times. The results of the comparisons are stated below, where also the results of Ender with tunny liver oil are quoted:

	D_2	D-concentrate of cod liver oil	D-concentrate of tunny liver oil
Ultra-violet spectrum	Max. 265 mμ	No max. 260–270 mμ	No max. 260–270 mμ
$[\alpha]_d$ in alcoholic solution	+ 103°	± 0°	± 0°
Per cent esterification with phthalic anhydride and pyridine after 10 days	about 30	100	100
Effect of maleic anhydride	none	none	none
Monohydric alcohol	+	+	+

The data are not sufficient to determine whether

vitamin D from cod liver oil and from tunny liver oil are different or identical. But they show that both these forms of vitamin D are different from irradiated ergosterol.

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Skøyen, Oslo.
Aug. 6.

[1] *J. Biol. Chem.*, **97**, 249; 1932.
[2] *Z. Vitaminforsch.*, 2, 241; 1933.
[3] *Science*, **80**, 596; 1934.
[4] *Bull. Soc. Chim. Biol.*, 16, 609; 1934.
[5] *Biochem. J.*, **20**, 685; 1926. **26**, 264; 1932.
[6] *Hope Seylers Z. Physiol. Chem.*, 224, 86; 1934.

Abnormal Magnetic Behaviour of Treated Cobalt Wire

THE magnetisation curve was determined for a length of cobalt wire of 0·194 in. diameter in the condition as received and the result is shown by the curve *A* in Fig. 1. In this figure the values of $4\pi I$, that is, the 'metallic magnetic density', are plotted against the magnetising force as abscissæ. The maximum permeability of the wire in this condition was found to be 100, the corresponding value of *H* being about 35 oersteds.

The wire was then heated by passing an alternating current through it in an atmosphere of hydrogen, and the current was of sufficient strength to raise the temperature of the wire quickly to about 1,200° C., this temperature being maintained for a few seconds. The magnetisation curve was obtained after the wire had cooled down, and the result is shown by curve *B* in Fig. 1. The maximum permeability in this case was found to be 370, the corresponding value of *H* being 7 oersteds. So far as I am aware, this is the highest value for the permeability of cobalt at room temperature which has yet been recorded.

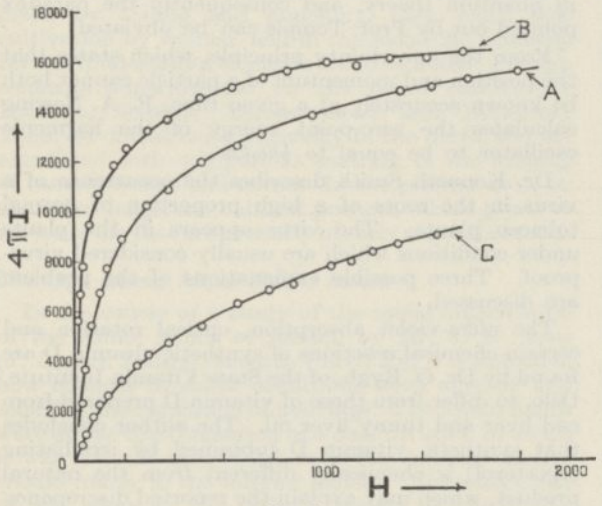

FIG. 1.

The wire was next placed in an atmosphere of hydrogen and an alternating current of frequency 50 was passed through it for several hours, the current being such that the temperature was maintained at about 1,200° C. After the wire had cooled down, the magnetisation curve was again obtained and is shown by curve *C* in Fig. 1. The striking features of this curve are that the saturation metallic density would appear to be only about 60 per cent of that of the normal cobalt, whilst the maximum permeability is now only 30.

The treatment is being continued to find out to what magnetic condition the wire will eventually settle down, and similar investigations are being made for iron and nickel wires.

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Aug. 6.

Unit of Force in the M.K.S. System

THE decision of the International Electrotechnical Commission to recommend the use of the M.K.S. system of electrical, mechanical and magnetic units, as reported in NATURE of July 6, may have far-reaching consequences, for experience has shown that a unit in daily use by engineers soon becomes a familiar quantity, and as such is preferred for quantitative work even by the pure physicist. The statistical examination of the question by G. A. Campbell[1] shows this very clearly: the practical units, volt, ohm, ampere, coulomb, etc., are used by the pure physicist far more than the corresponding C.G.S.M. or C.G.S.E. units. Since the M.K.S. system also possesses advantages for mathematical work, it is at least possible that it may ultimately become universally used.

This possibility will be very considerably increased if all the units have convenient names. In the M.K.S. system, the unit of energy is the joule, and the unit of power is the watt, but no name has yet been assigned to the unit of force, the force which, acting on a mass of 1 kilogram, gives it an acceleration of 1 metre per sec. per sec. G. Giorgi[2] has provisionally used the word 'vis' but the 's' ending makes the use of the plural awkward. Moreover, the derivation of the word is not in conformity with the derivation of the names of the closely related units of energy and power, which have been called after famous men of science. We venture to suggest that 'newton' would be more appropriate. The name of Newton is universally associated with the idea of impressed force, the word complies with the suggestion of G. A. Campbell[1] that the name chosen should have no more than two syllables, and as Newton's name cannot but occur again and again throughout the teaching of even the most elementary mechanics, pronunciation should present no difficulty in other countries.

We understand that the unit of magnetic flux has been called the 'weber'. If the ampere-turn be adopted as the unit of magnetomotive force, which means that the system would be rationalised, then no additional names for units would be necessary. This is certainly not the strongest of arguments for rationalisation, but we would emphasise the importance of easily remembered names with no risk of confusion, and would deprecate the use of a unit for *H* which would require yet another new name. Although a definite ruling on the use of the C.G.S.M. units, the gilbert, gauss, oersted and maxwell has been given, there is still confusion between them in published papers.

L. HARTSHORN.
P. VIGOUREUX.

National Physical Laboratory,
Teddington, Middlesex.
Aug. 12.

[1] *Bull. Nat. Res. Council*, No. 93, 48; 1933.
[2] Intern. Electrotech. Commission, Memorandum on the M.K.S. System of Practical Units.

Upper Carboniferous Fossils in America and Europe

THE interesting note by Prof. A. E. Trueman in NATURE of June 29, p. 1074, recalls to mind some studies of Upper Carboniferous cockroaches, which I made a number of years ago. The results are fully set forth in *Annals and Magazine of Natural History*, April 1927, but it is now pertinent to quote (p. 393):

"The typical Mylacridæ (using this expression to exclude the series related to *Hemimylacris*) abounded in America throughout Allegheny time, yet never, so far as we know, reached Europe. This suggests that the Blattid faunæ of the two sides of the world were not intermingled to any extent during that period, and makes it rather improbable that various Archimylacrid genera crossed over, though they may have done so prior to the rise of the Mylacridæ."

It is possible that land connexions northward were utilised by the plants, but were not usually available to the tropical or subtropical cockroaches. It is also possible that various types of plants did not appear simultaneously on both sides of the world, but developed first on one side and eventually reached the other. But all these matters require more detailed discussion, which is impossible here.

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July 21.

Methylene Blue as a Stain for Mucus

IN spite of a somewhat adverse criticism, and a statement apparently to the contrary[1], methylene blue is one of the best and easiest stains for mucus. According to Bolles Lee, "Microtomist's Vademecum", p. 497 (ninth edition), *Methylene blue is particularly useful from its power of bringing out the merest traces of mucin*, while the following very simple experiment illustrates this.

A few specimens of the common snail (*Helix aspersa*) are collected and placed on small pieces of glass. They soon crawl off leaving a trace of mucus. If the pieces of glass are placed, without further treatment, in a 0·01 per cent aqueous solution of methylene blue the mucus stains a deep blue within two minutes.

Chirocephalus lives apparently quite comfortably in this solution for an hour, and long before that time patches of mucus or a mucus-like secretion appear deeply stained within the median groove.

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[1] Cannon, H. G., "A Further Account of the Feeding Mechanism of *Chirocephalus diaphanus*", *Proc. Roy. Soc. Lond.*, Series B, No. 806, **117**, 455–470; June 1935.
[2] Lowndes, A. G., "The Feeding Mechanism of *Chirocephalus diaphanus*, Prévost, the Fairy Shrimp", *Proc. Zool. Soc. Lond.*, 1110; 1933.

Points from Foregoing Letters

MRS. BARLOW quotes from Darwin's unpublished manuscripts, dealing with the fauna of Galapagos Islands, to show that so early as 1837 Darwin had begun to doubt the stability of species.

