NATURE

SATURDAY, MARCH 12, 1932

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

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

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

No. 3254, VOL. 129]

National Economy and Fundamental Research *

THE report which is presented annually to Parliament by the Department of Scientific and Industrial Research is not only a summary of the Department's activities but also an impressive picture of the manifold ways in which scientific research is applied alike to the solution of industrial problems and to the everyday needs of society. It might be expected that, in a year of sustained industrial depression and unemployment, the financial stringency and imperative need for national economy would direct first attention to the details of the work carried out under the Department, in search of justification for the expenditure of the sums of money entrusted to the Department. It is probable, however, that the attention of most readers will be arrested in the first instance not by the summary of work but by the report of the Advisory Council, in which a masterly analysis, over the signature of Lord Rutherford, of the development of the Department and the fundamental relations of industry and scientific research is presented.

It is only when the fundamental principles which determine the influence of industry on science and of science on industry are rightly apprehended that any accurate assessment of the detailed results of the work of the Department is possible. Recent events do not encourage an easy optimism that these principles have yet received adequate recognition in the counsels of either industry or the State. On the contrary, the report of the May Committee on National Expenditure affords uncomfortable evidence that scientific research is still regarded as an expensive luxury.

The Advisory Council has set before itself, as its main endeavour, to encourage industry to look on scientific research not as a last resource but as an essential part in the business of production. While, however, this policy has substantially increased the competitive power of British industry, and while industry is more and more anxious to take advantage of applied science whether through the Department or by other means, the Advisory Council considers that the attitude towards research is still too often one of hope rather than of faith.

The fundamental factor of the situation, that the initial advantages which Great Britain secured through her island position, her natural resources, and the technical skill of her workers, are no

* Department of Scientific and Industrial Research. Report for the Year 1930–31. (Cmd. 3989.) Pp. iv+186. (London: H.M. Stationery Office, 1931.) 3s. net.

longer sufficient in themselves to enable our manufacturers to withstand the organised and scientific rivalry of competing countries, is now generally recognised.

"Scientific Research", declares the Advisory Council, "has in the past made striking contributions to industrial research and it will make them in the future. But the nation which will enjoy the benefits of science in the day-to-day progress of its industries is the nation which habitually applies scientific method and scientific knowledge; and it is that nation which will be able to seize the more spectacular achievements of science in the industrial sphere. Scientific research cannot provide a ready-made solution of any of the present industrial difficulties; but it does point the road along which persevering effort may enable industry to find a way out of some of those difficulties."

This emphasis on the need for scientific method and research in industry is welcome, but the Advisory Council does not advise or recommend unrestricted or greatly increased expenditure on research for the solution of industrial difficulties. The view is taken that the expenditure which is defensible in the national interest depends on the extent to which industry generally is prepared to apply scientific method and advances in scientific knowledge.

This admirable statement of policy has been hailed in some quarters as a justification for restricted expenditure on research, and, significantly enough, by industries the difficulties of which are notoriously due less to economic conditions than to neglect of scientific method and research in the past. Temporary protection of these industries by imposition of a tariff can only be justified as affording them an opportunity of putting their house in order, and should be contingent upon the industry re-orientating its attitude to fundamental research with the object of accumulating a reserve of fundamental knowledge to assist in tiding over bad times and to strengthen the industry to meet independently competition from abroad.

The report from the Advisory Council is, however, emphatically a plea for more widespread education in industry as in public affairs. The full utilisation of the results of scientific research and the substitution of scientific for empirical methods can only be secured as a result of confidence in the scientific workers engaged in the study of the problems concerned and of acquaintance with the existence and value of this large body of scientific knowledge and research. Marked progress in this task of education is indicated in the report, although the research associations themselves have found it advisable to take definite steps to bring home to their members the practical significance of the scientific conclusions which have been reached. As such educational work succeeds and extends, the Advisory Council will be committed, in the pursuit of its declared policy, to increasing expenditure on industrial research, until the progression from haphazard empirical methods to those of scientific control and direction by the use of instruments of precision in technical practice, which is characteristic of the present industrial revolution, has largely been effected. The national interest clearly demands that only the capacity and willingness of industry to apply the results of such research should limit the State expenditure thereon.

The moderation of this report is, however, equalled by the breadth of its vision, and in an important section which discusses the application of new inventions, the Advisory Council points out that new industries are not in general created by direct scientific discoveries. They can usually be traced to remote origins, and the history of the relations between invention and industrial development promises no short cut to renewed prosperity. As example of this contention the report cites the growth of the radio industry from John Henry, Clerk Maxwell, and Hertz's theories and investigations in the middle of last century. Numerous other examples have frequently been quoted in our columns in discussing the influence of creative science on industry, and recently Dr. L. V. Redman, in his address on "Research as a Fixed Charge" on receiving the Grasselli medal of the Society of Chemical Industry, stressed the great length of time that is usually required to bring a piece of promising research into a profitable industry.

It is these facts which lead us to view with misgivings the decision of the Committee of the Privy Council, in curtailing the expenditure of the Department of Scientific and Industrial Research, "to concentrate available funds on the work of the most immediate practical value to industry, leaving to happier times the expansion of work of which the results could only be available at some more distant date". For all that the Committee expresses the belief that the immediate usefulness of the Department to industry will not be seriously impaired by the economies necessitated, the fact cannot be disguised that the concentration recommended is, in fact, robbing the future.

It must be admitted that the Department had a difficult task and one that it could probably only

discharge satisfactorily when the education of industry and public opinion generally as to the value of scientific method and research has become much more advanced than at present. Misgivings about the actual policy adopted are less a criticism of the Department than of the general attitude to scientific research prevalent in Great Britain.

Although scientific methods are much more widely used in almost all our industries than even a few years ago, there is not yet a general disposition to accept an adequate and sustained programme of research as a fixed charge, comparable with insurance, depreciation, obsolescence, etc., without which no industry can progress, if indeed it can survive. Science, whether in its broadest aspect or its narrow technical sense, will not occupy its proper place in industry until the industrialist is prepared not merely to admit its possibilities and accept its occasional assistance but also to incorporate it as part of his industrial practice. Such incorporation involves not merely the support of research work, whether conducted in his own laboratories or outside, or in co-operation with other firms, but also continuous contact with research in matters of interest to his industry, wherever that research is prosecuted. For the pursuit of a policy of this kind, the industrialist must maintain a competent scientific staff of his own, and see that a scientific outlook is represented not only among the subordinate staff but also in high places.

This question of scientific outlook is all-important. Amid the complexities of modern industries, industrial research can easily prove sterile through misdirection; the best results can only be attained under the direction of those in whom familiarity with scientific method and outlook is accompanied by a knowledge of the economic and industrial aspects of processes which the researches may benefit or even create. Intimate contact between manufacturing practice and the work of the laboratory is essential if industrial research is to bear its proper fruit, and the development of industrial and scientific research is a matter of leadership as well as education. This is clearly recognised by the Advisory Council, and not the least important aspect of the Department's work is the assistance given to post-graduate students and others in their training in methods of independent scientific investigation under the general supervision of the Department. This assistance is a direct contribution to the staffing of scientific, technical, and administrative positions in industry with men of the requisite ability, and it is disappointing to find that during the period 1925–30 the number of students in training who proceeded to scientific service in industry or under Government was 141 and 52 respectively, as compared with 181 and 80 in the period 1920–25. The provision of an efficient scientific personnel in industry is all-important alike for the effective direction of research and for its proper assessment as an integral part of industrial policy and development.

There are many more firms than formerly in British industry where a considered research policy and programme is an accepted part of manufacturing practice, and in many others scientific and technical methods of control have replaced the less accurate empirical methods. The evidence does not show, however, that research, and in particular fundamental research, has yet received anything like full recognition from our industries as a whole. Largely this is due to the disparity between the number of administrative posts held by scientifically trained men, whether in industry or in Government service, in Great Britain as compared with other countries. The technical factors involved in modern industry and, indeed, in general administration cannot be accurately appraised apart from technical and scientific knowledge.

While admittedly many of our research workers, particularly those engaged in academic research, might with advantage be more closely acquainted with industrial conditions, there are few scientific workers indeed who imagine that research is a panacea for all industrial ills or more than one essential factor in industrial progress. Industry's difficulties arise much more from its direction by those without the essential technical and scientific training. Under modern industrial conditions, technical and scientific training is a *sine qua non* of competent leadership, and until our industries are much more widely directed by those whose scientific training and outlook render them competent to evaluate research along with other factors involved, it is improbable that industry will display the continuous reliance upon research for its development which it is the aim of the Department to foster. Still less can we expect a satisfactory and authoritative decision regarding the prosecution and endowment of the fundamental and long-range research upon which progress finally depends, until the question is considered in council by experienced industrial leaders and national administrators who count among their qualifications a first-hand experience of scientific technique.

Engineering History

(1) *The Story of the Road: from the Beginning down to A.D. 1931.* By Prof. J. W. Gregory. Pp. xii + 309 + 16 plates. (London: Alexander Maclehose and Co., 1931.) 12*s.* 6*d.*

(2) *The Quest for Power: from Prehistoric Times to the Present Day.* By Hugh P. Vowles and Margaret W. Vowles. Pp. xv + 354 + 88 plates. (London: Chapman and Hall, Ltd., 1931.) 15*s.* net.

ENGINEERING history not merely tells us of some of man's greatest achievements, but also of necessity carries us back to the beginning of the human race. Primitive men had their tracks and tools, and from these by a long process of evolution have come our great highways with their streams of traffic and our power-houses with their gigantic turbines and water-wheels. Thus in both these fascinating books, one on roads and the other on power, we are taken back to prehistoric times, and then step by step brought down to modern times, with all their marvellous constructions.

Both books are unusually entertaining, both can be read with pleasure either by the expert or the general reader, and both are valuable additions to engineering literature. While, however, Prof. Gregory sticks closely to his text and does not trouble us with the tools and appliances the road-makers have used, Mr. and Mrs. Vowles, in their anxiety to give the reader as much light on the subject as possible, have included chapters on tools, metals, coal, and oil, and even on counting, measuring, and time reckoning. The foretelling of eclipses is undoubtedly of great interest, but we would rather have learnt more of what the authors could tell us of ancient water-wheels and windmills.

It is quite evident that the writing of both these books has been a congenial task to their respective authors. (1) Through his travels abroad, Prof. Gregory has had experience of roads in many parts, and the reader will especially enjoy his lively reminiscences and his numerous photographs. The earliest roads, he tells us, were mere hunting trails or game tracks. Roads proper came into existence with the search for materials and for trade, and among the most famous highways of other times were the 'amber' roads of Europe and the 'silk' roads of China. Then, too, there were the 'pituri' roads in Australia, and that astonishing road of the Incas in Peru, four thousand miles long. Paved roads were laid by the Egyptians and Carthaginians, but the Romans were the first to establish a continental system of well-built roads. These matters are all dealt with in the first part of the book.

Interesting as is Prof. Gregory's account of the ancient and medieval roads, of far more immediate practical importance is the part devoted to "The Evolution of the Modern Road", with all its facts and figures. Everyone is a user of roads, everyone contributes to their upkeep, everyone grumbles if they fall into disrepair, but soon no one will remember the mud of the roads of thirty or forty years ago. Our roads to-day are costly, it is true, but the saving in discomfort, in shoe leather, in tyres, and in petrol is enormous. But whether it is the teacher intending to give a lesson on roads, a motorist wishing to know how roads are made and kept in order, or whether it is one of the thousands of local councillors in the country desirous to know something of road legislation or road finance, Prof. Gregory's book meets their case.

(2) The history of power is a far more complex subject than the history of roads, and calls for an intimate knowledge of up-to-date practice, a vast amount of research, and ability to marshal facts and present them in proper sequence. The success with which Mr. and Mrs. Vowles have carried out their task is a tribute to the amount of thought and labour they have expended upon it. The book is an admirable result of the combined work of an engineer and a historian. We greatly regret, however, to notice that Mrs. Vowles died on March 4, and thus a most valuable combination has come to an end.

The scope of the book is best seen from an enumeration of its various divisions. In the first place, the whole matter is divided into three 'books'. These books contain eight, seven, and four chapters respectively. In the first book the reader makes the acquaintance of man as a tool maker; he is given a sketch of the rise of craftsmanship and of the first control of water; there are accounts of the early structural achievements, such as the pyramids, and of the dawn of transport; and to these are added chapters on the transition to iron, on early measuring, and on engineering in Græco-Roman antiquity.

In the second book the stories of the steam engine and of the steam and hydraulic turbines are told. We meet again with Newcomen, Watt, Perkins, Porter, Edison, Parsons, De Laval, Curtis, Otto, Diesel, Akroyd Stuart, Fourneyron, Francis, and others whose names are familiar to all power engineers, and are given some interesting descriptions of modern power plants. Then in the third book come chapters on the materials of power—coal, oil, alcohol, iron, steel, and other metals—their produc-

tion and properties, and the book ends with an epilogue on " World Power and the Future ".

Many of the men mentioned in the book, we fear, will mean little to others than engineers, but the work does not aim at being a biographical dictionary. Like " The Story of the Road ", " The Quest for Power " has that most useful feature, a good index.

Plato and the Modern Age

After Two Thousand Years: a Dialogue between Plato and a Modern Young Man. By G. Lowes Dickinson. Pp. 213. (London: George Allen and Unwin, Ltd., 1930.) 6*s.* net.

TO what extent have the greatest thinkers of the world guided or in any way controlled its destiny, and are they likely to be more enlightened and inspired and successful now or in the future than they have been in the past? The answer will doubtless vary according to our knowledge and interpretation of history. According to Carlyle, the history of the world centres around its great men, by whom he meant primarily its great thinkers; but though these great ones in the past have undoubtedly played a leading part, as it seems to us, in shaping the course of events, it has been fairly generally acknowledged, at least by the leaders of nearly every religion, that there has been an overruling Power known under various designations, among which Fate or Destiny were the most generally recognised by the ancients. Be this as it may, and reverting to that part of our question which asks whether modern or future thinkers will be more effective, it must be admitted that the quality of modern thought, as compared with ancient, is not infrequently called in question and even deplored as greatly inferior to that of the ancients. Various reasons are assigned for this, but it may at least be urged in extenuation that existence to-day is far more complex and presents much more difficult problems to the thinker than in the olden days.

The extraordinary increase in scientific knowledge has vastly extended the realm of thought and revealed heights and depths which almost make the mind reel in contemplation of the physical universe. In the political and social spheres, largely owing to scientific discovery and invention, the most profound changes have taken place, infinite complexities have been introduced, touching among other things national and international relations, so that here too the thinker can quite easily find himself nearly if not quite out of his depth. Thus we can readily see that the fields of thought are now infinitely vast and infinitely complex; and turning to the thinker himself we find that he, for his part, has to spend so much time merely in the acquisition of knowledge, of which a certain minimum is essential, that he has little real leisure for serious meditation on the majestic but increasingly mysterious panorama of life which now unfolds before him.

It was therefore a happy thought of Mr. Lowes Dickinson to call up Plato and see how that mighty intellect would react when confronted with the problems of modern existence. The work takes the form of a conversation between the beloved master and a very modern young man, and we can say at once that it has been exceedingly well done, as was only to be expected from such a first-grade classical scholar as the author is universally acknowledged to be. The book is highly stimulative, in some parts helpful and suggestive, and occasionally provocative, thus conforming with most of the demands an eager and inquiring mind can make on any book.

If no very serious contribution is made to the solution of modern problems, it must be remembered that even a Plato, suddenly awakened after two thousand years and confronted with such a marvellously changed world, could scarcely be expected to produce, at short notice and after an hour or two's talk with a modern young man, reasoned solutions to present-day enigmas. But in the course of the talk he is often brilliantly suggestive, and at the finish he rises to transcendental heights and seems to show, though somewhat vaguely, a path upwards in which the human mind may walk with hope and faith that good will ultimately prevail, and some is even now glimmering down from a higher world to which men must strive to attain.