On removal of the xylan from manilla hemp cellulose fibres, X-ray photographs have been obtained which indicate a more perfect state of crystallisation, and are similar to photographs of fibres of low xylan content. W. T. Astbury, Dr. R. D. Preston and Dr. A. G. Norman state that this is compatible with the view that the association of the xylan with cellulose is a mixed crystallisation.

Dr. W. H. George submits a photomicrograph of an etched surface of a crystal of copper (grown by the Bridgman method). Its appearance, similar to that of polycrystalline metals, suggests that the crystal has broken down into a large number of small ones; X-ray photographs show that their orientation has remain unchanged.

New measurements, in vacuum, of the changes in magnetic susceptibility of tin, copper, silver and gold, during allotropic transformation or melting, have been made by Prof. K. Honda and Y. Shimizu. To check Honda's theory, they compared the experimental values with those obtained by adding the change in paramagnetic susceptibility calculated according to the equation of Pauli, Landau and Posener, to the change in diamagnetic susceptibility from the formula of Sommerfeld and Hirone.

Prof. G. Racah discusses the cross-section for the production of pairs of positive and negative electrons by collisions between electrons and nuclei. He submits several approximate formulæ and concludes that both the reaction of the process on the incident electron and the interaction between this electron and the nucleus must be taken into consideration.

Many papers discussing the principles of quantum theory have assumed that to every function of the classical variables there corresponds one unambiguously defined quantum operator. This assumption, writes Dr. R. Peierls, is not necessary in quantum theory, and consequently the paradox pointed out by Prof. Temple can be obviated.

From the uncertainty principle, which states that the position and momentum of a particle cannot both be known accurately at a given time, R. A. Newing calculates the zero-point energy of the harmonic oscillator to be equal to $\frac{1}{2}h\omega/2\pi$.

Dr. Kenneth Smith describes the occurrence of a virus in the roots of a high proportion of normal tobacco plants. The virus appears in the plants under conditions which are usually considered virus-proof. Three possible explanations of the problem are discussed.

The ultra-violet absorption, optical rotation and certain chemical reactions of synthetic vitamin D are found by Dr. O. Rygh, of the State Vitamin Institute, Oslo, to differ from those of vitamin D prepared from cod liver and tunny liver oil. The author concludes that synthetic vitamin D (obtained by irradiating ergosterol) is chemically different from the natural product, which may explain the reported discrepancy in their potency as a cure for rickets in children.

A cobalt wire was heated for some hours to about 1,200° C. in an atmosphere of hydrogen by an alternating current at frequency 50. After the wire had cooled down, Dr. T. F. Wall finds that the saturation value of the intensity of magnetisation was only about 60 per cent of that for the normal cobalt.

The word 'newton' rather than 'vis' is suggested by Dr. L. Hartshorn and P. Vigoureux as a name for the unit of force in the M.K.S. system, that is, for the force which, acting upon a mass of one kilogram, gives it an acceleration of one metre per sec. per sec.

Research Items

Culture Areas in Nigeria

MR. WILFRID D. HAMBLY, as leader of the Frederick H. Rawson-Field Museum Ethnological Expedition to West Africa, 1929–30, has made a cultural survey of Nigeria based upon a synthesis of the evidence of physical characters, language, social and material culture, also taking into account geographical factors (Field Museum of Natural History Pub. 346, Anthrop. Ser., 21, No. 3). Broadly, the country falls into three regions—southern, northern and an intervening plateau area. South of lat. 9° N., negro somatic traits prevail; north of that line modifying physical characters are to be noted, and the farther north the more strongly are negro traits overlaid until on the border of the Sahara the type is definitely non-negro. The intruding elements are Hamitic and Semitic. In linguistics the two main divisions are Bantu-speaking and Sudanic-speaking, the main languages north of lat. 9° N. being Hamitic and Semitic, supplemented by Sudanic negro languages. Culturally, there is a type of culture which is fundamental to the whole of Nigeria, though the negro elements are more deeply entrenched south of the line of 9° N. Allowing for local differentiation there is, in fact, in West Africa a predominating uniformity in the pattern of forest negro culture through Liberia, the Ivory Coast, Ashanti, Dahomey, Nigeria, Cameroon and the Congo Basin, into the land occupied by the Ovimbundu of Angola. Among such elements are, for example, skill in ironwork, wood and ivory carving, pottery made by coiling and punching, bark cloth, hoe cultivation by women, and in the social life similarly certain fundamental elements are to be noted. Foreign elements superimposed on the negro culture are Hamitic, Semitic, Mediterranean and European. These are found more especially in the north and are associated with occupations centring in the keeping of camels, horses and cattle. In the plateau area, on the other hand, are cultural pockets, which preserve modes of life that are probably of early negro character.

Marriage among Aimol Kukis, Assam

IN the course of a study of the social organisation of the Aimol Kukis of Assam, by Mr. J. K. Bose (*J. Depart. Letters*, Calcutta Univ., 25), it is indicated how changes in social conditions have affected and modified the regulation of marriage. The Aimol Kukis were at one time organised in a dual division, in which it was the rule that members of the superior moiety should marry in the inferior moiety. Nowadays, one of the clans in the inferior moiety is practically extinct, and the people of the superior moiety, now greatly in the majority, experience great difficulty in finding a suitable mate. Although they are strictly exogamous, they are thus forced to abandon the practice of marrying in the opposite moiety, and must wed within their own moiety, still, however, strictly avoiding marriage within the clan or its subdivisions. Another modification, which is being introduced, by outside contacts, is that of payment for the bride by money instead of the three years service by which formerly the bridegroom earned from the bride's family the right to return with her to his own village. This form of marriage by service was that which was most generally recognised, and even now purchase is only beginning to be introduced among the more well-to-do. Four other forms of marriage are admitted: elopement, when the parents do not like the marriage upon which the parties concerned have agreed between themselves; capture, which takes place when a young man, having served for a period of, say, a year, is driven out by his future father-in-law for no serious cause; marriage of a widow, usually by a younger brother of the husband, no ceremony taking place or price being paid; and mutual settlement between the parties to live together without any marriage ceremony, when a fine is imposed by the girl's father for the loss of his daughter.

Survival in Tree-Swallows

THE very great efficiency of nesting in the tree-swallow of the United States of America (*Iridoprocne bicolor*), under not quite natural conditions, is illustrated by the observations of Winton Weydemeyer (*Condor*, 37, 216, July 1935). For eight seasons he has kept records of the nesting activities of tree-swallows making use of bird-houses erected by him, and occupied yearly by eight to sixteen pairs. Full records of 60 nests, 52 of which were first brood nests, 8 second broods, show that the former contained 324 eggs, the latter 39. Of these there hatched 319 and 39; six nestlings of the latter died, and 12 of the former were taken by a sparrow-hawk; but of the total number of nests, in 44 out of 52, and 6 out of 8 their total clutch was raised without loss. Including all accidentals, of failure to hatch and so on, the efficiency of the nests studied is represented by 94·7 per cent of survival in the case of first broods and 84·5 per cent in the case of second broods.

A Warty Growth on the Head of Land-Snails

I. TAKI (*J. Sci. Hiroshima Univ.*, 3, 1935) directs attention to a peculiar warty structure on the head, between the two posterior tentacles, of adult snails belonging to the family Cepolidæ, and to a concavity, containing three to twenty tubercles, in a corresponding position in the family Pleurodontidæ. The head-wart consists of a number of modified dermal tubercles, in two genera in a single sinuous row, but in all others forming a group of various sizes and shapes. The head-wart has a particularly thick epithelium and its interior is occupied by connective tissue in which are fibrils, chromatophores and blood-lacunæ. The rudiment of the head-wart is visible in the early stages of development of the snail; the wart attains its full size by rapid growth at the time of sexual maturity. In the breeding season the head-wart in certain genera forms a conspicuous hemispherical protrusion; external stimuli cause its contraction. The protrusion of the wart is effected by increase of pressure of the blood, which takes place before copulation. From the position of the head-wart, its rapid growth at sexual maturity and its swelling, it is inferred that the wart has some bearing on the sexual activity of the snail, though it is not clear how it functions.