The subjects dealt with in the early stages of the discourse relate to property, forms of government, socialism, population control, war, and education. These comprise Part I. In the second part we have a supremely interesting discussion touching the subordination of the individual by the State in such a way that nobody was, in fact, pursuing any real good. The possibility is considered of enabling the mass of the citizens to attain a real good rather than that this privilege should be limited to a favoured few, but this is ultimately discarded as impracticable; and we next have a description of those things which may be regarded as real goods in themselves, as distinguished from means to other goods. In the final analysis real good consists in truth, art, love. The book ends

with the Platonic doctrine of immortality and of another life deeper and more significant, from which even now some light occasionally shines down.

It would seem that, despite the profound and far-reaching changes in the modern world as compared with the ancient, the essential mysteries of existence are very much the same to the modern as to the ancient philosopher. We may have advanced tremendously in physical knowledge, in social organisation, and in industrial efficiency, but despite all this we are no nearer to any adequate explanation of those baffling mysteries which have always loomed up as an impenetrable curtain of the blackest darkness before the human mind.

Those of us who still cling tenaciously, though only as it were by a thread, to some remnant of religious faith, who endeavour to discern a gleam of light in that darkness, and try our hardest to believe, with Plato, that there is a good and that it will ultimately prevail, have yet to acknowledge the harsh realities of existence, and carry on with as much faith and courage and dauntless cheer as we can summon or invoke to our aid. Mr. Lowes Dickinson seems to conclude on the right note, and the lofty faith of Plato prevails over the mournful scepticism of the modern young man.

W. G. LINN CASS.

South African Grasses

An Introduction to the Study of the South African Grasses: with Notes on their Structure, Distribution, Cultivation, etc. By Dr. E. P. Phillips. (South African Agricultural Series, Vol. 6.) Pp. 224 + 121 plates. (Johannesburg: Central News Agency, Ltd., 1931.) 25*s*. net.

IT is perhaps not a mere coincidence that the two most recent works of any size on the Gramineæ have come from South Africa. In 1929, Prof. Bews issued his book, "The World's Grasses", and now Dr. Phillips has written on the grasses of South Africa. The study of the Gramineæ in a country where vast stretches of veld are devoted entirely to the raising of stock is of more than mere academic interest. We in Britain, who are accustomed to the lush meadows of our own land, where the cultivation of grasses presents no real difficulty, often fail to realise the troubles confronting the South African agriculturist, who has to contend with the dual effect of a poor, often alkaline soil and a low atmospheric humidity. It is not surprising, therefore, that a great deal of experimental work is being carried out by the agricultural institutions of South Africa upon problems connected with grasslands.

Dr. Phillips has endeavoured to produce a general survey of South African grasses. In the introduction, exception is taken to Dr. Stapf's use of the term 'floret', which was merely a convenient expression to include with the flower the associated bract and bracteole. All agrostologists, however, will not agree with Dr. Phillips's contention that "the descriptions could be simplified, made more definite and understandable if the use of this term is discontinued".

Commencing with a survey of the principal publications dealing with the South African grasses, Dr. Phillips strikes an original note in Chap. ii. with a detailed list of authors and complete references to genera published by them, with the 'type' or 'standard' species of every genus. Such a comprehensive list has probably never before been compiled and should prove of great usefulness to all interested in the taxonomy of grasses.

The following chapter deals with migration and the distribution of grasses, in which the author, on the assumption that the temperate genera are more primitive than the tropical, and that South Africa enjoyed at one time a cooler climate than at present, suggests three main lines of migration: first, the migration northwards of the temperate grasses along the mountain ranges; secondly, a movement southwards of tropical genera along the valleys; and lastly, a westward migration of tropical grasses into the north-western area and the Karroo.

The questions of veld-burning, grazing, and cultivation are dealt with in another chapter, and stress is laid on the disastrous effects of overstocking, particularly of important watersheds, where the whole aspect of an area may be changed in a few years. A useful list of common names of South African grasses is also given—though, as is usual with 'common' names, the same name is frequently given to widely different plants.

A little more than half the book is devoted to the systematic side of the subject. There are keys to the grass tribes and to the genera, and a description and figure of almost every genus. For some reason, Dr. Phillips has preferred to adopt Hackel's arrangement of the tribes of 1890, rather than the more modern systems of Stapf and others. This has meant the retention of the Tristegineæ, an unnatural group which has been dropped by later workers and which did not even figure in the "Flora Capensis". Hackel's Zoysieæ also is placed in the Panicoideæ, whereas all recent authors

place the Zoysieæ in the Pooideæ. At the same time, the Oryzeæ appear in the Panicoideæ, although they occupy a more natural place in the Pooideæ. There appears to have been no justification for resuscitating Hackel's system at this stage, the more so since the other works on the Gramineæ available to the South African student, such as the "Flora Capensis", "Flora of Tropical Africa", and Bews' "The World's Grasses", adopt more natural arrangements.

The key to the genera is of the dichotomous variety. It covers 29 pages and appears to work reasonably well. The descriptions of the genera are in most cases very complete, and the distribution and altitudinal range of each genus is given in almost every instance. The illustrations, however, which are line drawings—and might, quite well, have contributed greatly to the value of the book—are very poor and reflect little credit on the artist responsible. Quite a useful feature in most of the illustrations is a cross-section of the leaf—often a useful character in confirming a determination.

The book is a volume of an agricultural series, and lacks a little in quality of paper and of binding. The high price is due, no doubt, to the large number of illustrations and to the restricted circulation such a work must inevitably enjoy. The book must obviously find a place on the bookshelves of all who study South African grasslands. F. B.

Short Reviews

The Bushman. By E. J. Dunn. Pp. xii + 130 + 34 plates. (London: Charles Griffin and Co., Ltd., 1931.) 15*s.* net.

THE author of this book tells us that his information was obtained by personal observation some fifty to sixty years ago while doing government geological work, chiefly in the districts bordering the Orange River. As a record of personal investigation among a people now practically exterminated, the work is of considerable value. Moreover, the writer is a geologist, and is therefore used to descriptive work and the careful noting of details.

It must be admitted, however, that the work is of unequal value. The latest books on the prehistory of South Africa, which in the nature of the case include studies of early Bushman cultures, do not seem to have been consulted. There is a large number of plates depicting stone implements, most of which would to-day be classed as belonging to the Smithfield culture; nothing is said of Wilton varieties. Admittedly, what would now be called Fauresmith types are shown as pre-Bushman on Plate xxxii., and those of the Still Bay culture on Plate xxxiii., though nothing is said about the older, Stellenbosch, implements, and no attempt is made to classify the various industries.

Similar comments apply to the art. Actually, the Bushman paintings and engravings vary in different geographical areas: for example, the engravings seem to centre around Kimberley, whereas the finest paintings are found in the mountains to the east; another series of paintings totally differing in style can be seen in the extreme south and south-east of the Union. Mention of superpositions of paintings, giving a chronological sequence, is made but not followed up. As a matter of fact, results of recent work on the superpositions of styles over large areas seem to suggest that most of the art in Southern Rhodesia is much earlier than that of the Union, and that it is these Rhodesian paintings which so resemble those of late Palæolithic age in eastern Spain. Incidentally, too, the African paintings are *not* really like those of the French and North Spanish group, such as can be seen at Altamira, with which the author compares them.

Yet after this somewhat drastic criticism, I should like to say again that records of first-hand observations of Bushmen, made at a time when they still flourished, are not easy to obtain to-day, and the memories of an observer with a scientific mind are therefore very valuable. M. C. B.

Publications of the Wagner Free Institute of Science. Vol. 2: *Studies of Evolution in the Genus Spirifer.* By C. L. Fenton. Pp. x + 436 (50 plates). (Philadelphia: Wagner Free Institute of Science, 1931.) 6 dollars net.

THE work of a palæontologist who applies experimental biological principles to his results, and by their aid formulates a theory of evolution, is bound to be of general interest. The author has studied the evolution of three gentes of spirifers, *Sp. varians*, *Sp. obliquistriatus*, and *Sp. hungerfordi*, in minute detail, and finds that none of the existing theories of evolution will account for the apparent orthogenetic tendencies of characters such as ornament, which cannot be of selective value. Natural selection, heterogenesis, Buffonism, Lamarckism, Eimer's theory of orthogenesis, and Guyer's serologic orthogenesis are all found to be insufficient or unsatisfactory.

The theory of racial life cycles is made the basis for a new theory of phyletic senescence through decreasing metabolism. Child has found that the metabolic rate is high in a young cell or organism, and that there is a general decline throughout normal life. Mr. Fenton applies this principle to the racial cycle as well as to the life cycle, and states that racial senescence is due to a similar falling off in the metabolic rate. Evidence of such racial senescence is shown by a "general progressive increase in susceptibility to injury and other disturbance, and a decrease in the capacity for repair". The whole hypothesis is based on a physiologico-heredity: that is, variations initiated physiologically are impressed on the germ plasm.

In proposing a theory which requires so close a connexion between ontogeny and phylogeny, the author states he finds that ontogeny recapitulates phylogeny in general in the spirifers, but the ontogenetic record of phylogeny may be distorted by

tachygenesis and lipopalingenesis. The Biogenetic Law is generally supported by palæontologists. This, he explains, is because in animals with shells, such as brachiopods and molluscs, the early stages form a permanent and not a temporary basis for new characters as in insects or vertebrates, usually selected by those who criticise the Biogenetic Law. Thus new characters arise by additions to the life cycles and not by modifications of pre-existing characters.

Пегматиты: их научное и практическое значение. Том 1: *гранитные пегматиты.* (*Pegmatite: Eigenschaften, Geochemie, Verbreitung, Verwendung.* Band 1: *Granitpegmatite.*) By A. E. Fersmann. Pp. 646. (Leningrad: Akademie Nauk SSSR, 1931.) 20 руб.

THE author has devoted more than twenty years to the study of pegmatite, personally explored many of the pegmatite areas in Russia and abroad, and initiated organised investigations of the problem in Russia centred in the Mineralogical Museum of the Russian Academy of Sciences. The book sets down, in a monographic form, the main results of theses and studies, and reviews critically the work of other authors. In the first part (Chapters i.-x.) a general discussion of the chemical, physical, morphological, and geological characters of pegmatites is presented, and the methods of investigations are described. The second part (Chapters xi.-xviii.) contains a monographic description of various pegmatites and their classification. The following chapters (xix.-xxv.) constitute the third part, containing a discussion on the mineralogy of pegmatites and on the geochemical and metamorphic phenomena connected with their origin. A bibliography of the main literature on pegmatites and a list of pegmatite areas of Russia are appended, while a special appendix is devoted to the economically important pegmatites. A second volume, dealing specially with the pegmatites of the basic, sienitic, and nephelin-sienitic magmas, is in the course of preparation.

The Reclamation of Land from the Sea. By F. M. Du-Plat-Taylor. Pp. xv + 153. (London: Constable and Co., Ltd., 1931.) 21*s.* net.

LAND reclamation and coast erosion are matters which very closely concern the inhabitants of sea-bordered countries. The Dutch have for centuries waged an unremitting contest with the sea, driving it back inch by inch, in order to provide themselves with space to live and expand. Not less vital in Great Britain to the dwellers of East Anglia and Yorkshire is the gradual but constant encroachment of the sea on their clay cliffs and erodible soils, and though, as Sir George Courthope points out in his introductory note, "England has gained from the sea more than she has lost", the local losses are not always, or necessarily, compensated by the gains elsewhere.

Major Du-Plat-Taylor's book commences with an exposition of the objects and methods of reclamation, and proceeds to consider in detail systems of reclamation by enclosure, with a special account of the project for the reclamation of the Zuyder Zee (to which two chapters are allocated). Reclamation by filling and by simple drainage are also considered. There are chapters on the auxiliary works and plant required for the various operations of reclamation and drainage work, embodying a good deal of useful information, a certain amount of which has been derived from the author's personal experience. Altogether, the book will be of undoubted utility to practising engineers, as assembling a quantity of data and information for reference in a compact and accessible form. There are numerous illustrations, both views of works and diagrams. B. C.

Jahrbuch des Forschungs-Instituts der Allgemeinen Elektricitäts-Gesellschaft. Band 2, 1930. Pp. 332. (Berlin: Julius Springer, 1931.) n.p.

THE second annual volume of the Research Institute of the Allgemeine Elektricitäts-Gesellschaft maintains the high standard of scientific and technical achievement reached in the first volume. It is beautifully printed on art paper, and so the photographs are excellently reproduced. All the economic and technical papers given have previously appeared in various trade journals, but the scientific worker will find most of them of great interest. Advanced mathematical theorems are given fairly fully, so that it is not difficult to verify them, and the mathematical symbols are clearly printed. The papers are collected into groups under definite headings, for example, acoustics, electro-optics, electron physics, atomic physics, atomic chemistry, electric heating, etc. The various sections are connected by prefatory reviews giving a résumé of the present state of the research field.

Scientific workers will be interested in the 'demonstration research' into Störmer's polar light theory by E. Brüche and W. Ende, and in the paper on "Theoretical and Experimental Results on the Aurora Polaris", by E. Brüche. The latter paper is printed in English. To illustrate the thoroughness with which the technical researches are carried out, we find in a paper on electric cooking the specific heats of many articles of diet. The specific heat of milk is given as 0·90, oysters 0·84, eggs 0·76, veal 0·70, fresh fish 0·80, fruit 0·81, game 0·80, pork 0·55, pork fat 0·50, blood 0·93, and so on.

The American Annual of Photography, 1932. Vol. 46. Edited by Frank R. Fraprie. Pp. 294 + Ads. 46. (Boston, Mass.: American Photographic Publishing Co.; London: Sands, Hunter and Co., Ltd., 1932.) Paper, 10*s.*; cloth, 15*s.*

THIS photographic annual is exceptionally well produced. It contains many examples of modern work. The book is mainly devoted to articles on photographic topics; a few of these are technical, but for the most part they deal with the artistic side of the subject. A few pages at the end of the book are devoted to a "Formulary" in which are brought together a great many formulæ for developers and such like necessities. S. O. R.

The British Polar Year Expedition, 1932-33

ON the ground that the relatively meagre scientific results from previous polar expeditions were due to their sporadic occurrence, Lieut. Weyprecht, of Austria, proposed in 1875 that an effort should be made to organise a number of simultaneous expeditions which would co-operate on a uniform plan over a full year. The result was the organisation of what has come to be called the First International Polar Year, 1882–83, when fourteen expeditions were sent out by twelve different countries, twelve to high northern latitudes and two to the Antarctic. Great Britain collaborated with Canada in establishing a station at Fort Rae, on the north arm of the Great Slave Lake. All the stations were fully equipped with such instruments as were then available for comprehensive meteorological and magnetic observations; they worked on a common pre-arranged plan. Judged from the practical results and the large number of researches that have been based on the data collected during that First Polar Year, the venture was entirely successful.

Since 1882, progress in meteorology, terrestrial magnetism, and allied lines of investigation has developed apace, and many problems dependent for their solution on a repetition of just such a co-operative network of stations as set up in the First Polar Year, but using improved and more refined methods of recording and observation, have presented themselves. It was felt that there could be no more fitting celebration of the jubilee of the first international year than by repeating it, and in 1929, on a proposal of Admiral Dominik of the Deutsche Seewarte, the International Meteorological Conference undertook to organise a Second Polar Year. The International Union of Geodesy and Geophysics, at its meeting at Stockholm in the same year, endorsed the proposal and promised financial aid. An International Commission for the Polar Year, 1932–33, was set up, with Dr. la Cour of the Danish Meteorological Service, as president. National committees were appointed in each country to organise the several contributions in these countries in collaboration with the International Commission.

In Britain the National Polar Year Committee, with Sir Henry Lyons as chairman, represents the interests of the Royal Societies of London and Edinburgh, as well as most of the other societies and institutions interested in such work. The Government, through the Meteorological Office, Air Ministry, has promised a grant-in-aid not exceeding £10,000 to the Polar Year efforts in Great Britain, and this has been supplemented by many generous donations in instrumental and food equipment by British manufacturers and wholesale firms.

Because it was strongly recommended by the International Commission that, so far as possible, the original Polar Year stations should be re-occupied, the British National Committee decided to send a party to the Fort Rae site on the Great Slave Lake. [Canada this year will organise her own Polar Year programme: the main station will be established at Chesterfield Inlet, with probably a second at Copper Mine for photographic auroral work.] The reopening of the mountain observatory on Ben Nevis was also considered, but questions of cost and doubts as to the real value to be obtained from only a year's further observations led to that part of the programme being dropped. Efforts were to be concentrated in equipping very fully the Canadian station at Fort Rae, and to reinforcing the observational facilities at key stations in the British Isles for meteorological and auroral work. At a later stage it was decided that advantage should be taken of opportunities for getting a complete survey of the variations in the magnetic field at high latitudes, and also auroral observations and photographs from the same stations, to establish a station for measurements of the ionisation content and its variations in the conducting regions of the upper atmosphere. It has now been decided that Prof. E. V. Appleton will take a fully equipped party to Tromsö this summer for such work, and the party will continue to observe throughout most of the Polar Year period.

The programme of observational activities drawn up by the International Polar Year Commission is concerned almost wholly with meteorology, terrestrial magnetism, aurora, and, to a less extent, atmospheric electricity. In each of these subjects the equipment of the British party to Fort Rae will be complete. In addition to maintaining continuous records of all the meteorological elements by autographic instruments, much attention will be given to the investigation of the conditions in the lower levels of the atmosphere by observational and instrumental methods. Frequent pilot balloon ascents will give an insight into the circulation over that part of north-west Canada, and special efforts will be directed to penetrating the stratosphere by sounding balloons on certain days each month previously selected by the International Commission. To obtain the most useful information about the temperature conditions up to and, if possible, well beyond the tropopause will necessitate the sounding balloon with its attached self-recording meteorograph ascending to 12 km. at least. The recovery of the instrument bearing the record after the apparatus has fallen in the difficult country around the Lake is one of the problems connected with the expedition not yet solved.

For the work in terrestrial magnetism the expedition will be equipped with alternative sets of absolute instruments, a Smith portable magnetometer and earth inductor representing the modern methods, and a Kew unifilar magnetometer and a dip circle representing the older technique. For the continuously recording instruments the intention is to take three complete sets of magnetographs, each independently capable of recording by photographic means the variations in the three components of the earth's field. Of these, two sets have been specially designed for high latitude

work by Dr. la Cour, Copenhagen, and will supply the standard and special quick-run traces respectively. By running a third set of variometers at low sensitivity it is hoped to ensure that even in the biggest perturbations of the field during magnetic disturbance no trace will be lost. The provision of a double set of absolute instruments is intended not to cater for emergencies alone; the present Fort Rae, which will be the main base of the expedition, is some seventeen miles farther up the north arm of the Great Slave Lake than the settlement of fifty years ago. For such purposes as establishing the secular change in the magnetic elements it will therefore be necessary to carry out sets of parallel observations at this subsidiary station.

The necessity for occasional occupation of the old Fort Rae site will be turned to further useful account by equipping the sledge party which will travel there in the winter months with a spare auroral camera, and by having some means of communication between the two bases. In this way it is hoped to use the two posts as base line stations for photography of aurora, and so to provide data for determining its height by the well-known methods developed by Prof. Störmer. It is of interest to observe in this connexion that, so far as is known, Fort Rae is very near to the zone of maximum frequency of aurora.

These three fields of meteorology, terrestrial magnetism, and aurora constitute the primary work of all the Polar Year stations, but, in addition, the party at Fort Rae hopes to obtain very complete information regarding the atmospheric electrical and allied phenomena of the region. Using a Benndorf electrograph, continuous records of the potential gradient of the earth's electric field will be kept; and equipment will be taken to observe, whenever opportunity allows, the conductivity of the air and the air-earth current using a modified Wilson electrometer, the small ion content of the air using a modified Ebert apparatus, the nucleus content with the standard Aitken instrument, and, if possible, the rate of production of atmospheric ionisation with an apparatus specially designed at Kew Observatory.

The Fort Rae party will consist of six men under the leadership of Mr. J. M. Stagg of the Meteorological Office. They will leave England about the middle of May of this year and proceed via Montreal to Edmonton. North of Edmonton the route will lie down the River Athabasca to the lake of that name, and then down the Slave River, past the seventeen miles of rapids between Fitzgerald and Fort Smith, to Fort Resolution on the south side of the Great Slave Lake, thence across the body of the lake and up the north arm nearly to its most northern extremity. This should be reached by the third week in June, thus giving time to erect the special non-magnetic huts required for the absolute observations and continuous registration of the magnetic field and instal the instrumental equipment in readiness for the official starting date of the Second Polar Year on Aug. 1. The party will continue observing until as late in August 1933 as may be safely done without undue risk of being frozen in for the next winter.

The Drumm Traction Battery

By Prof. A. J. ALLMAND, F.R.S.

WIDE interest has recently been aroused by reports of the successful trials of an electric train propelled by a Drumm transport battery, as also by certain details concerning the battery itself which have been made public. During the last two years I have had ample opportunity of examining and experimenting with the Drumm cell at various stages of its evolution, and it seems desirable now to put on record a statement of its main electrochemical features.

It is an alkaline cell, and the only metals which enter into its construction are stainless steel, pure nickel, and, at present, nickelled steel. Its mechanical strength and so forth are correspondingly satisfactory. As in other successful alkaline batteries, the positive plate system consists of the $Ni(OH)_2 - Ni(OH)_3$ mixture first developed by Edison; several types of such positives have been employed. Whereas, however, in other cells, the negative plate system is essentially $Fe - Fe(OH)_2$, it consists of $Zn - Zn(OH)_2$ in the Drumm battery. Moreover, $Zn(OH)_2$ is soluble in alkali, whilst $Fe(OH)_2$ is not. Consequently, instead of containing a solid hydroxide which becomes reduced to metal on charge, the Drumm negatives consist of nickel gauze grids, immersed in the solution of zinc oxide in potash constituting the electrolyte, and these on charge become coated with metallic zinc. The cell reactions in this 'zinc' accumulator, written in their simplest form, are consequently

$$2NiO + HZnO'_2 \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Ni_2O_3 + Zn + OH',$$

as compared with

$$2NiO + FeO \underset{\text{Discharge}}{\overset{\text{Charge}}{\rightleftharpoons}} Ni_2O_3 + Fe$$

in the 'iron' accumulator.

One feature of such a cell will be immediately obvious. Owing to the relative positions of zinc and of iron in the electrochemical series, its voltage will be unusually high for an alkaline cell. Depending somewhat on the part of the positive discharge curve used in practice, the average figure under normal conditions for the fully charged cell is about 1·86 volts, as compared with about 1·34 volts for the iron accumulator. The forty per cent increase represents a considerable advance. This is important, but the main advantage claimed by the inventor, which would seem to put the cell in a class of its own amongst transport batteries, depends on facts of quite a different nature.

Briefly, whilst the two electrode processes $Fe^{\cdot\cdot} + 2\theta \rightleftarrows Fe$ are subject to considerable irreversible effects, which limit the maximum practicable current densities to relatively low figures, this is not the case with the electrode processes $Zn^{\cdot\cdot} + 2\theta \rightleftarrows Zn$. There is no need to emphasise a point known to all. Iron is a metal which becomes passive with notorious ease when used as anode, and the work of Foerster has demonstrated the existence of important retardation effects during its cathodic deposition. Zinc, on the other hand, dissolves freely on anodic polarisation, as in many types of primary cell, and very high current densities are known to be used successfully in its technical electro-deposition. As a result, far heavier currents can be put through a $Zn/Zn^{\cdot\cdot}$ than through a $Fe/Fe^{\cdot\cdot}$ electrode, during both charge and discharge. The properties of the NiO/Ni_2O_3 electrode are sufficiently good from the same point of view, with the consequence that the Drumm battery, which combines these two electrode systems, can both be charged and discharged at abnormally high rates. The standard rate of charging of a single technical cell of total weight 112 lb., allowing for all losses in efficiency, corresponds to an input of 0·134 effective watt-hour/lb./minute, about four times the rate normal to other alkaline batteries. In practice, the same cell is normally discharged at a current of 400 amperes and an average voltage of 1·65 volts, equivalent to practically 0·1 watt-hour/lb./minute. This itself is twice the highest discharge rate recommended for other alkaline batteries. But, over and above this, the current can, when required, be raised to 1000 amperes for limited periods, corresponding to an energy delivery of about 0·22 watt-hour/lb./minute—a very high figure indeed. The cell deals with these heavy loads quite comfortably, with no sign of deterioration.

The power of furnishing energy at these unprecedented rates makes it possible for a traction battery of Drumm cells to overcome the grave disadvantage inherent in the majority of such batteries, namely, the impossibility of furnishing rapid accelerations. The train now operating between Dublin and Bray can accelerate from a standstill at about 1 mile per hour per second, attain speeds of 40-50 miles an hour with ease, and is provided with a successful system of regenerative braking, whereby an important fraction of the energy surge made available on a down-gradient or on decelerating at a station is returned to the battery.

There is one further very important matter. The specific watt-hour capacity of the Drumm cell on a single charge is not particularly high. In fact, in the case of the battery especially designed for the above train, it is very low—perhaps 15 per cent of that of an iron battery. But its capacity for high loads enables this battery to be charged at the termini and afterwards discharged many times during the working day; probably twenty such charges will be standard when in full operation. Consequently, the daily work of which unit weight of battery is capable will be, not 15 per cent, but 300 per cent of the normal—a fact naturally of prime importance when considering initial costs, quite apart from the elimination of the expense of an all-night charge.

With regard to other practical points, the cell possesses to a high degree the virtues of simplicity of construction and of operation, whilst there are definite grounds, which I am not at liberty to mention, for anticipating a long life. Neither overcharge, nor overdischarge, nor long idle periods have any ill effect of importance. Self-discharge is exceedingly low.

A few electro-chemical details may be added in conclusion. Under standard working conditions, the average current efficiency is 92-93 per cent, the concordant result of long-continued tests on cells of varying capacity. The average voltage during charge and discharge is 2·03 and 1·65 respectively. The energy efficiency is therefore practically 75 per cent. These are favourable figures, and strikingly so when it is remembered for what high loads they hold good; they also connote relatively small gassing and low temperature rise. During the greater part of both charge and discharge periods, the polarisation alters linearly with time. Investigation shows this change to be due almost entirely to the positive plate. The polarisation at the negative is considerably less than at the positive, and scarcely alters with time (unless the cell be overdischarged). Of the total voltage losses in a cycle, roughly half is associated with the positive, and one-quarter each with the negative and the electrolyte. The exact concentrations of caustic potash and of zinc oxide in the latter vary in accordance with the purpose for which the cell is designed, and there is no point in giving detailed figures. The essential points are, of course, an electrolyte of high conductivity and sufficient dissolved zinc oxide for the operating conditions.

It is clear that Dr. Drumm has produced a cell of somewhat remarkable properties, and that, although primarily designed for transport purposes, these properties may lead to its utilisation in other fields.

Adsorption of Gases

THE recent discussion held by the Faraday Society at Oxford, on Jan. 12–13, was devoted to a consideration of the problems connected with the adsorption of gases. The general introduction was given by Prof. H. S. Taylor of Princeton University, and a number of distinguished foreign guests presented their communications in person, including Prof. A. Magnus of Frankfort, Prof. A. F. Benton of Virginia, Prof. E. Hückel of Stuttgart, Dr. A. Farkas of Frankfort, and Drs. H. Dohse and Schuster of Ludwigshafen. The attention of the meeting was devoted almost exclusively to two important considerations, types of adsorption and discontinuities in adsorption processes.

A study of the chemical behaviour of adsorbed molecules as well as the great difference in the heats of adsorption of gases on substances such as silica

and the metals led to an early differentiation between two types of adsorption, one where the adsorbate was relatively lightly attached, with small heats of adsorption, and another type where the heats of adsorption approximate to those involved in chemical linkages. These were early characterised as physical and chemical adsorption respectively. If this is in fact the case, it should be possible to demonstrate the actual existence of these two types of adsorption in the same system, for the physical type which is only loosely held should be operative alone at low temperatures, whilst the other type should occur at higher temperatures, if as in chemical reactions an energy of activation is required. Examples of such dual adsorption processes in the same system were first demonstrated by Benton and later by Nikitin; more recently their number has been extended very considerably by Taylor, by Garner, and by Kingman.

Following the earlier concepts, it has been customary to consider the low temperature adsorption as due to Van der Waals forces, and the one occurring at higher temperatures and requiring an energy of activation as due to chemical forces, that is, due to a change in the character of the union of the metal to adsorbate. An analysis of the problem by Lennard-Jones indicates that this is not necessarily the case, for a diatomic molecule may be regarded as dissociated on activation into atoms on the metal surface, and it is shown that the potential curves for the approach of a molecule and of an atom may cut one another, so that the transition from one form to the other is possible. In the non-activated adsorption we are dealing with the system $M + X_2$, in the activated adsorption with $M + 2X$; the nature of the forces involved in both cases are, however, identical. It is clearly possible that, in addition to non-activated and activated adsorption, chemi-adsorption involving a more fundamental electronic change may occur, for example, $M + X \rightarrow M^+X^1$, requiring again a different energy of activation. Examples of all three types of adsorption are known, and the evidence for the presence of these three types in one system over a suitably wide range of temperature has been presented by Garner.

Activated adsorption probably cannot involve in all cases the actual separation of the atoms in a diatomic molecule into two independent entities, for example, carbon monoxide on metals; nor can the energies of activated adsorption and of chemi-adsorption be always widely different from one another, for it appears probable that oxygen on most metals, and nitrogen on many metals, undergoes chemi-adsorption as readily as or more readily than activated adsorption. It is interesting to note that the activated adsorption of carbon dioxide on iron probably involves the formation of carbon monoxide, which is 'physically' adsorbed, and chemi-adsorbed oxygen. It is also worthy of comment that the linkage of the metal atom holding the adsorbate is weakened by the process of chemi-adsorption, and in many cases on re-evaporation the substrate is removed in true chemical combination with the adsorbate.

The nature of the process of activation is as yet not so clearly visualised. Adopting for energies of activation values less than 15,000 calories per gm. molecule, activation cannot result on mere collision of a gas molecule with any portion of the metal surface, since the velocity of the process at low temperatures is too small. Certain portions of the surface appear more susceptible than others. The investigations of London and of Polanyi make it appear probable that the energy of activation is dependent on the lattice spacing or the distance between two metallic atoms in the adsorbent. The energy required for activaton rises rapidly as a certain optimum spacing is departed from either on contraction or expansion.

Over certain ranges of temperature the rate of uptake of gas in the activated adsorbed state is slow. No unanimity of opinion was obtained at Oxford as to the cause of this slow rate of uptake. It is believed by some that this actually represents the rate of activation, and energies of activation have been calculated from the velocities at different temperatures. That the process of surface migration and intergranular diffusion along the secondary structure of the metal crystal on solid surfaces requires an energy of activation for the adsorbate to jump over the potential barriers between the atoms has been experimentally demonstrated in a number of cases, and formed the subject of several communications, including those of Becker for alkali metals, Volmer for mercury and benzophenone, Chariton, Semenoff and Shalnikoff for metals, Ward for activated adsorbed hydrogen on copper, and by the writer for gases. As pointed out by Lennard-Jones and by Fowler, this is in accord with the general theory, energies of activation for migration of adsorbed, activated adsorbed, and chemi-adsorbed molecules being in general necessary and of different magnitudes.