Host Selection by Insect Parasites

G. SALT (*Proc. Roy. Soc.*, B, **117**, 805; 1935) has investigated the process of selection of host-species by the ovipositing females of a small chalcid parasitoid, *Trichogramma evanescens*. Ovipositing females were observed to examine, select and attack, besides a number of true hosts (such as the egg of the Angoumois grain-moth, *Sitotroga cerealella*) from which their progeny successfully emerged, several unsuitable hosts in which their progeny were unable to develop, and a variety of false hosts, such as particles of sand and globules of mercury, in which they were not able even to lay their eggs. Two strains of *Trichogramma* reared exclusively on *Sitotroga cerealella* and the Mediterranean flour-moth, *Ephestia kuehniella*, respectively for 63 and 43 generations, developed no dependence on or even preference for their respective hosts. Both strains preferred eggs of *Ephestia*, but an analysis of the preference showed that it was not a specific preference for *Ephestia* but a preference for it simply as the larger host. When two different kinds of hosts were simultaneously exposed to *Trichogramma* the latter showed a preference for the larger of the two, even though the preferred host was unsuitable for the development of its progeny or was a false host in which the parasite could not even lay its eggs. Size appears to be the principal criterion used by ovipositing females of *Trichogramma* in the selection of their hosts.

Vessel-less Dicotyledons

THE anatomy of the four homoxylous genera of Angiosperms, *Drimys*, *Zygogynum*, *Tetracentron* and *Trochodendron*, has been re-examined by K. M. Gupta, University of Lucknow (*J. Indian Bot. Soc.*, **13**, No. 1, 1934). He points out that they may be sharply divided into two groups: (1) *Drimys* and *Zygogynum*, with several species distributed in Australian and South American regions; and (2) *Trochodendron* and *Tetracentron*, monotypic genera confined to Japan and China respectively. In the *Drimys* group the growth rings are absent or faintly marked, the rays scarcely or not at all enlarged at the junction of the growth rings, the ray cells uniformly pitted on radial and tangential walls and the pitting on the tracheids of the spring wood is of the multiseriate type. In the *Trochodendron* group, growth rings are well marked and the rays enlarged at the junction of the growth rings, and the pitting of the tracheids of the spring wood is scalariform. He also points out that all four genera can be distinguished by the shape of the ray cells as seen in tangential longitudinal sections. The anatomical data are briefly used in a discussion of the vexed problem of the origin of the Angiosperms but, apart from emphasising the importance of the Magnoliales in connexion with this problem, the theoretical significance of these vessel-less dicotyledons still remains obscure.

English and Canadian Tomato Virus Diseases

THE presence in England of Dr. G. H. Berkeley, a Canadian plant pathologist, has been put to considerable profit in the elucidation of difficulties of virus disease nomenclature. A co-operative study has been made with the Rothamsted and Cheshunt Experimental Stations ("A Comparison of English and Canadian Tomato Virus Diseases" by Drs. G. C. Ainsworth, G. H. Berkeley and J. Caldwell, *Ann. App. Biol.*, **21**, No. 4, 566–580, Nov. 1934). Seven distinct viruses have been studied, namely: tomato mosaic, yellow mosaic, single-virus streak, mixed-virus streak, ring mosaic, tobacco virus No. 9, and spotted wilt. The last-named disease apparently does not occur in Canada, whilst ring mosaic and the No. 9 virus have not yet been recorded in England. Mixed-virus streak is not common in England, but the other viruses mentioned above are relatively common in both countries.

Virus Diseases of Ornamental Plants

DR. KENNETH SMITH has published a paper on "Some Diseases of Ornamental Plants caused by the Virus of Tomato Spotted Wilt" (*J. Roy. Hort. Soc.*, **60**, Part 7, July 1935). The disease on the tomato causes the leaves to curl downwards and inwards, whilst bronze-coloured spots, with an almost metallic lustre, appear upon the leaflets. Many other garden plants are attacked, including the Iceland poppy, various stocks, tropæolum, begonia, several plants belonging to the Compositæ, campanula, calceolaria, gloxinia, arum, hippeastrum, and more than a dozen species of Solanaceæ. Symptoms vary on each of these hosts. *Thrips tabaci* is the only insect concerned in distribution of the malady, and destruction of this pest, along with the removal of infected plants, are the chief methods of control advocated in the paper.

Molasses and Nitrogen Fixation in Soil

IN two recent publications, N. R. Dhar and S. K. Mukerji (*Proc. Acad. Sci. U.P., India*, **4**, 175; 1934; 330; 1935) have shown that when cane sugar is added to sterilised or unsterilised soil and exposed to light and air, there is an appreciable increase in the ammoniacal nitrogen content; with unsterilised soils the ammoniacal nitrogen is nine times greater than that originally present in the soil. With sterilised soil it is about three times as great. The amount of ammonia in presence of light is always greater than in the dark. By the addition of molasses to soils which have been properly aerated, the ammoniacal nitrogen may become three times as great as that originally present in the soil. When the aeration of the soil is less, the increase of ammonia is less and the soil becomes acidic. It appears that in tropical countries in ordinary soils, the fixation of atmospheric nitrogen by the addition of energy-rich compounds is partly bacterial and partly photochemical. The oxidation of the energy-rich organic compounds by air either by chemical induction, light absorption or bacterial action causes the fixation of the atmospheric nitrogen in the soil. These researches may be of considerable practical importance, because the molasses available in the sugar factories in India are wasted at the present time.

The "Amal" Bunsen Burner

THIS new type of laboratory burner, which was briefly described in NATURE of December 1, 1934, has been improved by the inclusion of a pressure-damping device which, by proportioning the flow of gas to the size of the jet orifice, enables the flame to be turned down still lower than was previously possible; and also by the provision of a set of detachable heads. These provide a horizontal rose flame, horizontal and vertical batswing flames, the fully aerated bunsen flame and, for the smaller burner only (the "Amal minor"), a dental head that gives a rotatable flame projecting at a convenient angle so

that molten material cannot drop into the burner and choke the jet, this flame being convertible at will into a luminous flame by putting on a small tip. The head giving the vertical batswing flame contains a small hole providing a tiny hot flame for 'spot' heating. The Amal burner possesses all the advantages and more of the Meker and Teclu burners, and also all those of the ordinary 'bunsen' except the control of air-supply. A further adaptation is the "Amal" petrol-gas burner, which works well on the gases from Silverlite and Aerogen plants. It resembles the town's gas burner, but has only one hole for admitting secondary air, and this is regulated by a spring band clip.

Mandelic Acid: a Urinary Antiseptic

INFECTIONS of the urinary tract are troublesome and serious complaints that frequently fail to yield to ordinary treatment. A ketogenic diet has been found to be curative, and A. T. Fuller (*Lancet*, **1**, 1933 855 ;) showed that under it β-hydroxybutyric acid is formed, appears in the urine, and is the actual bactericidal agent. This acid cannot, however, be given orally, as it becomes oxidised in the body before excretion. A ketogenic diet, moreover, requires careful and institutional supervision, and is also not tolerated by all patients. Seeking for a substitute, M. L. Rosenheim (*Lancet*, **1**, 1935) 1032 ; tested numerous keto- and hydroxy-acids allied to β-hydroxybutyric acid, and found that mandelic acid best realises the conditions necessary, for it is excreted unchanged, is non-toxic in therapeutic doses, and is bactericidal in an acid urine to *Bacillus coli* and other organisms that may infect the urinary tract. In order to ensure an acid condition of the urine, ammonium chloride is given with it. Mandelic acid is a white crystalline powder, readily soluble in water, and is now being manufactured by Messrs. Boots Pure Drug Co., Station Road, Nottingham, from whom particulars may be obtained.

Preparation of Silanes

ALTHOUGH monosilane, SiH_4, was prepared by Buff and Wöhler in 1857 and its physical and chemical properties have been exhaustively investigated by Stock and co-workers since 1916, the method of preparation has been unsatisfactory. Stock allowed magnesium silicide, prepared by the reduction of silica with magnesium at high temperatures, to drop into aqueous hydrochloric acid, when a mixture of gases was evolved containing 40 per cent SiH_4, 30 per cent Si_2H_6 (disilane), 15 per cent Si_3H_8, 10 per cent Si_4H_{10} and 7 per cent higher compounds. Only 23 per cent of the silicon in the magnesium silicide appeared as gaseous hydrides. In 1934, Kraus and Carney reported a very convenient and efficient method of preparation of hydrides of germanium, giving yields of more than 60 per cent by dropping ammonium bromide into a suspension of magnesium germanide in liquid ammonia, the ammonium salt behaving as an acid in somewhat the same manner as hydrochloric acid in aqueous solution. W. C. Johnson and S. Isenberg (*J. Amer. Chem. Soc.*, **57**, 1349 ; 1935) now find that this method may be used to obtain high yields of silanes, varying from 70 to 80 per cent. Magnesium silicide was prepared by heating finely divided silicon with magnesium filings at 475°–1,000° in an atmosphere of hydrogen. The fine blue powder so obtained was dropped into a solution of ammonium bromide in liquid ammonia and the gas evolved passed through slightly acidified water and then dried with phosphorus pentoxide and condensed in liquid nitrogen. The product was then fractionally distilled. It was found that pyrex stopcocks lubricated with vacuum grease were satisfactory, and that it was not necessary to use mercury valves in manipulating the gases. The physical properties of the mono- and disilanes agreed with those found by Stock and co-workers. It was found that 50 per cent ferrosilicon did not react with ammonium bromide in liquid ammonia unless first heated with magnesium filings, when an unusually high yield of disilane was obtained.