The increase in rate of activated adsorption with the temperature and the energy of activation calculated therefrom must be ascribed either to an increase in the number of doublets formed by thermal agitation of the metal or alternatively to an increased rate of diffusion of the activated adsorbed molecules (in some cases possibly as atoms) away from the doublets. Both factors may indeed be operative over certain ranges of temperature. That activated adsorbed gas can actually leave the seat of activation and migrate over the substrate was evident from the communication of Frumkin and of Egerton and Ubbelhode, and a distinction between the two hypotheses is also possible by an examination of the effects of poisons on the process, as exemplified by the work of Maxted.

Whilst the pressure retention curves both for adsorption and activated adsorption over considerable ranges of pressure and temperatures obey the isotherm of Langmuir, examples of change of state of the adsorbed gas or vapour, as exemplified by the interesting work of Farkas and Bonhoeffer on the para-ortho hydrogen inversion on nickel surfaces, are by no means uncommon, for example,

cæsium on tungsten, examined by Langmuir. Even more remarkable, however, are the minor discontinuities or steps observed by Allmand, Burrage and Chaplin for the adsorption of vapours such as carbon tetrachloride and sulphur dioxide on charcoal and on silica gel, and by Benton and White for hydrogen at low temperatures on metals and nitrogen on copper and iron.

The phenomenon appears to occur with normal adsorption rather than with activated or chemi-adsorption, and is ascribed by Benton to preferential adsorption on various selected portions of the substrate, such as the edges and corners of the micro-crystals of the metal.

It is probable that many of the visitors to this large and well-organised meeting came with the idea that only one type of adsorption was certain, but it is almost inconceivable that they left Oxford without being conversant with at least three types of adsorption, the characteristics of which could easily be recognised but the nomenclature of which remained undetermined. Eric K. Rideal.

Obituary

Sir William Somerville, K.B.E., LL.D.

Although illness led to his retirement from active work some years ago, the sudden death from pneumonia, on Feb. 17, of Sir William Somerville, emeritus professor of agriculture and rural economy in the University of Oxford, came as a shock to many friends. To the progress made by agricultural education during the past fifty years his contribution was outstanding. Those who knew Somerville only in the committee room or common room, even those who recognised in him a delightful companion in the open air, equally at home in the field and woodland and garden, happy with a gun under his arm, but, above all, content with a rod in his hand and a meerschaum pipe between his lips, must sometimes have asked themselves how it was that among practical farmers his reputation was unrivalled, and why among foresters his opinions on arboricultural questions were so highly valued. Other notices of him have dealt with his later career; here reference will be made chiefly to his early work in the years when he acquired the experience which made him in later life so valued a counsellor.

Somerville had attended the agricultural class at the University of Edinburgh when John Wilson was professor; but I do not think that he then had any intention of taking up agricultural education as a career. When Robert Wallace moved from Cirencester to succeed Wilson at Edinburgh in 1885, Somerville, attracted by the energy and reputation of the young professor, resumed his interrupted studies; he was class medallist in Wallace's first year, and when he had graduated at Edinburgh and at Munich, I believe it was the influence of Wallace that led him to adopt teaching as a profession. He considered the offer of an appointment in India in 1889, but for family reasons he then decided not to leave Edinburgh, and being specially interested in forestry, which he had studied in Munich, Somerville began his career as lecturer in forestry in his own University.

In 1891, Somerville went from Edinburgh to Newcastle-upon-Tyne as professor of agriculture and forestry in the Durham College of Science (now Armstrong College). Reference to his work there is made below. In 1899 he was elected Drapers' professor of agriculture at Cambridge. He was the first occupant of this chair, and the two years which he spent in Cambridge were devoted to the organisation of the new department, the provision of a farm for experimental work, and to establishing contact with farmers in the eastern counties. In 1901 he left Cambridge on being appointed an assistant secretary in the Board of Agriculture and Fisheries; but the multifarious duties which tie an assistant secretary to a Whitehall desk were little to the taste of a man with Somerville's love for the field and woodland, and in 1906, when an opportunity of returning to educational work presented itself, he accepted the Sibthorpian professorship at Oxford, and there the rest of his working life was spent.

When he settled in Oxford, Somerville had two objectives. In his official capacity it was his duty to develop there a course of study suited to the needs of the Oxford student. It was clear that the special circumstances of those likely to inherit land or to undertake estate-management must be kept in view, and to them Somerville was specially fitted to act as friend and guide. But Somerville's ideals were not satisfied by lecturing on principles. He held it to be his duty to practise as well as to teach; he therefore acquired and farmed land in two English counties. He had had much experience in experimental work; but here his object was demonstration, not experiment—his farms were run on commercial lines. He knew that he could make farming pay, and he did.

Somerville's concentration on teaching and demonstration in his later years gave rise to an impression that his interests lay chiefly in practical farming, and that by nature he was not an experimenter who loved his work for its own sake. This was not the case. In his early years Somerville was an enthusiastic and indefatigable experimenter. He was not prepared to take statements on trust. His motto, indeed, was 'Prove all things', and he followed up this injunction by holding fast to what he found to be good. In public discussion, once his point of view had been stated he was very difficult to move: he always had facts ready if his views were challenged. But Somerville was by no means dogmatic; he would weigh deliberately points put to him in conversation, and was as ready to agree as to differ. His attitude when his views were challenged in public, those who knew his early work can explain and can justify.

When Somerville went to Newcastle in 1891, his knowledge of the subjects then interesting Scottish farmers and his German training in scientific methods enabled him both to grasp quickly those

questions on which farmers in the north of England required exact information and to devise field experiments of a kind likely to give the information needed. He was as active as he was methodical. He sought out farmers, got permission to use their land, and enlisted their interest so fully that most of the cost of the experimental work carried on was borne by them. The result was that in a belt of country between the Solway Firth and the North Sea numerous local stations were established and hundreds of experimental plots laid down. The purpose was strictly experimental, the sites selected were not intended for demonstration, for at the time it was not known how crops would respond to the special treatment. Some of these field stations were used for demonstrating results, but this use came at a later stage.

The range of Somerville's field experiments was wide. In the early years the crops of arable land and meadow hay were prominent subjects; the work on pastures with which his name was afterwards identified began in 1896. Most of the local experiments related to the effects of manures; but other subjects such as the prevention of finger-and-toe in turnips, lucerne inoculation, and a study of the productiveness of important pasture plants occupied his attention.

After the acquisition of Cockle Park Farm by the Northumberland County Council in 1896, experiments on arable land were extended to a group of miniature farms, permanent meadow plots were laid down, experiments in cattle and sheep breeding were initiated, a series of experimental plantations, including the chief forest trees, was formed, and the well-known work in 'Tree Field' was begun. Animals (in this case sheep) were used to measure the changes brought about in pastures by different fertilisers, for Somerville then realised, as does the biochemist to-day, that the apparatus and reagents of the laboratory may fail to detect subtle differences in the food of animals.

Somerville was a keen observer; he kept careful notes, he used the weighbridge wherever its use was applicable, and he accumulated a mass of data on which his reports were based. By 1899, when he left the north of England, he had published eight reports on his work. These reports extended to more than 800 octavo pages; they contained many thousands of figures and much discussion of experimental results.

Somerville not only worked hard, but he worked also in favourable circumstances. His district provided a wide range of soil types and several markedly different climates. These were just the conditions likely to supply hints for further experimental studies to a pioneer investigator. This was not all: it was his good fortune to work among observant and intelligent men, holding very definite opinions acquired as the result of their own experience; but men not unwilling to learn if satisfied that their instructor's knowledge, like their own, had been acquired at first-hand. Lectures were not greatly appreciated, but discussions were enjoyed, and might be protracted.

Somerville took a deep interest in his pupils, and this interest was shared by his gifted wife; in term time they kept open house, and any Sunday visitor would find a gathering of students there. Nor did interest end when undergraduate days ceased; former pupils were frequent visitors. Pupils and Oxford colleagues combined to present him with his portrait in 1924. Thereby they earned the enduring gratitude of Somerville's friends, for the man himself stands out in Mr. Hall Neale's picture. The stalwart build, the familiar pose, the well-coloured meerschaum, the twinkle in the eyes—they are there, and any visitor to Oxford may see what manner of man William Somerville was. Linking the skilled practice of the nineteenth century with the new knowledge of the twentieth, he commanded the confidence of farmers and foresters, the respect of his pupils, and the affection of his friends.

THOMAS H. MIDDLETON.

SIR FREDERICK ANDREWES, O.B.E., F.R.S.

F. W. ANDREWES was born at Reading in 1859. He was educated there and at Oxford, where, from Christ Church, he took a first class in the final honour school of natural science in 1881: he was afterwards Burdett-Coutts scholar and held the Sheppard medical fellowship at Pembroke. In 1882 he went to the Royal Hospital of St. Bartholomew with an open scholarship to pursue his medical studies, and remained in intimate association with that institution for the rest of his life.

At first Andrewes dallied with practical medicine and was at one time in professional charge of the nursing staff at Bart.'s and an assistant physician at the Royal Free Hospital. But after Kanthack was translated to Cambridge in 1897, he settled down to pathology, and for thirty years was head of that department and in due course a professor in the University of London. He retired in 1927, though he went on with his own laboratory work until a few months ago. In the summer of 1931 he had a desperate illness while on a visit to New York, from which he made a remarkable recovery, but he died from an extension of the disease on Feb. 24. He was elected F.R.S. in 1915 and knighted in 1920.

Andrewes' interests were always clinical and he looked on pathology as something which promoted good medical and surgical practice: he was little concerned with general and academical problems. In this field he was extraordinarily successful, primarily at his own hospital and indirectly elsewhere, in drawing the laboratory and clinical practice together and showing his medical colleagues by actual experience that bacteriology could be a great deal more useful to them than they had supposed.

In those days this was more difficult than it is now, and Andrewes owed much of his success to his sympathy and personality and his capacity for seeing points of view other than his own. Many of his assistants and colleagues in the pathological department were clinicians, and one of the pieces of work for which he is best known is his investigation with T. J. Horder of the streptococci pathogenic for

man. Their classification was put forward in 1906 and has formed the working basis of innumerable subsequent inquiries; it is only in the last few years that further progress has shown that their criteria of differentiation are not wholly adequate in the systematisation of a difficult group.

Throughout his career Andrewes was so constantly adding here and there to bacteriological knowledge that it is difficult to pick out particular pieces of work and it would be tedious to enumerate them all. During the War, he became interested in the serological analysis of dysentery and typhoid-like organisms, and in 1922 made an important contribution to what has since proved to be a singularly fertile field. In morbid anatomy he published little: one recalls his definition of the histological characteristics of Hodgkin's disease in 1911 and a chemico-anatomical study of degenerate arteries in 1912.

Andrewes was one of the few pathologists of his day who could write and talk with clarity and distinction: it was always a pleasure to read or listen to him. Amiable and witty, he was universally popular, and he will be very much missed. His son, Dr. C. H. Andrewes, has already made his mark as a member of the research staff of the Medical Research Council.

WE regret to announce the following deaths:

Mr. Andrew A. Blair, formerly chief chemist of the United States Geological Survey, known for his work in the chemical analysis of iron and steel ores and alloys, on Jan. 25, aged eighty-three years.

Prof. E. H. Griffiths, F.R.S., honorary fellow of Sidney Sussex College, Cambridge, formerly principal and professor of experimental philosophy in the University College of South Wales, on March 3, aged eighty years.

Mr. H. Chapman Jones, formerly for many years senior demonstrator in chemistry in the Royal College of Science, London, on March 7, aged seventy-seven years.

News and Views

Royal Society's Selected Fellows

THE following seventeen candidates have been recommended by the Council for election to the Royal Society: Prof. F. C. Bartlett, professor of experimental psychology in the University of Cambridge; Prof. Davidson Black, professor of anatomy in the Union Medical College, Peking, and honorary director of the Cenozoic Laboratory of the Geological Survey of China; Dr. F. W. Carter, consulting engineer to the British Thomson-Houston Co., Ltd., Rugby; Prof. W. G. Fearnsides, Sorby professor of geology and dean of the Faculty of Science in the University of Sheffield; Prof. F. E. Fritsch, professor of botany in the University of London (East London College); Prof. J. A. Gray, Chown research professor of physics in Queen's University, Kingston, Ontario; Prof. J. B. S. Haldane, Sir William Dunn reader in biochemistry in the University of Cambridge, head of the Genetical Department, John Innes Horticultural Institution, and Fullerian professor of physiology, Royal Institution; Prof. D. R. Hartree, Beyer professor of applied mathematics in the University of Manchester; Dr. K. Jordan, director of the Zoological Museum, Tring; Prof. F. R. Miller, professor of physiology, Faculty of Medicine, University of Western Ontario; Sir Basil Mott, Bt., past president of the Institution of Civil Engineers; Dr. J. B. Orr, director of the Rowett Research Institute, Aberdeen; Prof. J. L. Simonsen, professor of chemistry in the University College of North Wales, Bangor, and formerly professor of organic chemistry, Indian Institute of Science, Bangalore; Mr. T. Smith, head of Optics Section, National Physical Laboratory; Prof. H. S. Taylor, professor of physical chemistry and chairman of the Department of Chemistry, Princeton University, U.S.A.; Prof. H. W. Turnbull, professor of mathematics in the University of St. Andrews; Prof. Warrington Yorke, professor of tropical medicine at the Liverpool School of Tropical Medicine, University of Liverpool.

Royal Society of Edinburgh Elections

AMONG the fellows elected into the Royal Society of Edinburgh at a meeting held on March 7 were the following associated with scientific work: E. C. Barton-Wright, chief assistant to the Scottish Society for Research in Plant Breeding, Edinburgh; Major S. L. Bhatia, professor of physiology and Dean, Grant College, Bombay; Prof. J. C. Brash, Department of Anatomy, University of Edinburgh; Prof. E. P. Cathcart, Department of Physiology, University of Glasgow; Prof. V. Gordon Childe, Department of Prehistoric Archæology, University of Edinburgh; Dr. David Clouston, formerly agricultural adviser to the Government of India and director of the Imperial Agricultural Research Institute, Pusa; Prof. L. S. P. Davidson, Department of Medicine, University of Aberdeen; Prof. A. Murray Drennan, Department of Pathology, University of Edinburgh; Prof. Andrew Hunter, Department of Biochemistry, University of Glasgow; J. B. Lockhart, mathematical master of Edinburgh Academy and honorary treasurer of the Edinburgh Mathematical Society; A. G. MacGregor, geologist, H.M. Geological Survey (Scotland); Prof. J. J. R. Macleod, Department of Physiology, University of Aberdeen; Prof. Charles McNeil, Department of Child Life and Health, University of Edinburgh; J. M. Murray, divisional officer, Forestry Commission, Edinburgh; M. Y. Orr, botanist in government service, Edinburgh; Dr. J. N. Pickard, research worker in genetics and physiology, University of Edinburgh; Dr. G. Prasad, reader in mathematics, University of Allahabad; Prof. T. Slater Price, Department of Chemistry, Heriot-Watt College, Edinburgh; Dr. John Pringle, senior geologist, acting palæontologist, Geological Survey (Scotland); Dr. J. M. Robson, research worker, Institute of Animal Genetics, University of Edinburgh; A. R. Barbour Simpson, senior geography master, Cranford School, Wimborne, Dorset; J. B. Simpson, geologist, H.M.

Geological Survey (Scotland); Dr. J.-B. O. Sneeden, lecturer on heat engines, Royal Technical College, Glasgow; Dr. W. E. Swinton, curator of fossil reptiles and amphibia, British Museum (Natural History); Henry Wade, senior lecturer in clinical surgery, University of Edinburgh.

Royal Horticultural Society

THE unveiling of a plaque commemorating the foundation of the Horticultural Society in 1804 (designated 'Royal' in 1861, during the presidency of the Prince Consort), the initial proceedings of which were conducted in a room at Messrs. Hatchards, booksellers, Piccadilly, London, was the occasion of a representative gathering on March 7 at the firm's establishment, which is on the site of the older house. It is claimed that London annals do not provide any precedent recording in this way the foundation of a society having scientific relationships. The plaque has been placed on the face of the building in Piccadilly, whilst an illuminated record, inscribed with the names of the original promoters, is placed inside. These were: The Right Hon. Charles Greville, Sir Joseph Banks, John Wedgwood, R. A. Salisbury, W. T. Aiton, William Forsyth, and James Dickson. The unveiling ceremony was performed by the Hon. Henry McLaren, president of the Society, and Mr. Gerald Loder, past president.

AT the original meeting of the Horticultural Society in 1804, John Wedgwood (1766–1844) was chairman. He was the eldest son of the illustrious Josiah Wedgwood, and was strongly attached to horticulture, notwithstanding the limitations of the period. An early paper of his dealt with the propagation of dahlias. Some proposals that Wedgwood drew up, accompanied by useful notes, were largely instrumental in bringing the Society into being. He had observed the rise of societies for the improvement of agriculture—the British Mineralogical Society of that time was actively engaged in examining specimens of earths or soils to aid the science of husbandry—but no organisation existed for the sole purpose of encouraging horticulture. Hence, the object of the newly formed Society was the collection of information respecting the culture and treatment, culinary as well as ornamental, of plants and trees, and the publication of papers on horticultural subjects. From modest beginnings, the Society has now achieved a membership of 27,000.

Faraday's Work in Electrochemistry

The subject of Sir Harold Hartley's Friday evening discourse at the Royal Institution on March 4 was "Michael Faraday and Electrochemistry". From 1832 until 1834 Faraday was mainly occupied with electrochemical researches. He first showed that amounts of electricity which produced the same effect on a galvanometer also liberated the same amount of iodine when passed through a solution of potassium iodide. He then went on to systematic investigation of the amounts of different elements which are liberated when the same current is passed through a series of solutions or fused substances, and established the two fundamental laws of electrolysis which still stand as the quantitative basis of electrochemistry. He investigated also the mechanism by which a current passes through an electrolyte, and his ideas were crystallised in the nomenclature which he devised with the help of Whewell. All his new names—ion, anion, cation, electrode, and electrolysis—we use to-day with the significance which Faraday gave to them. In addition, he explored the source of the energy of the voltaic cell and forecast its relation to the affinity of the chemical reaction taking place in the cell. With the help of extracts from Faraday's diary, Sir Harold traced the development of Faraday's electrochemical work, repeating the decisive experiments which were the milestones of its progress. Faraday's electrochemical researches rank among the highest of his achievements. They were carried out in a short space of time with amazing economy of effort—it took him only two days to establish a connexion between the quantity of electricity and the amount of chemical action due to it—thanks to the combination in Faraday of brilliant imagination, unerring instinct for essentials, and unrivalled mastery of experimental technique; and his main conclusions still hold good to-day.

The Aryans

SIR ARTHUR KEITH'S Frazer lecture on "The Aryan Theory as it stands To-day", which was delivered in the University of Glasgow on March 4, was lacking neither in courage nor in imagination. Much water has passed under the bridge since Max Müller was accused of confusing race and language. Sir Arthur, holding that race and language are two aspects of one problem, nevertheless admits that for clearness we should have one name for the languages of Europe and another for its peoples, namely 'Caucasian'. From a reconsideration of the problem in the light of the evidence which has accrued recently from Ur, Kish, and Susa, and a survey of the distribution of racial types in early times, he derives the Caucasians from the plateau extending from Mesopotamia to India, for which he suggests the name 'Gedrosian'. In rejecting Europe as the place of origin of the Aryan tongues and practically reverting to the area west of the Pamirs put forward by Max Müller, Sir Arthur relies on the evidence of prehistory that down to somewhere about 3000 B.C. the culture of Europe was of too rudimentary a type and its inhabitants too few to make it probable that migration was to, rather than from, the highly organised agricultural communities of the east. It will be seen that Sir Arthur gave his hearers much material for careful pondering, his views implying a frank acceptance of racial and linguistic anomalies difficult to explain on any theory. He went further and asked of the Aryan theory that it should explain the triple racial zone of Europe and the diffusion of the Aryan tongues.

Forecast and Fact in Science

THE fourteenth annual Earl Grey Memorial lecture of Armstrong College (University of Durham) was given on March 3 by Dr. R. A. Sampson, Astronomer

Royal for Scotland, on " Forecast and Fact as seen by an Astronomer ". Dr. Sampson began by showing how man has transformed the world by his intellect, pointing out that such discoveries as those of Michael Faraday will live for ever, while the work of man's hands will crumble away. The world is growing more and more dependent upon science, and the changes brought about by science are for the good of humanity. Yet man cannot become superior to Nature : Nature is complicated, and the physicist is apt to go too far when he views it as something precise when it is really something vast, the mysteries of which can only be guessed. Forecast in science is, therefore, like a shot fired at an unseen target ; the starting-point is clear, but afterwards we enter into unknown country, and next to nothing is really known of remote epochs in the future. Many great prophecies, such as the ' heat death ' theory, representative of what has been put forth in the name of mathematical certainty, are only of value scientifically if they are certain ; but as science advances and ideas change, are they certain ? A distinction should be made between the immediate applications of science and the wider claims that are sometimes made for it, and scientific forecast should be taken with a grain of the salt of common sense. Scientific workers, however, realise that all they really know is due to men like Faraday and Einstein, who do not think of practical results. The theoretical mind is the soul of science—the prophetic soul dreaming of things to come ; but one should read any scientific forecast as one would read an imaginative poem.

Institute of Chemistry

AT the fifty-fourth annual general meeting of the Institute of Chemistry, held on March 1, the president, Dr. G. C. Clayton, presented the Meldola Medal, the gift of the Society of Maccabæans, to Dr. G. F. Marrian, of University College, London, in recognition of his researches on vitamins and hormones. In moving the adoption of the Report of the Council, Dr. Clayton said that the roll of fellows and associates of the Institute now exceeds six thousand. The proposal to petition for a supplemental Royal charter, with the view of securing for members the use of the title " Chartered Chemist ", has been postponed. The examinations arranged by the Board of Education and the Institute jointly for National Certificates in Chemistry are proving of real value in co-ordinating and raising the standard of chemical training in technical colleges. Referring to the separate publication of various lectures, including Sir Frank Smith's Gluckstein memorial lecture on " Chemistry and the Community ", Dr. Clayton emphasised Sir Frank Smith's view that, even in these difficult times, chemical research must be continued. New problems are awaiting solution, and many which have been solved are yet to be developed on the large scale. Chemical industry is an excellent barometer for indicating the outlook in industry generally, because it supplies some of the materials required for so many industries, and signs of a change for the better are not lacking. The Appointments Register Committee of the Institute reports that about 190 (or rather more than 3 per cent) of the members are without appointments ; the number of unemployed qualified professional chemists in Germany is 1500 out of about 10,000 (15 per cent). Dr. G. C. Clayton was re-elected president of the Institute.

Education in Public Schools

THE headmaster of Eton gave a very interesting and suggestive address, which has recently been printed, on " The Education of the Average Man ", at the Royal Institution on Dec. 18. His humour and open-mindedness, and his wide and special knowledge of the public schoolboy, command a sympathetic hearing for his views ; and with the general tenor of them most people will agree. He deplores the constriction caused by the examination system ; thinks the boys are called upon for a sort of all-round specialism which it is impossible to achieve and is calculated mainly to engender a distaste for further learning, and would himself lay stress on three great aims—accuracy, curiosity, and observation. He speaks frankly as the spokesman of the public schools, which he describes as lying between the upper and nether millstones of the preparatory schools and the university examiners. In all of this there is much sound criticism and good sense ; but one is bound to recognise the limitations of Dr. Alington's point of view. He is almost entirely critical, except of these public schools which are to him the one virtuous element struggling with adversity, and he is also almost entirely *laudator temporis acti* ; the older system, as he himself knew it, seems almost always preferable.

WITH all possible sympathy and thanks, one must put one or two larger questions than Dr. Alington has raised. Is he really content with the ideal that the education of the élite of the young men of Great Britain should go on indefinitely on the lines of a simple bifurcation of ' sides ' as between classics and mathematics, which is what he seems to imply ? The classics boy, which is what he was himself, is not to be bothered with the algebra which he cannot understand, and is to have some general or recreative lessons or lectures on science, literature, and history. Would he not agree that with improved methods far more might be done without distaste or overloading, and, in particular, that a modicum of mathematics is desirable for the average boy, this modicum to include an introduction to the calculus ? As to history and literature we are inclined to agree with him that they are not suitable subjects for examination, certainly not for the present type of examination. But as to the scope of the history taught we should go much further than he suggests. History and the historical spirit are in fact the new element in human thought, which is bound to become, we will not say dominant, but reconciling, in the increasing complexity of the curriculum. Through that alone we may hope to gain some harmony and a simplication of the mass of knowledge we have to face.

Association of Technical Institutions

THE annual general meeting of the Association of Technical Institutions was held in the Leathersellers' Hall, London, on Feb. 26–27. Sir John Dewrance was elected president for the year 1932. Among the papers read to the meeting were "Technical Education and the Bakery Trade", by W. H. Quinn of the Leeds Technical College; "Technical Education in Canada", by Prof. R. W. Angus of the University of Toronto; and "The Teaching of Modern Languages in Technical Colleges", by P. G. Wilson of the City of London College. Each of these papers contained special points of interest to those who govern and administer technical colleges, as well to those who seek, at this kind of conference, specialist information. It is possible, however, that interest in papers (which have already been printed and placed in the hands of those attending some days before the conference) is considerably lessened when they are again read exactly from their text. There is a procedure vaguely called 'speaking to the paper'; it may not always be the happiest procedure, but it has the merit of allowing the writers of the papers to bring out succinctly matters which are afterwards the points round which debates may swing.

PROBABLY the *pièce de résistance* of the meeting was the report on "Policy in Technical Education". It had been drawn up by a Joint Committee of the Association of Technical Institutions and the Association of Principals of Technical Institutions. It was accepted, and will doubtless be discussed further by other interested bodies: indeed, the charge was made at the meeting that an earlier consultation might have been made with bodies representing local education authorities. Whether that charge could be sustained or not, however, the recommendations are such as might be strengthened by help from other interested bodies. They do not present what might be called new ideas for the better conduct of technical education. Indeed, the majority of them have already been passed in resolution form by at least one other body, and have received publicity in our own columns and those of other, more purely educational, journals. But their present grouping will do much to help their translation into practice. In particular we welcome the recommendations urging administration of technical colleges on a regional basis (industry does not organise itself in local units), closer co-operation with universities, increase of full-time senior day technical courses, the extended provision of junior technical schools as an alternative form of secondary education (including arrangements for transfer at appropriate ages from one form of secondary education to another), the development of the teaching of industrial economics, and of facilities for physical training and social activities.

THE first part of the work undertaken by the Commission on Educational and Cultural Films—the preparation of a report on the use of the cinematograph in the service of education and social progress—is now drawing to a close. The report is in progress of completion, and will be considered at a full meeting of the Commission in April. The researches of the Commission have been far-reaching, and the conclusions deal not only with the advantages to be derived from cinematography within the narrow limits of scholastic education, but also with its cultural influence in the public cinema. The emphasis laid at successive meetings of the Imperial Conference on the assistance which motion pictures can give to the stimulation of Imperial trade and scientific research, combined with the investigations of the Colonial Office into their use among native races of the Empire for educational, medical, and agricultural instruction, present cinematography in a new light as a bond of unity in the British Commonwealth of Nations. A study of the organisation of film institutes in foreign countries leads to the consideration of the possibility of a similar national institution which will apply constructive ideas to cinematography both in Great Britain and throughout the Empire. The Commission has been impressed by the need for a central organisation capable of distributing information concerning the use of motion pictures in all departments of activity. If provision can be made for the Commission to continue its work for a while, it is proposed to take as the main object the preparation, in conjunction with educational associations, of a catalogue of films approved for use in teaching and in research.

Gallium, a Commerical Product

WITH reference to the paragraph in NATURE of Feb. 27 (p. 309) on the commercial production of metallic gallium at a moderate cost by the Vereinigte Chemische Fabriken at Leopoldshall, Stassfurt, it was stated that the price ruling about twelve months ago for the commercial metal was about 175 gold marks per gram. This price was quoted from the *Chemiker-Zeitung*. Messrs. Adam Hilger, Ltd., inform us that they have been able to supply, not the commercial metal, but highly purified gallium, since October 1925, together with a spectrographic report upon the residual impurities in it, at prices ranging between £5 10*s*. and £6 10*s*. per gram. The chief impurity contained in this material is indium (0·8 per cent), though slight traces of lead and silver were also found. Messrs. Hilger also state that they are now in a position to supply, at £5 5*s*. per gram, together with a still more detailed spectrographic report, a product of even greater purity, which has been extracted electrolytically from the oxide in the research laboratories of the Sir John Cass Technical Institute, London.

Species Hybridisation in Animals

A BOOK on species hybridisation in animals is very badly needed, but would involve much labour in its compilation, as, although there is a good deal of information on the subject available, it is very much scattered. A notable and well-illustrated contribution is that of Mr. R. I. Pocock in the *Field* for Jan. 30, on captive-bred hybrids between the lion and the tiger, apropos of the recent death of the well-known specimen at the London Zoological Gardens. This animal was bred in India between a tiger and a lioness, and

resembled a lioness with stripes; these were very faint. A mane was present, but so poorly developed that it could be rivalled by the frill of some tigers. Mr. Pocock, on the other hand, has met with a specimen in which the colour was so rich that it resembled rather a stripeless tiger, and it may be mentioned that others have been bred in which the stripes, though not so strong as in the pure tiger, are quite noticeable; one such is figured, as well as the Zoological Gardens specimen, but not mentioned in the text. These hybrids appear to be always sterile, and because of this, and because of the lesser distance between the parent species, are less interesting than the hybrids between the male polar and female brown bear which were bred in Germany before the War. These were fertile, at any rate with the polar bear; one of the three-quarter-bred animals was like the latter, with a brownish back, a first cross being brown with a white polar-bear-shaped head; both were on view at the London Zoological Gardens.

'Bullying' amongst Birds

IN *Cage Birds* for Jan. 23, p. 62, R. E. D. Barrington records a curious case in which a female siskin, which had been persistently bullying a male before a blue-fronted Amazon parrot, was, after careful inspection, pulled through the bars of the cage and killed by the latter after it had been released from its own. This disposition to interfere in the quarrels even of alien species in what we should call the cause of justice appears to be widely spread in birds, judging from occasional instances which the writer has witnessed. A çariama thus interfered between two greater black-backed gulls, striking one which had injured and was pursuing the other; a female ruddy sheldrake forced a male common sheldrake to drop a mallard duckling which he was holding up by the tail; a piping crow-shrike (*Gymnorhina*) habitually attacked a magpie when it was bullying some other bird of the crow tribe, jay or jackdaw, and ultimately, it was said, killed it: these were captive birds, but Indian house-crows at large attacked a kite which was plucking alive a dabchick, not by the usual stealthy manœuvres with which they often try to rob this bird of its food, but by a fierce direct assault, which seemed to suggest a sympathy one would certainly not have expected in crows. He has seen no similar instance in mammals, but Romanes, in "Animal Intelligence", records what seems like one, when a very sensitive terrier would seize his sleeve if, when driving, he touched the horse with the whip, in evident deprecation.