Crane Hooks, Links, etc.

AMONG the papers selected by the Council of the Institution of Mechanical Engineers for publication in *Proceedings* is a contribution by Messrs. Gough, Cox and Sopwith, on the "Design of Crane Hooks and other Components of Lifting Gear". These components consist in the main of curved beams, made of ductile material, of which the radii of curvature are, usually, relatively small. They are distinguished by very complex stress distributions, and have been the subject of various theories from which and from much accumulated practical experience their makers have evolved methods of design giving safe but not, in the opinion of the authors, economical results in practice. The National Physical Laboratory and the British Standards Institution have been engaged in research, standardisation and specification in connexion with this group of lifting gear components with the results reported in the paper now issued. The effect of the curvature of the centre line is first discussed, then that of local yielding, and it is shown that, when this occurs, the removal of the load results in a reversal of stress in the locality of the set. The calculated elastic stresses thus become, in service, ranges of stress as the component is loaded and unloaded, and the material is called upon to withstand the calculated stress as a range which should not exceed the numerical sum of the yield stresses in tension and compression. The method of calculating the bending moment in rings, links, etc., is shown, with comparisons between approximate and exact methods, and general formulæ are obtained for egg links, studded links and eyebolts, typical examples from recent British Standard Specifications being worked out.

Spectrum of a Hot Carbon Star

THE spectrum of the irregular variable star *R* Coronae Borealis has been studied in detail by L. Berman (*Astrophys. J.*, **81**, 369) in three-prism spectrograms taken at the Lick Observatory. The wave-lengths of about 650 lines have been measured over the region 4300–4900 A., and the absolute numbers of atoms engaged in their production deduced from observed line intensities and theoretical intensity ratios of supermultiplets. Carbon is found to be abnormally abundant, and constitutes 69 per cent of the atmosphere of this star, the remainder of which is composed of 27 per cent hydrogen, 4 per cent metals (chiefly magnesium and iron), and less than 0·3 per cent nitrogen. The effective temperature of the star is computed to be 5300° K. ; the colour temperature in the blue is about 1,000° higher, and in the red about 1,000° higher still, though the last result may be vitiated by the difficulty of defining the true continuous background in this region.

Imperial Botanical Conference

THE Imperial Botanical Conference which met on August 27–30 in the rooms of the Linnean Society, Burlington House, London, is the third of a series which dates from the years immediately following the War. At that time, the International Botanical Congresses, initiated in pre-War years, which were due to be held at five-yearly intervals, were in abeyance. Thanks to the efforts of a committee of British botanists a conference of Empire botanists, on a scale fairly comparable to that of an International Congress, was arranged for the year 1924, and took place in London. Quite apart from its value to scientific botany generally and to the advancement of botanical study within the Empire in particular, that Conference undoubtedly acted as a stimulus to the resumption of normal friendly relations between European botanists which had been sadly interrupted.

Now that the International Congresses are again established—first at Ithaca, N.Y., in 1926, then at Cambridge in 1930, and in the present year at Amsterdam—the need for Imperial Conferences has to some extent disappeared, at least from the point of view of general botanical science. It was felt, however, that such conferences would still serve a useful purpose in relation to problems of special Imperial interest, to the organisation of research, and not least to the formation of contacts between widely scattered groups of workers. A small committee was therefore kept in being. A short conference, of a purely formal nature, was held in 1930, and now the third of the series has taken place. The subjects for discussion were limited to those of general economic interest to the Empire, and were in the main suggested by botanists overseas.

In his address of welcome to members, the president, Sir Arthur Hill, emphasised the ever-increasing importance of botanical research in the development of Imperial agricultural resources, not merely with regard to crops which figure in export trade, but also to the food plants of the native and his animals. The study of native crops with the view of obtaining maximum yields under the various local conditions is a work of the greatest national importance which calls for the continued co-operation of botanical and agricultural workers at home and overseas.

Pasture Research

Prof. R. G. Stapledon, in introducing a series of papers on "Pasture Research Within the Empire", dealt with the importance of 'strain' in pasture plants. Studies at Aberystwyth have abundantly shown that grassland plants are no exception to the general rule that botanical species contain within their ambit a more or less indefinite number of strains or varieties. Between the strains of a particular grass or clover there might be a greater difference in agricultural value, for example, permanence in the pasture, feeding value, economic return, etc.—than there is between desirable and undesirable species. These strains or groups of strains have been evolved on a geographical basis, partly in response to climatic and soil conditions, but probably to a large extent as a result of long-continued farming practices. The work of the plant breeder is in the first place to discover which are the most desirable of these local groups for special purposes, and then to ensure that in commercial exploitation any tendency to deterioration is effectively checked. The sowing out of pure strains is not desirable inasmuch as a certain degree of variability gives some insurance against the vagaries of climate and of farming practice. The maintenance of pure strains, with subsequent judicious blending, is a splendid ideal which is very difficult to achieve and is in fact not necessary. The difficulty of maintaining the quality of a certain group of strains ('ecogroup') is not so great as is sometimes imagined and can be overcome for all practical purposes if the work is carried out in a suitable locality and on a large enough scale. The essential point is to safeguard the quality of the original stock, and this can only be done under the direct control of the plant breeding station.

The problems involved in the improvement of pastures in the Dominions were outlined by Dr. I. B. Pole-Evans for the Union of South Africa, and by Prof. G. W. Scarth and Mr. H. J. Whyte for eastern Canada. Dr. Pole-Evans described the natural pasture areas of the Union, and in this connexion exhibited a comprehensive series of coloured plates illustrative of the South African flora. Much damage to natural pastures has already been done by indiscriminate grazing, by burning and by other malpractices. This he ascribed to a general absence of fundamental knowledge relating to the problems of veld management. He reviewed the research work which has been carried out in the Union up to the present and stated that a national research programme has now been organised which will deal in particular with problems relating to the general decline in the carrying capacity of the veld due to faulty grazing methods. This programme will also aim at the building up of an organised animal industry based on the development of the natural pasture potentialities of the country.

In presenting the Canadian problems, Prof. Scarth pointed out that the natural pastures of eastern Canada are at the moment the most important in the Dominion, inasmuch as they carry more than half of the total livestock. A striking feature is that though these pastures have never been ploughed, the significant part of the herbage consists of introduced European plants which have in course of time colonised these areas. The pastures are generally poor and the trend is towards further deterioration. A very comprehensive programme of research, organised both on a Federal and on a State basis, is now being carried out, involving ecological mapping in association with soil surveys, manurial trials in relation to quantity of herbage and to stock rearing or milk production, biochemical studies of pasture plants, etc. The main result so far established is that the pastures as a rule respond markedly to the addition of phosphatic fertilisers, the poor type of *Agrostis* sward being replaced in time by the better grasses with clovers. The formulation of recommendations applicable to the different soils and climates will only be possible after vigorous research over many years. An ecological study of certain

pastures of eastern Canada was presented by Mr. H. J. Whyte and served to illustrate the poor quality of many of these and the need for improvement.

Certain detailed aspects of pasture research in England were described by Mr. G. E. Blackman and by Mr. Martin Jones of the Jealotts Hill Research Station of Imperial Chemical Industries, Ltd. Mr. Blackman showed that under spring conditions, nitrogenous manuring stimulates growth within a certain temperature range only. During midseason, water supply rather than nitrogen is the controlling factor. The effect of light on the growth of pasture plants is complex, varying with the species, with the available nitrogen supply and even with the form in which the latter is added.

Mr. Martin Jones dealt with the competition to which the constituents of grassland are subjected by neighbouring plants and showed how differences in habit or rate of growth lead to the dominance of certain forms or the suppression of others. Grazing by animals is of the greatest importance in this connexion, the effects on the development of any particular constituent varying according to the intensity of grazing at any given period. The correct management of grazing is therefore essential for the maintenance of any particular type of pasture.