Archæological Expedition to the West Indies

IT is announced by the Smithsonian Institution that, in pursuance of the plan for a systematic anthropological and zoological survey of the West Indies, Mr. Herbert W. Krieger, a curator of ethnology of the Institution, is proceeding to the little-visited San Salvador and Cat Islands of the Bahamas as a 'one-man expedition' of archæological investigation. The specific object of the expedition is to identify the "naked, painted Indians, with fine high foreheads" who were the first inhabitants of the New World to be encountered by Christopher Columbus. It is by no means certain which island was the scene of Columbus's first landing; though San Salvador would appear to have the best claim. The record of the appearance of the Indians affords little clue to their identity; but Mr. Krieger is of the opinion that the fact that several of these islanders served Columbus as interpreters along the coast of Cuba, up to a point to the west where their language was no longer understood, suggests that they may have been of the Arawak stock. It is known that the inhabitants of the Cuban coast were Arawak. It is possible, however, that they may be entirely unrelated. Mr. Krieger's previous investigations in the West Indies have revealed evidence that the Arawak were preceded by a race of primitive non-agricultural people who lived in caves, and of whom rumours appear in the writings of the early Spanish chroniclers. Mr. Krieger will follow up his investigations in the Bahamas by an examination of the shell-heaps of central Cuba, which previously has not been explored archæologically.

Hydroelectric Power in Southern Scotland

THE central area of Scotland will soon be largely supplied with electric power by three water power companies. Two of them, the Grampians Electricity Supply Company and the Lanarkshire Hydro-Electric Power Company, are already operating, but it will be three or four years' time before the Galloway Water Power Company will be in a position to supply. The Galloway Company will shortly begin to build five water power stations, of a total capacity of 102,000 kilowatts, extending from the neighbourhood of Loch Doon in Ayrshire to Tongland near Kirkcudbright. Four of these stations depend for their power on the falling level of the River Ken, the lower part of which is the Dee. The other station, Glenlee, gets its power from a large artificial reservoir to be formed by a concrete dam on the Black Water of Dee between Newton Stewart and New Galloway. It will store the run-off water from an area of about forty-nine square miles. The scheme provides for a dam across Loch Doon which will raise its level twenty-three feet. At present Loch Doon discharges itself by the River Doon into the Firth of Clyde. In future the main portion of its water, with the exception of the compensation water which the company must continue to supply to the River Doon, will be diverted into the River Ken. Thus it will flow into the Solway Firth. When this is done, the water in the Doon, made famous by Burns, will be very appreciably less in bulk, but its flow will be more uniform than at present. The greatest of the water power stations is at Tongland on the Dee, about 1½ miles above Kirkcudbright. A dam is to be built across the gorge, giving a fall of just over a hundred feet. The level of Loch Ken is to be raised several feet, so as to give additional storage for Tongland.

Proposed Ship Canal in France

THE ambitious project of a ship canal across southern France has lately been revived and is receiving some attention. In *Terre, Air, Mer* for February a few details of the scheme are given. The proposal is that the

canal should start at the port of Bordeaux, follow the River Garonne to Toulouse and then the course of the railways to Narbonne, and open into the Mediterranean at La Nouvelle, about twelve miles to the south. The course would be approximately that of the present barge canal that crosses from Atlantic to Mediterranean and about 250 miles long. But the new canal would have a depth of 44 feet and a width of nearly five hundred feet at the surface and about two hundred at the bottom. There would be fourteen locks, but apart from the delay at these, vessels would be able to maintain a speed of 14 knots. The gain in distance between, say, Southampton and Port Said by the use of the canal would be about twenty-three per cent of the total mileage.

Announcements

SIR WILLIAM J. POPE, professor of chemistry in the University of Cambridge, has been elected chairman of Council of the City and Guilds of London Institute in succession to the late Dr. Morton Latham.

DR. B. A. KEEN, assistant director of the Rothamsted Experimental Station, will deliver the G. J. Symons memorial lecture before the Royal Meteorological Society, on March 16, at 7.30. The subject of Dr. Keen's lecture will be "Soil Physics in Relation to Meteorology".

THE sixth International Botanical Congress will be held in Amsterdam on Sept. 9-14, 1935. The following executive committee has been elected: *President*, Prof. F. A. F. C. Went (Utrecht); *Vice-President*, Prof. J. C. Schoute (Groningen); *Treasurer*, Dr. W. C. de Leeuw (Bilthoven); and *Secretary*, Dr. M. J. Sirks (Wageningen).

A SYMPOSIUM entitled "Is the Carbon a Failure? a Symposium on Arc Illumination and its efficiency under present conditions in Studio and Cinema", will be held at a meeting of the British Kinematograph Society at the Gaumont British Theatre, Film House, Wardour Street, on April 4, at 7.45 P.M. Anyone interested in the subject is invited to attend the meeting.

SIR GEORGE BUCKSTON BROWNE, donor of Down House and of the Royal College of Surgeons Research Farm, Kent; Sir David Thomas Chadwick, secretary of the Imperial Economic Conference; and Mr. Philip Guedalla, author of "The Duke" and other works, have been elected members of the Athenæum under the provisions of Rule II. of the Club, which empowers the annual election by the committee of a certain number of persons of distinguished eminence in science, literature, the arts, or for public service.

AT the annual general meeting of the Geological Society of London, held on Feb. 19, the following officers were elected for this year: *President*, Sir Thomas Holland; *Vice-Presidents*, Prof. E. J. Garwood, Mr. J. F. N. Green, Mr. W. Campbell Smith, Dr. H. H. Thomas, and Prof. W. W. Watts; *Secretaries*, Prof. W. T. Gordon and Prof. P. G. H. Boswell; *Foreign Secretary*, Sir Arthur Smith Woodward; *Treasurer*, Mr. F. N. Ashcroft.

THE PRINCE OF WALES will declare open Manson House, Portland Place, the new headquarters of the Royal Society of Tropical Medicine and Hygiene, on March 17, at 5.30. The Right Hon. Sir Austen Chamberlain, with the president, Dr. G. Carmichael Low, will be present to receive the Prince. Admission will be by ticket only. A laboratory meeting will be held on the same day, at 8.15, at the Royal Army Medical College, Grosvenor Road, Millbank, by kind permission of the commandant, Colonel R. B. Ainsworth.

A PAMPHLET showing the provision made for professional and middle class people at voluntary hospitals in London, that is, the 'pay beds' available, has just been published for King Edward's Hospital Fund for London, by Sir Joseph Causton and Sons, Ltd., 9 Eastcheap, London, E.C.3 (price 3*d*., post free). A useful preliminary statement describes the 'pay bed' system and the contributory schemes available in connexion with it. The 'pay beds' in London have increased from 590 in 1920 to 1577 in 1931.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A principal of the Sheffield City Training College for Teachers—The Director of Education, Education Office, Sheffield (March 14). An assistant aeronautical engineer in the Army Air Corps, Irish Free State—The Secretary of the Civil Service Commission, 45 Upper O'Connell Street, Dublin, C.8 (March 18). An inspector for general duties and two inspectors for live-stock duties, under the Department of Agriculture for Scotland—The Establishment Officer, Department of Agriculture for Scotland, Queen Street, Edinburgh (March 19). A whole-time qualified research worker at the Hospital for Consumption and Diseases of the Chest, in connexion with the Halley Stewart Grant for Investigation of Tuberculosis in Children—The Secretary, Hospital for Consumption and Diseases of the Chest, Brompton, S.W.3 (March 19). A clinical assistant and research student at the Cardiff City Mental Hospital—The Medical Superintendent, Cardiff City Mental Hospital, Whitchurch, Cardiff (March 21). Two whole-time veterinary inspectors under the Agricultural Committee of the East Sussex County Council—The Director of Agriculture, County Hall, Lewes (March 29). A Jenner memorial student in bacterial chemistry at the Lister Institute of Preventive Medicine—The Secretary, Lister Institute, Chelsea Bridge Road, S.W.1 (April 8). An assistant lecturer in mathematics at the Royal College of Science—The Secretary, Imperial College of Science and Technology, South Kensington, S.W.7 (April 11). A geneticist and botanist at the Institute of Plant Industry, Indore, Central India—The Secretary to the Board of Governors, Institute of Plant Industry, Indore, Central India (applications from the Orient); The High Commissioner for India, India House, Aldwych, W.C.2 (applications from Great Britain and overseas) (in each case June 9). A director of the National Institute for Research in Dairying, University of Reading—The Secretary, National Institute for Research in Dairying, Shinfield, near Reading.

Letters to the Editor

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Oxygen and Everest

THE discussion at Section I of the British Association, following Prof. J. Barcroft's paper, as well as Dr. Greene's article [1] and the correspondence from Dr. Greene and Mr. N. E. Odell [2] which have followed, on "Oxygen and Everest", suggest that there is no accord among physiologists as to whether oxygen may be of assistance to climbers at very high altitude. In reality, Dr. Greene's "oxygen school" and "no-oxygen school" do not exist at all. All physiologists agree in believing that the limiting factor of altitude is, roughly, the alveolar partial pressure of oxygen.

A few years ago Talenti [3] brought some people breathing 98 per cent oxygen in a steel chamber down to a pressure of 115 mm. mercury, which corresponds to a utilisable oxygen pressure of 67 mm. mercury $\left[(115\text{-}47) \times \frac{\%O_2}{100}\right]$. The limit to low barometric pressure breathing air may be fixed at about 300 mm. mercury (Margaria, 1929), which corresponds to a utilisable oxygen pressure of 53 mm. mercury. As people when brought to low barometric pressures showed a much higher pulmonary ventilation when they breathed air than when they breathed oxygen, so the alveolar oxygen pressure ought to have been very nearly the same in both cases. This fact alone would be sufficient to show that practically the only difficulty due to altitude is the low oxygen tension, and that when it is removed by increasing the oxygen tension in the air, the limiting altitude would be increased. In view of these facts and my results [4] on the working capacity of men breathing air at various barometric pressures, we had very little doubt when we tried climbing experiments in the low barometric chamber in Oxford (Barcroft, Douglas, Kendal, and Margaria) [5] of the success of the experiments.

These experiments showed once more, directly, that a man can work at a much lower barometric pressure than that existing on the top of Mount Everest if the utilisable oxygen pressure is kept to a sufficiently high level.

The only thing which may have raised some doubt about the utility of oxygen, climbing at high altitudes, was the report of the Everest expedition of 1924, when climbers did not get any appreciable advantage from 'breathing oxygen'. We must first criticise what 'breathing oxygen' meant in that case, and see if the experiments on Everest have been carried out with a technique good enough to justify the striking conclusions at which they arrived.

The breathing apparatus used in that Everest expedition (Odell) was 33 lb. (15 kgm.) weight, had a capacity of 1605 litres oxygen, and was arranged to give a delivery at continuous flow of a maximum of 2 litres per minute: the oxygen was conveyed by a rubber tube to a pipe kept between the teeth. Now assuming a utilisation of 75 per cent of the oxygen in this way, and a pulmonary ventilation of, say, at least 30 litres per minute, the percentage of oxygen in the inspired air must have been raised from 21 to 24·4, due to the extra oxygen, and the utilisable oxygen pressure from 43 mm. to 50 mm. mercury. So the effect of the 'breathing apparatus' was, in the most favourable conditions, to raise the utilisable oxygen pressure only 7 mm. We can scarcely believe that this value was high enough to compensate for the greater work necessitated by a heavy apparatus, the trouble of looking after it—for it needed continuous care—and the difficulty of working with the pipe between the teeth, with an open mouth, and doing complicated movements to prevent oxygen flowing during the expiration.

In this way we can explain why in the last Everest expedition climbers did not get any advantage from the oxygen, but that is not due to the oxygen being of no value, but because the principle of the oxygen apparatus was wrong and did not increase the oxygen tension in the inspired air to an appreciable extent. Such an experiment cannot form the basis for a 'no-oxygen school'.

There is no doubt then that oxygen, if supplied in sufficient amount by a good breathing apparatus, is useful for the climber at high altitude; the experiments in the pressure chamber were carried out on subjects not acclimatised to low barometric pressure, though the climbers of Mount Everest arrive at the point of attack of the mountain already acclimatised, after weeks of walking at high altitude. The doubt of some climbers as to whether the experiments in the pressure chamber are comparable to the experiment of real climbing, owing to the difference in acclimatisation of the subjects, has not much ground; in fact there is no reason to suppose that the acclimatisation to low barometric pressure decreases the resistance to the low oxygen pressure, when pure oxygen is breathed: on the contrary, this is very probably increased by acclimatisation to high altitudes.

So there remains only what Prof. Barcroft calls 'the problem of the engineer', that is, the construction of a suitable apparatus for the respiration of a rich enough oxygen mixture. The safest and simplest way would be, of course, to breathe pure oxygen from a mouthpiece or a mask. On this principle the expired air may be (*a*) wasted, that is, not utilised again, as we did in the chamber experiments, or (*b*) rebreathed after previous absorption of the carbon dioxide by soda lime.

In (*a*), assuming a pulmonary ventilaton of 30 litres per minute at 250 mm. pressure, the requirement of oxygen would be, for 5 hours climbing, 3000 litres of oxygen at 760 mm. mercury, about 4·3 kgm. The transport of such an amount of oxygen would not be possible with oxygen gas because of the weight of the containers: it would only be possible with liquid oxygen, if it were possible to bring it to the highest camps and fill the specially constructed breathing apparatus with it.

As regards (*b*), assuming an oxygen consumption similar to that in the Oxford chamber, where the subjects made an ascent and descent of 1000 feet an hour, the amount of oxygen required would be, for a 5 hours' climb, not more that 450 litres or 0·64 kgm. To this the weight for the carbon dioxide absorber must be added, which, if it were caustic soda, would be 80 gm. for every 32 gm. of oxygen, assuming a respiratory quotient of 1; assuming an efficiency of 50 per cent of the caustic soda absorber, the weight of it ought to be 3·2 kgm., making altogether about 3·8 kgm. Then the 'engineer' ought to be able to provide a suitable breathing apparatus with such amounts of oxygen and carbon dioxide absorber, which, together with the weight of the containers, does not weigh too much, say 20-25 kgm.; and the breathing apparatus ought to be well tested, particularly as regard the action of cold on the functioning of the respiratory valves on the freezing of the condensed water in the tubes, etc. This could be tested on our Alps.

If it is not possible practically to use liquid oxygen or even oxygen gas because of the excessive weight of the containers, oxygen could be provided by some peroxide, say sodium peroxide: from the reaction $2Na_2O_2 + 2H_2O_2 \rightarrow 4NaOH + O_2$, we see that we can get 1 molecule of oxygen for every 2 molecules of Na_2O_2. Then for case (*a*) 3000 litres of oxygen could be provided by 21 kgm. of sodium peroxide, for case (*b*) 450 litres could be provided by 3·1 kgm.; in this case the caustic soda resulting from the decomposition of the sodium peroxide could also be utilised for the absorption of carbon dioxide.

The relative practicability and suitability of the above methods is the 'problem of the engineer'. From the physiological point of view, the problem of reaching the top of Mount Everest is already solved within the limits of probability of biological experiments.

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Torino, Feb. 2.

[1] Greene, R., NATURE, **128**, 893, Nov. 28, 1931.
[2] Odell, N. E., NATURE, **128**, 1037, Dec. 19, 1931.
[3] Talenti, C., *Arch. Sc. Biol.*, **14**, 125; 1930.
[4] Margaria, R., *Arbeitsphysiologie*, **2**, 261; 1929.
[5] Barcroft, Douglas, Kendal, and Margaria, *Arch. Sc. Biol.*, 1932, in the press.