Tropical Forests

In a session devoted to "Succession of Tropical Forest Types" Dr. Burtt Davy dealt with the evolution of tropical African forest types and pointed to the presence of a considerable percentage of Indo-Malayan forms in West Africa though they are no longer to be found in East Africa. He attributed this peculiar distribution to elevation of the land surface, subsequent to migration, with resulting lowering of temperature and desiccation of considerable areas of low country. It was therefore suggested that low-level, broad-leaf tropical rain-forest was at one time more widespread in East Africa than it is now. The presence of a small but significant palæoarctic element extending from Abyssinia as far south as temperate South Africa indicates relatively modern immigration along the temperate zone corridor formed by the high eastern mountain chain.

The distribution of forest types in Nyasaland was briefly described by Mr. P. Topham. The range of elevation within the region extends from 200 ft. to 10,000 ft. and at least nine groups of forest types are to be noted. The biotic factors of greatest importance in relation to distribution are local history, bush fires, cultural methods, fallow periods, grazing and soil rejuvenation by termites. In the absence of long-term fire protection experiments and of fuller local records, the ecological succession of the different types is largely speculative.

The distribution of various Nigerian forest types in relation to temperature, rainfall and elevation was described by Mr. W. D. MacGregor, and particular stress was laid on the succession from the open park-land to the moist deciduous type of forest. Experiments have shown that over considerable areas such a succession takes place with fair rapidity provided there is a nucleus of deciduous forest sufficiently near to supply an abundance of wind-borne seed and provided the area is protected from farming and, in its earlier phases, from grass fires. The importance of enlarging the area of deciduous forest as a check to advancing desiccation from the Sahara was emphasised.

Mr. P. Richards gave a comparative account of three areas of tropical rain forest situated in British Guiana, Sarawak and Nigeria respectively. Each area was studied intensively rather than extensively, and the data were collected so far as possible in a quantitative form. The structure was studied by means of profile diagrams based on measurements of all the trees on clear-felled plots, and the floristic composition was at the same time determined. The structure is fairly similar in all three localities. An interesting point is the close analogy of the forests on white sand in Sarawak and British Guiana, suggesting that there may be parallel edaphic variations from the climax in different regions of the tropics.

An ecological investigation of peculiar interest was described by Mr. C. G. Trapnell in relation to the application of ecological methods to the study of native agriculture in Northern Rhodesia. Various native tribes have discovered—some more exactly than others—the association of certain wild plants with soils of a certain type and are able to fix on the location and decide on the nature of their cultivated crops in accordance with such observations. Efforts to advance the prosperity of the country should be directed towards building on the foundations already laid by the native himself, rather than to hazardous introductions or innovations.

Fruit Storage

The enormous amount of research, much of it emanating from Empire sources, which has in recent years been directed to problems of fruit storage and transport, made it peculiarly suitable that a session of the Conference should be devoted to that subject. The fact that, as one speaker pointed out, imports of Empire fruit into the British market have increased six-fold in the last twenty-five years and now constitute nearly half of the total import shows how research and the practical application of it are proceeding hand in hand with the advancement of Imperial trade.

Of the eight papers presented, five came from overseas contributors and the remainder from workers of the Food Investigation Board. The problems involved are of extraordinary complexity, involving as they do not merely the factors which immediately affect storage of fruit—for example, temperature and humidity of the store, mode of packing, state of maturity of fruit when put in the store, etc.—but a multitude of others which come into play while the fruit is still on the tree. Such are the effects of soil, of climate, of rootstock and so forth on the keeping quality of the fruit. The problems are in the main similar whatever the fruit or the country of origin, though the relative importance of the different factors may vary from one problem to another. For these reasons no summary which would even indicate details will be attempted here.

Dr. C. Wardlaw and Mr. R. Leonard discussed the problems of the storage of tropical fruit. Investigations at the Imperial College of Tropical Agriculture range from empirical testing of the storage behaviour of various tropical fruits—banana, lime, grape fruit, avocado pear, etc.—to fundamental studies of the gaseous exchange occurring during growth and ripening. Canadian researches, summarised by Dr. H. T. Güssow, covered the whole field of the storage of apples. Mr. H. Turner of the New Zealand Fruit Board dealt chiefly with systems of refrigeration and

methods of stacking fruit in the holds of ships. Mr. N. E. Holmes, in connexion with the transport of Australian citrus fruit, discussed fungal spoilage and loss of flavour in relation to age of the fruit, and the value of various methods as tests of the state of maturity, while Mr. D. J. Dreyer described experiments relating to mechanical damage to South African pears. With reference to the gas storage method, which has been rapidly taken up by some English growers of apples in the last few years, Dr. C. West advised a certain amount of caution, as much research work still remains to be done before the method is placed on a sound basis. Finally, papers of a fundamental nature were read by Dr. A. S. Horne and by Mr. R. Gane, the former discussing the results of a quantitative study of the resistance of apples to fungal invasion and the latter dealing with some interesting effects of ethylene gas on the respiration and maturing of banana fruit.

In the final session, Prof. E. E. Cheesman directed attention to the pressing need for greater facilities within the Empire for the collection and classification of crop varieties and related species. The menace of Panama disease and of witch-broom disease to banana and cacao cultivation respectively makes it imperative that wholehearted attempts should be made to discover or to breed suitable varieties of the crop plants resistant to these diseases. The work is seriously handicapped at the moment by the lack of adequate facilities.

An interesting feature of the Conference was a series of exhibits comprising, in addition to the illustrations of South African plants already mentioned, a collection of types of cultivated *Sorghum* and of cowpea (*Vigna* sp.) prepared by the staff of the Royal Botanic Gardens, Kew, and an exhibit illustrating Linnæus's development as a botanist arranged by the Librarian of the Linnean Society.

Conference of Empire Meteorologists

TWENTY-FIVE Dominions and Colonies were represented at the third Conference of Empire Meteorologists which was in session at the Meteorological Office, South Kensington, on August 12–21. Six years have elapsed since the previous conference and there have been important changes during that period, both in the organisation of colonial meteorological services and in the demands made upon them for data, either for home consumption or for international dissemination. There were two main reasons for calling the conference, first to give the directors of services an opportunity of discussing their problems before proceeding to the International Conference of Directors to be held at Warsaw this month; secondly, to discuss the meteorological arrangements necessary to meet the Government's requirements in connexion with the Empire air-mail scheme.

At the same time, the meetings provided an opportunity for the exchange of views on many other questions of a general character. In meteorology, problems of co-ordination are not less important than purely technical problems. It is, therefore, very necessary that the administrators of meteorological services should meet from time to time to discuss these matters. Within the Empire we have a wide diversity, not only in climate but also in the administrative arrangements for handling meteorological data. A meeting of Empire meteorologists thus provides a means for considering problems from every angle, and has a special value for that reason.

At the opening meeting on August 12, the delegates were welcomed by Sir Henry Lyons, vice-chairman of the Meteorological Committee. Mr. J. Patterson, director of the Canadian Meteorological Service, was elected president of the Conference. At the first business meeting, the Government's policy in regard to the Empire air-mail scheme was outlined. This scheme involves both day and night flying, and adequate meteorological services must be a fundamental part of the necessary ground organisation. Linked up with the question of organisation are such technical matters as the making of synoptic charts on a uniform plan, the coding of reports from land stations and ships and the choice of hours of observation. Air-mail pilots are familiar nowadays with synoptic charts, and it is important that they should be able to consult up-to-date charts at their ports of call. It is also important that a symbol they see on a chart in one country should have the same meaning as a similar symbol on a chart they see in another country. The delegates will have to consider the international aspect of this matter of symbols at Warsaw, and the discussion in London proved very useful.

Questions connected with aviation and with synoptic meteorology occupied the first few meetings. These were followed by discussions on meteorology for the Army and for the Navy, instruments, upper-air observations, marine meteorology, geophysics, climatology and agriculture, and seasonal forecasting. The use of upper-air data has assumed increased importance with the advent of air-mass analysis for the purpose of synoptic diagnosis. In many colonies there are special difficulties, however, in the way of obtaining the data. One difficulty is that of procuring hydrogen for the inflation of pilot balloons, and it was of interest to learn how the difficulty is being met in Canada by the use of a portable electrolytic generator, and in East Africa by an ingenious chemical generator, the essential part of which has been adapted from a commercial pressure-cooker.

In connexion with geophysics, the Conference passed a resolution recommending the establishment of a station at Chesterfield Inlet, Hudson's Bay, Canada. This station would be in near proximity to the North Magnetic Pole and its situation would also be very favourable for auroral studies. The conference also recommended the establishment of a station at Tristan da Cunha, observations from which, situated as it is about midway between the Cape of Good Hope and South America, would be of great value.