MR. ODELL'S remarks,[1] regarding Dr. Argyll Campbell's experiments, which were designed to test the power of acclimatisation of animals to low oxygen pressure, are not quite accurate. These experiments were undertaken to supply information that was wanting, and to endeavour to explain the adverse symptoms recorded in the official reports of the Everest expeditions. The animals were exposed to gradual decrease of oxygen pressure such as occurs in climbing. They showed all the well-known signs of so-called acclimatisation, for example, increase of red blood cells, increased depth of breathing, etc. Some of the experiments, unlike the expeditions, did not stop at a pressure equivalent to 28,000 ft. but went on to one near 30,000 ft. Some of the animals were exposed to 7-7½ per cent of an atmosphere of oxygen for eight days continuously, and recovered completely when put under normal oxygen pressure again. In spite of heroic efforts, no man has been exposed to so low a pressure for even one day, and Dr. Campbell's animals hold the record for toleration of low oxygen pressure by mammals.

It is impossible to tell what is happening to the organs of man, or of animals, under such conditions without post-mortem examination. The animals exhibited loss of appetite, weakness, and air hunger such as is described in the case of the climbers in the official reports. In view of the degenerations observed in animals' tissues, it is assuming a great deal to say that the Everest climbers did not, and will not, suffer any such degeneration. In any event, no climber has lived more than a day or so above 26,000 ft., and Dr. Campbell's experiments with animals indicate what is likely to happen if they do remain longer.

Mr. Odell states that the animals were completely inactive and thus could not acclimatise. This is erroneous, since the most active animals showed all the signs of so-called acclimatisation, and others showed relatively as much activity as was reported by the climbers at very high altitudes. Although strenuous exercise may hasten acclimatisation, it is not essential. In the case of Norton and Somervell it was evidently considered a disadvantage. The argument cannot be used both ways. No man or other mammal has been acclimatised completely to much below ten per cent of an atmosphere of oxygen (20,000 ft.), and so far as proof goes, the powers of toleration of low oxygen are less in man than in certain other mammals, for example, in mice, rats, and rabbits.

Of course, the climbers recovered on descending the mountain, as did the animals when the oxygen was increased. It was only by examining the tissues of dead and killed animals that the damage to their organs was detected. The damage was repaired in the surviving animals when these were put under normal oxygen pressure. If any man is similar to certain of the surviving mice and rabbits, he should be able to reach the top of Everest without the use of oxygen apparatus, and recover after the descent. The results of the expeditions certainly leave the question, whether he is similar, open. It is obvious, however, that the risk is great, and the degenerations detected in the animals' tissues indicate what that risk is.

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[1] NATURE, **129**, 244, Feb. 13, 1932.

Fertility in Hybrids between New and Old World Cottons

THE first hybrid between Asiatic and New World cottons ($n = 13 \times n = 26$) was recorded and described by Zaitzev.[1, 2, 3] The parentage of this cross was *Gossypium herbaceum* (female) by *G. hirsutum* (male), and the resulting plants were, without exception, completely sterile on both female and male sides. Other workers have since confirmed Zaitzev's results. Desai[4] obtained a single plant of similar parentage to that described by Zaitzev. This plant was also sterile. He states that the pollen was successfully used on both parents. More recently, Vycotski[5] again produced hybrids between *G. herbaceum* and *G. hirsutum* which were sterile when self-pollinated and when backcrossed to the parents. Nakatomi[6] reported a hybrid in which the New World type ($n = 26$) was used as female. He found complete sterility of the hybrid, which he ascribed to irregular chromosome behaviour in meiosis.

Since 1926 several thousand crosses between Asiatic and New World cottons have been made at this Station, using various races of each both as female and male. Using Asiatics as female met with no success. Apparently sound seeds were often obtained, but these contained only minute, shrivelled embryos. Using New World as female, two hybrids were produced, and one of these, *G. barbadense*, L. × *G. arboreum*, var. *sanguinea*, although sterile on the female side, has proved to possess some functional pollen grains, since it will cross with *G. barbadense*.

A detailed account of this interesting hybrid will be presented at a later date, and it will be sufficient to refer to a few important features:

Flower Colour	*sanguinea*	Red, with a large and intense petal spot.
	barbadense	Yellow, with a less intense petal spot.
	F_1	Yellow, with a red flush at the petal edges. Spot intermediate between the parents.
Colour of Plant Body . .	*sanguinea*	Leaves red.
	barbadense	Leaves green.
	F_1	Leaves red, but intensity reduced.

In inter-Asiatic crosses, the complex red leaf, red flower, intense petal spot is inherited as a single unit character. F_1 plants exhibit reduction of anthocyanin

in the flower with certain combinations of factors, but in the *barbadense-arboreum* hybrid there is a much greater reduction of colour in the flower.

In respect of other characters the F_1 was intermediate, sometimes approaching one of the parents, sometimes the other.

Back-cross, G. barbadense × (*G. barbadense* × *G. arboreum*).—Back-crosses were successfully made to various types of *G. barbadense*. Usually only one seed per boll was obtained, and many of these either failed to germinate or gave rise to weak and abnormal seedlings which died in a few days. Ultimately eight healthy plants were raised to maturity.

Of the eight plants, five showed the red-leaved character of *arboreum*, with a varying amount of red in the flower. This indicates that an Asiatic chromosome, or that part of it containing the red factor (*R*), was carried by some pollen grains. A considerable weakening of the effect of the *R* factor was found in some of the plants. In one plant (F_1 × *barbadense*, with faint petal spot) the red colour of the flower almost disappeared and the spot was considerably weakened. This suggests that the compound character, red plant body, red flower, intense petal spot, is the result of a basal gene *R*, for red plant body, acted upon by modifiers to produce a further development of colour in the flower.

Back-crossing with a New World type results in the Asiatic modifiers being eliminated or replaced by New World factors, since if the Asiatic modifiers had been represented in *S. barbadense* there would have been no reduction in flower colour or spot intensity. It is further evident that the *R* modifiers must be present in an almost homozygous condition throughout the Asiatic cottons, since they exhibit little or no segregation in inter-Asiatic crosses.

The eight back-cross plants were again back-crossed with *G. barbadense* of various types in both directions. Three plants proved to be fertile on both female and male sides, and several seedlings from the second back-cross are now being studied. The great increase in fertility of the plants in the first back-cross suggests that one or more Asiatic chromosomes may be capable of functioning in a New World plant body. If this surmise is correct, the way is opened towards the synthesis of new types of cotton combining the desirable economic characters of the New and Old World groups of cottons. The cytology of these hybrids is being investigated by Dr. A. Skovsted at this Station.

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[1] *Agr. J. Ind.*, **20**, p. 213.
[2] *Agr. J. Ind.*, **21**, p. 460.
[3] *Agr. J. Ind.*, **22**, p. 155.
[4] *Agr. J. Ind.*, **22**, p. 351.
[5] *Bull. Sci. Res. Cott. Inst., Tashk.*, **1**, p. 26.
[6] *Jap. J. Bot.*, **5**, p. 371.

Spectrum of Bismuth Hydride

SOME time ago [1] we reported a band system $^1\Sigma^* \rightarrow {}^1\Sigma$ in bismuth hydride, having its origin in the vicinity of the Bi line λ4722. With the aid of improved light sources, we have been able to trace this system more completely, the bands (0, 0), (0, 1), (1, 0), (1, 1), (1, 2) being analysed at high dispersion. In addition, two new band systems are now reported. In the red part of the spectrum a $^1\Sigma^* \rightarrow {}^1\Pi$ system appears, having a common initial state with that of the blue system. The bands here analysed are the (0, 0), (0, 1), (1, 0), (1, 2) states of vibrations.

This band system is specially interesting as showing indications of a hyperfine structure due to the high nuclear spin in the bismuth atom.[2] Further, we observed two faint and sporadic bands at λλ4840, 5170, belonging to a new $^1\Sigma_x \rightarrow {}^1\Sigma_y$ transition, not combining with the states mentioned above. Both bands have a common initial state, very unstable as indicated by its large r_0-value and by the abrupt cut-off in the intensity of lines above $K = 5$. Temporarily we assign this level to $v' = 0$ and the final levels to $v'' = 0, 1$. Later on we intend to make a study of the pressure effect in these bands, which bear a strong likeness to the well-known C-band in the spectrum of calcium hydride.[3]

Some data on the electronic states discussed above are given below :

	T_e	ω_0	$\omega_0 x$	B_0*	$-D_0 \cdot 10^5$	α	$r_0 \cdot 10^8$
$^1\Sigma$	0	1656·93	21·23	5·063	18·35	0·147	1·819
$^1\Pi$	4936·58	1693·07	23·87	5·1775	20·0	0·155	1·802
$^1\Sigma$*	21278·33	~1678	~17·5	5·214	20·05	0·189	1·792
$^1\Sigma_y(0)$	x	..	..	4·31	..	..	1·97
$^1\Sigma_y(1)$	1313·6 $+x$	..	..	4·20	..	..	..
$^1\Sigma_x(0)$	20647 $+x$	..	..	3·88	..	..	2·09

For the lower $^1\Sigma$ and $^1\Pi$ levels the calculated energies of dissociation, expressed in cm.$^{-1}$, are respectively 32,500 and 30,000, and consequently they may be derived from the same state in Bi. The corresponding value for $^1\Sigma$* is roughly estimated to 40,000 cm.$^{-1}$. As available levels in the doublet system of Bi, fitting into these limits, we have already suggested [1] the $6s^2p^3\ {}^2D_1(-47323, -43304)$ and $6s^2p^2 . 7s(-26153)$ levels.

On the basis of Van Vleck's theory, a study of the Λ-doubling in $^1\Pi$ is likely to give more detailed information regarding the electronic configuration in bismuth hydride. Our observations give :

$$\Delta_{dc}(\nu) = 0{\cdot}020K(K+1) + \ldots \quad (T_d > T_c),$$

which does not vary to any considerable extent with v.

Mulliken and Christy [4] have recently examined a great number of $^1\Pi$, $^2\Sigma$, and $^2\Pi$ states, especially those belonging to the hydrides, and stated that they stand to each other in the relation called by Van Vleck 'pure precession'. The restated relation for q_0, the coefficient of the Λ-doubling in Π, given by these authors, is :

$$q_0 = \frac{2B_v{}^2 l(l+1)}{\nu(\Pi\Sigma)} \text{ where } B_v = B_v{}^* - q_0.$$

Assuming the precession brought about by a p-electron ($l = 1$) and using the values in our table above, we get :

$$q_0 = 0{\cdot}021,$$

in fair agreement with the observed value above.

Finally, we wish to express our gratitude to the Nobel Foundation, Stockholm, for the gift of high tension transformers, which enabled us to carry through the experimental part of this work.

E. HULTHÉN.
A. HEIMER.

Laboratory of Physics,
University of Stockholm, Jan. 20.

[1] A. Heimer and E. Hulthén, NATURE, **127**, 557 ; 1931.
[2] E. Hulthén, NATURE, **129**, 56 ; 1932. *Note:* The estimated effect of the molecular rotation on the line width ~0·02 A. mentioned in this paper should be read ~0·002 A.
[3] B. Grundström and E. Hulthén, NATURE, **125**, 634 ; 1930.
[4] R. S. Mulliken and A. Christy, *Phys. Rev.*, **38**, 87 ; 1931.

Nuclear Spin and Hyperfine Structure in Band Spectra

PROF. E. HULTHÉN [1] has attempted to show that the splitting of mercury hydride (HgH) band lines into four components, as was found by me [2] in the (0, 0), (0, 1), (0, 2) and (0, 3) bands and by R. Rydberg [3] in the (2, 1) and (3, 2) bands of the $^2\Pi_{\frac{1}{2}} \rightarrow {}^2\Sigma$ electronic transition, is a normal isotope effect caused by the difference of masses between the isotopes of mercury. The failure to explain the observed line structure by the usual isotope formula he interprets

as indicating the inapplicability of this formula to a mercury hydride molecule, which forms a unique example of an unstable molecule in the $^2\Sigma$ state. Prof. Hulthén further states that the isotope splittings calculated with the aid of Birge's formula (concerning the vibrational effect) show sufficient agreement with my data, and that there is no need to search for another explanation based on consideration of the magnetic and electric constitution of the nuclei.

However unexpected may be the observed approximate constancy (to twenty per cent) of $\Delta\nu$ in the wide interval of the band (0, 0) from $\Delta\nu_{\text{rot.}} = 446$ to $\Delta\nu_{\text{rot.}} = 986$ cm.$^{-1}$, with regard to the prevailing influence of the rotational isotope effect in this band, nevertheless, taking in account the conformity of Prof. Hulthén's calculations with my experimental data, it may be admitted that the values of splitting cannot be considered as a sufficient argument in favour of my suppositions. However, it gives another argument for my assumptions not examined in my former paper,[2] namely, the distribution of intensity in a group of components forming a line of the band. This distribution is shown qualitatively in Fig. 1 (upper diagram), where we have a curve analogous to the curves obtained with the aid of a self-recording Moll microphotometer for various lines of the mercury hydride bands. In the lower diagram is given for comparison the percentage abundance of mercury isotopes found by Aston[4] in his accurate measurements. The discrepancies of the two diagrams are very evident, especially if it is remembered that the strong triplet found by me was very well resolved in the region of the (0, 0) band, the resolution increasing toward the larger frequencies. It is not clear why the first component of the quadruplet appears well resolved, while with the resolving power used it ought to merge with the 199- and 200-isotopes components into a diffuse band of asymmetrical character.

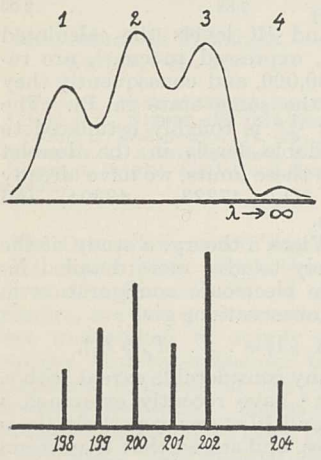

FIG. 1.

The same difficulty exists concerning the results of R. Rydberg's investigations,[3] to which Prof. Hulthén also refers. Rydberg worked with a spectrograph of a little lower resolving power than that of the Lummer-Gehrcke parallel plate used in my experiments, and has also resolved the lines of the (2, 1) and (3, 2) bands into four components, which he ascribes to the four even isotopes of mercury. On account of the relatively high percentage of the 199-isotope it appears difficult to make clear the appearance of the well-resolved 198-isotope component. It is worth noting that the amount of splitting measured by Rydberg is approximately equal to that found by me.

With regard to the above difficulties, I think that the problem can be resolved only by new investigations carried out with spectrographs of greater resolving power.

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[1] E. Hulthén, NATURE, **129**, 56; 1932.
[2] S. Mrozowski, *Z. Phys.*, **72**, 776; 1931.
[3] R. Rydberg, *Z. Phys.*, **73**, 74; 1931.
[4] F. W. Aston, *Proc. Roy. Soc.*, A, **126**, 511; 1930.

Periodic Precipitation Structures

RECENT correspondence[1] has indicated that it is possible to explain the formation of periodic precipitation structures without invoking the aid of colloid-chemical principles. The amount of work which has been done on this subject is probably greater than even those who have made valuable contributions are aware. During the past ten years I have been collecting a bibliography, and I have recently had the assistance of the Science Library, South Kensington, through the kindness of Dr. S. C. Bradford. My collection now contains almost five hundred references. The investigations include not only periodic structures formed by chemical double decomposition, both with and without the presence of colloids, but also those produced by salting-out, coagulation, crystallisation (from melts and from solutions), condensation, evaporation, desiccation, and sedimentation.