The discussions on climatology and agriculture began on August 19. Perhaps the most interesting subject in these categories was that of the broadcasting of climatological data. Students of world climatology have previously been handicapped

seriously by the difficulty of obtaining current climatological data. The monthly summaries issued by the various services are often published many months in arrear, and it has thus been impossible to put together an up-to-date picture of the climatological conditions all over the land areas of the globe. Lieut.-Colonel E. Gold gave an outline of a scheme for the broadcasting of brief data from selected stations in each country on the fifteenth of the month following that to which the data refer. This scheme will come before the international conference at Warsaw; its successful realisation would be an advantage not only to climatologists but also to business men who require recent information in regard to the general weather conditions in distant lands.

The subject of seasonal forecasting gave rise to an interesting discussion. Everyone of course recognises the great advantages that would ensue if some reliable method could be evolved for forecasting the general character of the weather some weeks or months in advance. The existing methods were brought under review, but it can scarcely be claimed that we are within sight of a solution. An elaborate preliminary study of the main causes of variation may, as in the case of the monsoon rainfall of India, result in the derivation of an equation from which a forecast can be made with a certain degree of success. The general view, however, was that none of the methods hitherto explored had given results good enough to justify the inauguration of an official service of long-range forecasts. E. G. B.

Educational Topics and Events

GLASGOW.—The King has been pleased, on the recommendation of the Secretary of State for Scotland, to approve the appointment of Mr. Duncan MacCallum Blair, professor of anatomy and Dean of the Medical Faculty, King's College, University of London, to be regius professor of anatomy in succession to Prof. T. H. Bryce, whose resignation takes effect on September 30.

COLLEGE library administration carried to a high pitch of activity is exemplified in Columbia, Missouri, where librarians, spurning the role of mere custodians of books, make it their business to become acquainted with and contribute to class-room instruction and make systematic provision for acquainting lecturers with the library's resources with reference to current work. They visit classes, participate in faculty meetings, hold instructional conferences with students and conduct introductory orientation classes. Collections of books are disposed where they are most easily accessible to students both in common-rooms, in class-rooms, in laboratories and in hostels. Conversely, the instructional staff, besides encouraging students to make the most of the library's resources, act as assistant librarians and give regular instruction in the technique of reading, especially the timed reading exercise followed by a comprehension test. In fact, reading is recognised as the student's chief tool, and the college holds itself responsible for seeing that every student becomes highly skilled in the use of it. The head librarian is at the same time dean of instruction and his aim is to make the library the "heart of the college". The above facts are gleaned from correspondence in *School and Society* of May 18.

Science News a Century Ago

Consumption in Man and Animals

IN a long review of "A Treatise on Pulmonary Consumption" by Dr. James Clark, M.D., F.R.S., the *Athenaeum* of September 5, 1835, said: "The Chapter on the Statistical History of Consumption contains many curious facts, and is accompanied by several valuable tables affording much matter of interesting reflection to the political philosopher. It appears that more than one-fourth of those who die from birth to puberty are affected with tuberculous disease; that the greatest number of deaths from consumption occur between the age of twenty and thirty . . . the mortality being probably at its maximum at thirty and gradually diminishing from that age. . . . The chapter on the disease in animals affords much interesting information. . . . In the gardens of the Zoological Society in Regent's Park Mr. Owen has found the disease in the tiger, the Persian lynx, the paradoxure gennet, the civet cat, the Indian ichneumon, the brown coati mondi, the Nepâl bear of the Himalayas, the American tapir, the American elk, in various monkeys, in the Eskimaux dog and in the lungs of the Python tigris".

The Zoological Society

AT a meeting of the Zoological Society held on September 8, 1835, Thomas Bell being in the chair, "a marmazet was presented from Mr. Moore of Rio Janeiro, the first that has ever been seen alive in this country. This, the most diminutive species of the monkey tribe, is about the size of a small rat, and even when full grown can be put into a half-pint tumbler. The greatest singularity is its large bushy tail, in which it completely envelopes itself when it retires to repose, to screen itself from the cold. The countenance of this species is that of an old man; and the one presented to the Zoological Society is said to bear an exact resemblance to that of a celebrated French diplomatist". (*The Times*, September 14, 1835.)

Capt. Back's return from the Arctic

ON September 10, 1835, *The Times* announced the arrival in Liverpool of Capt. George Back on his return from his journey in search of Capt. John Ross, and the following day quoted the following passages regarding Back's expedition from the Montreal papers: "During the first winter the expedition had to endure great privations, owing to the scarcity of food and the severity of the weather. Captain Back is the first European who has visited the Great Fish River and examined its course to the Polar Seas. Its very existence was doubted by many geographers. It is said to be large, but dangerous navigation; greatly impeded by ice; it falls into the Polar Sea. Further than this, we only know that the party of intrepid travellers had to encounter every obstacle to which Polar navigation is liable, and we are led to believe that immense masses of ice, with severe weather finally arrested their progress. Captain Back will, we believe, have much interesting information to communicate respecting his observations on the Aurora, the changes on the needle as he drew northward, etc. The extreme cold he experienced, we learn, was 70 degrees below zero. The expedition returned to Fort Reliance which Captain

Back left on the 20th March 1835, and travelled on snow-shoes to Chippewayan; from this station he departed on the 28th of May and arrived at Lachine on the 6th of August." Back, who was born in 1796, was knighted in 1839, and was made an admiral in 1857. He died on June 23, 1878.

Progress of the London and Greenwich Railway

THE *Mechanics' Magazine* of September 12, 1835, said: "The London and Greenwich Railway viaduct is now fast approaching completion, and presents a very imposing appearance. It forms a highly interesting object from the summit of Nunhead Hill, at the back of Peckham, from which the whole range of arches, seen in nearly its entire length, appears like the 'counterfeit presentment' of a Roman aqueduct. Nunhead Hill is decidedly the best point from which to obtain a general view of this magnificent work, which there forms a part of the foreground to an exquisite and comprehensive panorama of the metropolis, in its whole enormous length from Chelsea to Greenwich, with all its 'domes and spires and pinnacles', amongst which those of Westminster Abbey and St. Paul's are of course the most conspicuous."

Societies and Academies

PARIS

Academy of Sciences, July 16 (*C.R.*, 201, 181–244). JEAN LOUIS DESTOUCHES: Definition of the stability of propositions. ROBERT FORTET: Probabilities '*en chaine*'. ANTOINE APPERT: Normal measures in separated spaces. A. RAUCH: The extension of a theorem of Lindelöf and Phragmén. DAVID BELORIZKY: The nebular spectrum of Nova Herculis. MATÉI MARINESCO: The use of low-frequency reaction in triode valves. GEORGES VAUDET and RENÉ SERVANT: The spectra of exploded wires in the extreme ultra-violet and the Schumann region. A fine wire, exploded by an electric current, forms a very intense light source, as although the time of exposure was of the order of 20 microseconds, good photographs were obtained with a grating. The lines were spark lines. MICHEL DUFFIEUX: The influence of the chemical medium on the bands of the second positive group of N_2. HUA-CHIH CHENG and JEAN LECOMTE: Some remarks on the vibration frequencies of chlorine derivatives. Discussion of Raman and infra-red spectra. PAUL SOLEILLET and SERGE NIKITINE: Comparison of the polarisation of the light emitted by resonance in an atomic jet and in the non-directed vapour. ANDRÉ KLING and ARNOLD LASSIEUR: The electrical conductivity of water. The electrical conductivity of water does not appear to be constant, and the determination of small quantities of carbon dioxide in solution by measuring the electrical conductivity is impossible. GEORGES COLANGE: Research on the optimum lighting of photographs and engravings. WITOLD BRONIEWSKI and W. PIETREK: The structure of the nickel-cobalt alloys. Curves are given showing the variation of physical properties with the composition. There is no evidence of the existence of a definite compound of nickel and cobalt in these alloys. ETIENNE CANALS, PIERRE PEYROT and ROGER NOËL: The fluorescence of some pure substances. ARTHUR AKERMANN: The adsorption by active carbon of dilute organic vapours and their desorption by pure air. LÉON MOREAU, GEORGES CHAUDRON and ALBERT PORTEVIN: A new method of extracting the gases contained in metals. The metal forms the cathode in an evacuated discharge tube, connected with a Langmuir pump. The extraction is made at the ordinary temperature. Aluminium, after removing gas by the ordinary method (fusion in a vacuum) gave additional gases by the new method, sixteen times the original amount. FÉLIX FRANÇOIS: The system, antimony iodide – ammonium iodide – water. VICTOR LIVOVSCHI: On 4.7-dimethyloxindol. GEORGES DUPONT and RAYMOND DULOU: The pyrolysis of pinene. A new type of monocyclic terpenes, the pyronenes. The new hydrocarbons are characterised mainly by their Raman spectra. FRANÇOIS KRAUT: The origin of the breccias of Chassenon (Charente). These breccias are sedimentary formations, in which occur remains of pumice and scoria, probably from an ancient volcano nearby, in addition to debris of the crystalline substratum. CONSTANTIN PIERRE NICOLESCO: Hydrological researches in the chalk of the Paris basin. AUGUSTE CHEVALIER and RAYMOND FURON: Some Tertiary and Quaternary deposits of the islands of Cape Verde. HENRI BESAIRIE and VICTOR HOURCQ: The stratigraphy of the upper Jurassic of Madagascar. A. GUILLERD and E. BEDON: An experiment with fluorescein on the losses of the Ognon, above Lure (Haute-Saone). This river disappears into permeable strata. Experiments with the dye showed that one third of the missing water emerged in the springs of La Font (Lure), and La Noireau (Magny). JAMES ALLOITEAU: The necessity of studying sections for the determination of the Polypiers of the Cretaceous. RENÉ SOUÈGES: The embryogeny of the Verbenaceæ. The development of the embryo in *Verbena officinalis*. ROBERT LÉVY and RENÉ AUDUBERT: The emission of radiation by the eggs of *Discoglossus* in the course of development. MAURICE LEMOIGNE and ROBERT DESVEAUX: The formation of hydroxylamine in cultures of *Sterigmatocystis nigra* in a medium enriched with ammonium nitrate. GASTON RAMON and ANDRÉ STAUB: Vaccination for anthrax.

LENINGRAD

Academy of Sciences (*C.R.*, 2, Nos. 5–6, 1935). M. G. KREIN: A special class of differential operators. G. V. PFEIFFER: An integrating factor of a system of symbolic equations, equivalent to a system of linear equations in Jacobians, which satisfies the generalised conditions of Hamburger. G. B. GUREVICH: Classification of trivectors of the eighth degree. P. P. LUKIN: Dependence of internal forces on the main virial of the outer forces. N. V. ADAMOV: Geometrical meaning of the stability condition given by Liapunoff. V. EFREMOVICH and M. KREINES: Topology of surfaces of second order. TH. JUDALEVICH: Optical phenomena connected with the change in size of the spherical particles of a disturbed medium. P. A. WALTHER and S. D. PONOMAREV: Investigation of hydraulic grids. N. N. GUSEV and M. B. NEUMANN: Rate of combustion of pentane mixtures. L. J. KURTZ: Kinetics of the formation of anode films on metals (1). Protective films of silver chloride and bromide on silver. N. J. DEMJANOV and N. I. PUTOCHIN: Action of nitrous acid on triptophane. V. O. LUKASHEVICH and M. A. VOROSHILOVA: Reduction of nitrogen compounds by

iron shavings. M. K. DJAKOVA, A. V. LOZOVOJ and S. I. CHERTKOVA : An investigation of the chemical composition, properties and methods of treatment of primary tars of Cheliabinsk brown coal. G. N. MASLIANSKIJ and M. S. NEMCOV : The poisoning of molybdenum-zinc catalyst. E. A. RAZBAUM and A. N. FILIPPOV : Chemical composition of lawrovite. A. E. CHODJKOV : Tertiary deposits and the boundary of glaciation in the eastern part of the Narym region, Western Siberia. P. P. LAZAREV and L. N. FORMOZOVA : Influence of illumination on some processes in plants (2). Influence of illumination on the quantity of water and of organic substances in plants. R. I. SEREBROVSKAJA and N. I. SHAPIRO : Frequency of mutations induced by X-rays in the autosomes of mature and immature germ-cells of *Drosophila melanogaster* males. S. G. LEVIT : Sex-linked genes in man (and their relation to the problem of dominance). V. N. NIKITIN : Physiology of milk secretion.

VIENNA

Academy of Sciences, June 27. MARGARETE HOFFER : Evaporation experiments in vacuum with polonium, radium D and radium E. With electrodes containing RaD, RaE and Po, the last evaporates at lower temperatures than RaE or RaD, the differences being about 250° and 300° C. respectively. With aged electrodes, the values are higher for all three elements, but the order remains the same. ELISABETH RONA and MARGARETE HOFFER : Evaporation of polonium in oxygen and nitrogen. An apparatus is described which allows of the preparation, evaporation and measurement of the polonium in a definite gas-space, without contact with the external air. The evaporation occurs at a lower temperature in nitrogen than in oxygen. MARIETTA BLAU and HERTHA WAMBACHER : Sensitiveness of desensitised photographic films in dependence on atmospheric oxygen and on the concentration of the desensitiser. The results obtained agree best with the oxidation theory of the desensitisation process. JOSEF SCHINTLMEISTER and ERNST FÖYN : Disintegrability of the elements from argon to manganese by polonium α-rays. Only potassium gave an observable, though very small, yield of H-rays, other elements giving not more than about 0·2 H-rays per 10^6 polonium α-rays. ERNST BEUTEL and ARTUR KUTZELNIGG : Behaviour of cellulose towards liquid chlorine, iodine, and iodine monochloride. ERICH TSCHERMAK-SEYSENEGG : Genetics of dimorphism and occurrence of homostyly in primulas. FRITZ LIEBEN and BELLA BAUMINGER : The system sugar – amino acid – yeast. LEONORE BRECHER : Pre-induced alterations in the light-reaction threshold for the coloration of *Dixippus morosus*, Br. et Redt. FRANZ MAUSER : Synchronous metamorphosis of transplanted fore-legs in *Dixippus morosus*, Br. et Redt. ATMA MALABOTTI : Histological investigation of the stick grasshopper with transplanted head. HANS PRZIBRAM : (1) Heat-sum and temperature quotient. Results obtained in the investigation of egg development, larval growth and chrysalis duration are given. (2) Quantum growth with vertebrates. (3) Transference of the metabolic level of temperature-modified rats to their progeny. KONSTANTIN TZONIS : Direct current narcosis in insects. JUSTUS ROSENHAGEN : The path of the Prambachkirchen meteorite. ARMIN DADIEU and WOLF ENGLER : Raman spectrum of $CDCl_3$. For ordinary chloroform, the spectrum consists of the six frequencies (intensities in brackets), 263(4), 369(4), 671(5), 765(3*b*), 1219(2), 3022(4). For $CDCl_3$, these become 265(4), 367(4), 657(5), 740(3*b*), 916(2), 2254(4). The line 2254 cm.$^{-1}$ corresponds with the C–D valency vibration, and 916 cm.$^{-1}$ also depends essentially on the C–D linking. ARMIN DADIEU and HANS KOPPER : Raman spectra of DBr and C_2H_5SD. RUDOLF LEUTNER : Velocity of hydrolysis of cyclic acetals (2).

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 21, 301–412, June 15). CHARLES H. MCBURNEY, WALTER B. BOLLEN and ROGER J. WILLIAMS : Pantothenic acid and the nodule bacteria – legume symbiosis. The stimulating effect of innoculating alfalfa and other legumes with appropriate bacteria has hitherto been explained on the theory that the bacteria fix nitrogen. Small quantities of pantothenic acid, which can be synthesised by *Rhizobium meliloti*, exert a marked stimulating effect on the growth of alfalfa. Culture experiments suggest that pantothenic acid is not the deciding factor in the nitrogen fixation process, but rather it plays an important part in the carbohydrate anabolism of the plant. FRANCIS G. BENEDICT and ERNEST G. RITZMAN : Lability of the basal metabolism of the dairy cow. Feeding experiments on five Holstein (*c.* 600 kgm.) and four Jersey (*c.* 300 kgm.) cows, ranging in age from 3 years to 15 years and extending over periods from two months to three and a half years, show a significant higher level (ranges of 10–90 per cent for individuals) during the pasture season (June) and a tendency for a minimum during March. There was also frequently a profound change in the metabolic level within a period of two months (ranges of 30–85 per cent for individuals). Rubner's concept, formulated about fifty years ago, that all resting warm-blooded animals give off heat in direct proportion to their surface areas, and at a constant rate, irrespective of species, of 1,000 cal. per sq. m. of body surface per 24 hours, now requires modification. L. D. LEET : The Provincetown, Massachusetts, earthquake of April 23, 1935, and data for investigating New England's seismicity. A very slight earthquake was felt on this date along the tip of Cape Cod. It was recorded at Harvard, Mass., with a Benioff seismograph. This instrument has been calibrated by recording dynamite blasts in quarries, and it was therefore possible to fix the focus at 117·5 km. from Harvard. More such instruments, which are capable of giving useful records of such slight local earthquakes, are required. ROBERT A. MILLIKAN and H. VICTOR NEHER : Equatorial longitude effects on cosmic rays. A progress report. Shielded and open electroscopes taken on voyages round the world show a sudden dip in causing the equatorial belt—varying from 8 to 12 per cent on different sides of the globe. A similar survey at high altitude, at present incomplete, shows an exponential rise in ionisation with height. These results indicate a dissymmetrical distribution in outer space of the earth's magnetic field with respect to a line passing through the centre of the earth. J. A. STRATTON : Spheroidal functions of the second kind. RICHARD C. TOLMAN : Thermal equilibrium in a general gravitational field. A theoretical discussion. W. W. HANSEN : On the expansion of Green's function. The discussion is confined to scalar equations of mathematical physics. FRANCIS B. SUMNER and DENIS L. FOX : Studies of carotenoid pigments in fishes. (3) The effects of ingested carotenoids upon the xanthophyll content of *Fundulus parvipinnis*. Batches of the Pacific

killifish fed on the chopped flesh and skin of the garibaldi, a brilliant orange-red fish containing much xanthophyll, showed a substantial increase in the concentration and absolute amount of xanthophyll in their tissues. Other batches fed on chopped white meat of the California 'halibut', which contains practically no xanthophyll, neither lost nor added to their stock of xanthophyll. Still other batches fed on beach worms, which are rich in carotene but have no xanthophyll, showed an increase in xanthophyll content. Hence these fish, while unable to produce xanthophyll on a diet free from carotenoids, can apparently convert carotene into xanthophyll, contrary to the prevalent belief that animals must ingest such substances directly or indirectly from plants. A. H. WRIGHT: Some rare amphibians and reptiles of the United States. F. B. SUMNER: Studies of protective colour change. (3) Experiments with fishes both as predators and prey. The predators used were blue-green sunfish, and *Gambusia* adapted to light and dark backgrounds formed the prey. The results confirmed the earlier experiments in which penguins were the predators; that is, light-adapted fish were more readily caught in a dark tank and vice versa. Fish which were immobilised by drugs were also caught more quickly. Conspicuousness, rather than availability, determines survival, and total quiescence is a definite handicap when the predators are also fish. S. BOCHNER: Summation of multiple Fourier series by spherical means. MAX ZORN: The automorphisms of Cayley's non-associative algebra. GEORG AUMANN: On a topological characterisation of compact convex point sets. MARSTON MORSE: Generalised concavity theorems. S. LEFSCHETZ: A theorem of extremals (2). J. H. C. WHITEHEAD: A certain region in Euclidian 3-space. J. VON NEUMANN: On normal operators. A. D. BERGNER and A. F. BLAKESLEE: Chromosomes ends in *Datura discolor*. CURT STERN: The effect of yellow-scute gene deficiency on somatic cells of *Drosophila*. Female cells homozygous for this deficiency are rarely viable. CLYDE E. KEELER: Headdot: an incompletely recessive white spotting character of the house mouse. G. W. BEADLE and A. H. STURTEVANT: X-Chromosome inversions and meiosis in *Drosophila melanogaster*. A general theory of the behaviour of inversions, supported by genetic evidence. HELEN DEAN KING and W. E. CASTLE: Linkage studies of the rat (*Rattus norvegicus*). Breeding tests show that, in the eleven genes which have been identified, two linkage systems occur. E. LUCILE SMITH: X-Ray and abnormalities: increased abnormality of segments in *Drosophila* due to X-raying of gametes. Irradiation of virgin females led to a number of individuals in the first generation having irregular abdomens, increase of irradiation producing larger numbers of abnormal individuals. The effect was not inherited. The suggestion that the effect is due to changes produced in the cytoplasm of the eggs seems to be confirmed by the appearance of few abnormal individuals on irradiation of males, the gametes of which carry little cytoplasm. HENRY FAIRFIELD OSBORN: The ancestral tree of the Proboscidea: discovery, evolution, migration and migration over a 50,000,000 year period. An advance account of a forthcoming monograph on the Proboscidea, with a discussion of the bearing of this work and of Prof. Osborn's corresponding work on the Titanotheres on the mechanism of the evolution of species.

Forthcoming Events

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

Sunday, September 8

BRITISH MUSEUM (Natural History), at 3 and 4.30.—Miss M. R. J. Edwards: "Pioneers".*

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (NORWICH MEETING)

Monday, September 9

At 10 a.m.—Sir Arthur Smith Woodward: "Recent Progress in the Study of Early Man" (Presidential Address to Section H).

Prof. P. T. Herring: "The Pituitary Body and the Diencephalon" (Presidential Address to Section I).

At 12.—Mr. F. T. Brooks: "Some Aspects of Plant Pathology" (Presidential Address to Section K).

At 3 p.m.—Exhibition of Prof. J. S. Huxley's film "The Private Life of the Gannets" (in the Stuart Hall).

At 9 p.m.—Exhibition of educational films by courtesy of the British Gaumont Instructional Films.

Tuesday, September 10

At 8.15 p.m.—Dr. C. S. Myers: "The Help of Psychology in the Choice of a Career" (Evening Discourse in the Agricultural Hall Assembly Room).

INSTITUTE OF METALS, September 9–12. Annual Autumn Meeting to be held in Armstrong College, Newcastle-upon-Tyne.

September 9.—Dr. H. W. Brownsdon: "Metal Melting—Its Effect on Quality" (Fourteenth Autumn Lecture).

Official Publications Received

Great Britain and Ireland

Transactions of the Third International Congress of Soil Science, Oxford, England, 1935. Vol. 1: Commission Papers. Pp. xii+428. 23*s.* net to Members of the International Society of Soil Science; 28*s.* net to non-Members. Vol. 2: Plenary Session Papers and the Presidential Address. Pp. iv+194. 11*s.* net to Members; 13*s.* net to non-Members. (London: Thomas Murby & Co., Ltd.)

Sir John Cass Technical Institute. Syllabus of Classes, Session 1935–36. Pp. 114. (London: Cass Technical Institute.)

Department of Scientific and Industrial Research. Report on Certain Trials of Geo-electric Methods in S. Wales, with Special Reference to the possibility of their use in Detecting Underground Water in Mining Areas. By Prof. A. Hubert Cox, Dr. D. A. Bryn Davies and Dr. T. G. Williams. Pp. v+34+20 plates. (London: H. M. Stationery Office.) 2*s.* 6*d.* net.

Other Countries

U.S. Department of the Interior: Office of Education. Bulletin, 1934, No. 11: Courses in Occupational Information. By Maris M. Proffitt. Pp. v+47. 5 cents. Bulletin, 1934, No. 20: Graduate Study in Universities and Colleges in the United States. By Walton C. John. Pp. xiii+234. 20 cents. (Washington, D.C.: Government Printing Office.)

University of Illinois: Engineering Experiment Station. Bulletin No. 274: A Supplementary Study of the Locomotive Front End by means of Tests on a Front-End Model. By Prof. Everett G. Young. Pp. 42. 50 cents. Bulletin No. 275: Effect of Time Yield in Concrete upon Deformation Stresses in a Reinforced Concrete Arch Bridge. By Prof. Wilbur M. Wilson and Ralph W. Kluge. Pp. 32. 40 cents. Bulletin No. 276: Stress Concentration at Fillets, Holes and Keyways as found by the Plaster-Model Method. By Prof. Fred B. Seely and Thomas J. Dolan. Pp. 34. 40 cents. Bulletin No. 277: The Strength of Monolithic Concrete Walls. By Prof. Frank E. Richart and Nathan M. Newmark. Pp. 36. 40 cents. (Urbana, Ill.: University of Illinois.)

Malta. Annual Report on the Working of the Museum Department during 1934–35. Pp. xxii. (Malta: Government Printing Office.)

Catalogues

Mandelic Acid B.D.H.: for Use in the Treatment of Urinary Infections as a substitute for a Ketogenic Diet. Pp. 8. (London: The British Drug Houses, Ltd.)

Apparatus for the Examination of Soil. Pp. 40. (London: A. Gallenkamp and Co., Ltd.)