It may be argued that these are different phenomena, having a merely outward resemblance. Nevertheless, it is possible to explain even the most diverse types of periodic structure, assuming two conditions: (*a*) a critical condition for precipitation, crystallisation, or other change (supersaturation, undercooling, and a threshold concentration for coagulation are included in these conditions); (*b*) mobilisation of one or more of the substances (including diffusion, adsorption, capillary attraction, etc.).

It is not possible to discuss this general theory further in the space at my disposal here, but it will shortly be published in my book, "Liesegang Rings and Other Periodic Structures" (Chapman and Hall, in the press), where it is shown that in its application to the Liesegang phenomenon the theory includes those of Wi. Ostwald, Bradford, Dhar and Chatterji, and Wo. Ostwald.

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[1] McBain, NATURE, Dec. 19, 1931; Friend and Vallance, *ibid.*, Feb. 6, 1932.

UNLESS qualified, the views of Prof. J. W. McBain,[1] as well as those of Drs. Friend and Vallance,[2] are apt to convey a wrong impression. Is the colloidal state *always* not essential in periodic precipitations? Is any particular state or phase essential to these formations?

Although the electrolytic, dilution, rapid cooling, and hydroxy-organic methods make it increasingly more difficult to indicate a clear demarcation line between transient colloids and non-colloids, still a general survey of the vast number of periodic precipitations affords us cases where the colloidal state is not only absent, or not essential, but also where it *is* the determining factor.

The co-ordination of recent work[3] on periodic precipitations such as Kundt's figures and change of phase with or without chemical interaction (condensation, coagulation, salting out, evaporation, etc.) reveals the following significant facts:

1. Periodic precipitations are in general not confined to physical or chemical phenomena only, and are not restricted to any specific state or phase of matter or to any definite number of components.

2. Periodic precipitations are the material record of an undulatory movement in a mobile magma. This movement characterises generally the relationship of matter and energy, and is expressible in terms of wave mechanics.

3. As a record of change or transition, periodic precipitations are determined by the relation existing between the frequency-amplitude of undulation and

the boundaries of the system. Reducing the former, we can maintain a relationship adequate to periodic precipitation only by a corresponding reduction in the diameter of the boundary system; thus, in the case of slow movements, periodic precipitations are restricted to narrow tubes, capillaries, and ultimately large surfaces afforded by colloids.

The maxima and minima involved in this relationship find expression in practically all theories of periodic precipitation under such terms as nodes and antinodes, critical points, compression and rarefaction, under- and super-saturation, etc.

In considering the problem of periodic precipitations, we must bear in mind, however, the fact that whilst the fundamental principles of periodicity and its material records are not confined to any state or phase, the actual type and complexity of each periodic precipitation is determined by all the properties of the particular phase of matter involved in the phenomenon. This is specially the case with the colloidal state capable of functioning as either a system's boundary, medium, or component, or even all these rolled together, thus evolving the biological and mineralogical periodic structures in all their ramifications.

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[1] NATURE, **128**, 1042, Dec. 19, 1931.
[2] NATURE, **129**, 205, Feb. 6, 1932.
[3] Copisarow, *Koll. Z.*, **54**, 257; 1931: *Chem. News*, **143**, 341; 1931: *J. Phys. Chem.*, **36**, 752; 1932.

AFTER placing a drop of oil on a smoked glass and observing the system about an hour later, a new observation of periodic structure has been discovered.

The smoked glass under observation carried a continuous carbon film of particles about 0·2 micron in diameter, and the oil drop in slowly spreading caused the previously regular and continuous carbon film to become rearranged into alternately opaque and clear concentric rings or zones underneath the spreading drop. The effect was readily repeatable with other oil drops and smoked slides.

In every case so far observed, the central zone is a dark one, followed by a comparatively narrow, concentric, clear zone. In general, so far as trials yet go, the alternate zones are repeated several times in one experiment.

Whilst the phenomenon at once brings to mind the analogous chemical instance of periodic precipitation, it would seem to be purely physical. Oils of varying viscosity may be used, and the effect is best observed if, after carefully posing one drop of oil on the film, the glass is set down in a perfectly horizontal position. After, say, twenty-four hours, the spread oil film may be removed with carbon tetrachloride without destroying the ring structure formed in the carbon film.

Whilst, in addition to normal periodic precipitation, J. W. McBain [1] quotes work showing that periodic precipitation can occur in the absence of colloids, and E. S. Hedges [2] records the production of sodium chloride periodic structures without chemical action by salting out from solution, this is a case where periodic structures are formed in the absence of colloids, chemical action, and dissolution. Experiments and observations will be continued.

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[1] NATURE, **128**, 1042, Dec. 19, 1931.
[2] NATURE, **128**, 401, Sept. 5, 1931.

Rate of Ionisation of the Atmosphere

THE calculation of the rate of ionisation of the atmosphere on the basis of the well-known Schweidler recombination law, by G. R. Wait [1] and J. J. and P. J. Nolan,[2] has shown a large variation in the rate, in the course of the day, at observing stations in Washington, D.C., in the United States, and near Dublin, Ireland. It is of interest to note that the maxima of the diurnal variation curves for these stations agree closely when plotted on Greenwich Mean Time.

The Department of Terrestrial Magnetism, in connexion with its programme of study of atmospheric pollution in relation to ionisation and other atmospheric electric phenomena, has constructed, and installed on the laboratory grounds at Washington, D.C., an apparatus for measuring simultaneously the small ion and large ion content from the same sample of air.

Results obtained with this apparatus permit the calculation of q, the rate of ionisation, with greater accuracy than was possible by the method employed in the previous work by Wait, in which values of nuclei content, obtained on the observatory grounds, were utilised together with values of small ion content computed from conductivity records obtained on the observatory roof. Values of q were obtained for three sets of observations in the free atmosphere on successive days in November 1931. All three days show a maximum value at approximately the same time as that previously found by Wait, as may be seen from the following table:

Values of q on 75° Mean Time.

Nov. 23.			Nov. 24.			Nov. 25.		
hr.	min.	q.	hr.	min.	q.	hr.	min.	q.
	..			..		9	37	2·0
	..		10	00	2·1	9	59	3·0
	..		10	30	2·9	10	22	2·7
10	54	3·2	10	47	3·2	10	46	2·4
	..		11	05	2·6	11	08	3·6
11	18	4·0	11	27	4·3	11	29	6·0
11	46	2·9	11	49	6·4	11	49	3·4
12	09	2·7	12	08	5·7	12	11	2·9
	..		12	26	5·1		..	
13	35	1·8	13	32	3·3	13	46	1·8
14	00	1·6	14	01	1·2	14	11	1·7
14	25	1·8		..		14	30	1·7
	..			..		14	49	2·0
	..		15	04	1·3	15	11	1·5
15	28	1·5	15	26	2·5	15	34	1·8
15	49	1·5	15	46	2·0	15	53	1·6
16	09	1·6	16	07	3·2	16	14	1·5

The maxima in this table are about two to three times as large as the average value of q, and, furthermore, all values, including the maxima, are lower than that which is usually accepted as normal (q about 10) for most localities. Similar results were obtained by J. J. and P. J. Nolan, according to the publication already cited. It is worthy of note that, by using their modified form of the Schweidler equation on the data here discussed, the values of q are trebled and are thus brought to what appear to be more reasonable magnitudes.

Possible explanations for the variations in q have been considered. Barometric records have been examined but no correlation has been found between variations in atmospheric pressure and variations in q. Furthermore, the maximum in q is associated on only one day with a maximum in nuclei content; on the other two days it is associated with maxima in small ion content. This would indicate that the maximum in q cannot be explained by the assumption

that radioactive carriers suspended in the atmosphere become attached to nuclei and so cause increased ionisation with increase in nuclei.

Finally, some consideration has been given to the possibility that the variation in q appears only because the presence and behaviour of intermediate ions have not been taken into account. Perhaps intermediate ions are present which become least numerous as the large ions become most numerous, and, further, these intermediate ions may have a much larger recombination coefficient with the small ions than have the large ions. While no data have as yet been obtained to define the part played by intermediate ions of mobility greater than 0·004 cm./sec./volt/cm., some observations have been made on intermediate ions with smaller mobilities. The results indicate that ions of this type do not vary in number in such a manner as would, if given separate consideration, produce a more constant value of q than has been shown above.

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Washington, D.C.,
Jan. 13.

[1] *Terr. Mag.*, **36**, 111-131; 1931.
[2] *Proc. Roy. Irish Acad.*, A, **40**, 11-59; 1931.

The Highest Atomic Number

IT has been suggested (I believe by Sommerfeld) that the highest possible atomic number is the constant $hc/2\pi e^2 = 137$. According to Eddington's theory, this number represents the number of degrees of freedom of a system of two charges. It is natural to suppose that there is a correspondence (direct or indirect) between degrees of freedom and independent wave-functions, so that the maximum number of independent wave-functions for a nucleus and satellite electron is 137. By the exclusion principle each satellite electron must be provided with an independent wave-function, so that there cannot be more than 137 of them.

In Eddington's analysis, 136 of the degrees of freedom are relativity rotations associated with the symmetrical matrix expressions $E_aE'_b + E_bE'_a$, where a and b have values from 1 to 16. The generalised interaction energy is $\sum_{s=1}^{16} E_sE'_s/137r$, where r is the invariant proper distance of the two charges, although the portion $\sum_{s=1}^{4} E_sE'_s/137r$, turns out to be of special significance in a four-dimensional space. Also, the general matrix expression associated with the interchangeability of charges is $\sum_{s=1}^{16} E_sE'_s$. I have found that this last expression is invariant only for 91 out of the 136 rotations; it is altered by the 45 rotations for which E_a, E_b commute and are not equal to each other or to $E_{16}(=i)$. Having regard to the association of wave-functions with constant energy, it is perhaps permissible to assume that wave-functions are generated only by the 91 rotations which leave the energy invariant.

If this is right, it follows that the highest possible atomic number is $91 + 1$ instead of $136 + 1$; so that there can be no element beyond uranium (92).

V. V. NARLIKER.

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Feb. 26.

Possible Existence of a Neutron

IN a paper to appear shortly in the *Proceedings of the Royal Society*, I have reported observations on the absorption of the radiations produced in beryllium and other light elements by bombardment with polonium α-particles. The experiments indicated that the radiations emitted from beryllium, boron, and fluorine in the 'forward' direction, that is, in roughly the same directions as the α-particles producing them, were less absorbable than those emitted in the backward direction. In my paper I show that this observation is very difficult to reconcile with conservation of momentum and energy if the radiations are assumed to be γ-radiations corresponding to the energy available.

Now that Dr. Chadwick has put forward evidence for the existence of neutrons,[1] this difficulty appears to be solved. Thus if the radiations are assumed to consist of neutrons, it follows immediately from the conservation laws that those emitted in the forward direction must have considerably more energy (50 per cent in the case of beryllium) than those emitted in the backward direction. This suggests that the radiations from boron and fluorine, as well as that from beryllium, consist at least in part of neutrons.

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March 2.

[1] NATURE, **129**, 312, Feb. 27, 1932.

Protection of Herbarium Specimens

IN making a herbarium collection of Indian types of cotton, the necessity was felt of protecting the mounted specimens from injury while handling. To meet this difficulty, the senior writer suggested using a transparent celluloid material as a covering for the specimens. 'Cellophane', 'Cellglass', 'Sidac', and other trade names are applied to such products, which are sold in sheets, and are very thin, tough, flexible, transparent, damp-proof, and inexpensive. In commerce, these materials are used for wrapping boxes of chocolates, etc.

The universal practice of mounting pressed and dried plants without protective covering has the serious disadvantage that the leaves and flowers become brittle and are liable to break off. Thus, if the specimens are constantly being examined, these losses ultimately deprive the collection of its scientific value. The celluloid tissue used, while protecting the specimens from injury and breakage, at the same time allows the observer to examine the specimens with ease, even with a lens.

The technique employed is very simple. After the specimens have been pressed and dried, they are fastened to the mounting paper with a celluloid-base cement, such as 'Durofix', an improvement which does away with the necessity of stitching or using strips of paper to keep the specimens in position. A sheet of tissue is then cut to the required size, the edges are smeared very thinly with celluloid cement, and the sheet is then laid over the specimens on the mount, to which it adheres readily.

An additional advantage is that if the celluloid tissue has been carefully applied, the risk of damage by insects is reduced.

F. K. JACKSON.
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Indore, Jan. 27.

Research Items

The Jinn in Eastern Folklore.—In the course of some notes on Arabian and Persian folklore in *Folk-Lore*, vol. 41, no. 4, Prof. R. A. Nicholson points out that old Arabian pre-Islamic folklore has a character all its own, and that, notwithstanding the belief in jinn, the supernatural played a very small part in the life of the sixth-century Beduin. Belief in the jinn was made an article of faith by Mohammed, and his authority is cited for the statement that every Muslim at his birth and throughout his life is attended by a jinni or familiar spirit. Though normally invisible, they can assume any shape they please, yet so long as a spiritual being is looked upon by the human eye it cannot change its form—a belief which appears also in Irish folklore. The Muslim jinni, however, can evade the difficulty by producing a form before itself like a screen. When this is moved the eye follows it involuntarily and the jinni escapes. The jinn have much in common with our fairies. In Persia, a rite known as "The Feast for the Daughter of the Fairy King" is employed to propitiate the fairies whose wrath has been aroused, especially when this is manifested by a visitation of sickness or misfortune. Priestesses, old women acquainted with the rite, alone are allowed to perform it. A mirror, chafing dish, cup of water, some sugar-cane, collyrium, frankincense, and the egg of a black hen are carried to the top of a hill or other suitable spot which previously has been swept clean. A fire is lighted, into which seeds of rue are thrown, and incantations are chanted. At night the sick person is brought to the spot, or, if he is too ill, the objects named are carried to his bedside in a wallet. He must eat some of the sugar-cane, apply the collyrium to his eyes, and then look at his miserable face in the mirror, while he listens to the auguries which the old woman draws from the appearance of the yolk of the egg. Usually the verdict is that an entertainment must be given to the daughter of the Fairy King, so that, eating salt with the man, she may pardon his offence.

Teleilat Ghassul.—An account of excavations carried out by Père Mallon of the Biblical Pontifical Institute, Jerusalem, in 1929-30 and 1930-31 at Teleilat Ghassul, is given by the Rev. J. G. Duncan in *Ancient Egypt*, 1931, pt. 3. The site lies about six kilometres north of the Dead Sea and about four kilometres east of Jordan, almost in the centre of the plain Arboth Moab. The number of the tells in the neighbourhood argues that the population in the copper and bronze ages was considerably more dense than it is nowadays. Of these tells, Teleilat Ghassul is one of the most ancient. The natural soil, reached at a depth of about 18 ft., is sand, an ancient sea floor. The whole ruin, including suburbs on the southern side, is 800 metres by 400 metres in extent. Four strata of occupation were found, the suburbs belonging to the latest and largest. Each city was destroyed by fire, as is demonstrated by the deposit of ashes which overlies each floor. The pottery falls into two or three classes, neolithic, and copper and bronze age, pointing to an occupation lasting from about 2500 B.C. to 1900–1800 B.C. After the destruction of town iv. by fire, the site was not re-occupied. Prof. Petrie has pointed out that bronze may appear in Palestine at a date earlier than that implied by Père Mallon, which might give a date for the destruction of the town at 2100 to 2000 B.C. This would strengthen Père Mallon's identification of the southern mound with Sodom. A remarkable feature of the site is the large number of inscribed stones and seals, sherds and brick which have been found. These have not yet been deciphered; but they support the conclusion, reached on other grounds, that from the earliest to the latest settlement, notwithstanding the marks of development and transition, the same civilisation prevails. This also holds of the northern mound, which, tentatively, is identified with Gomorrah.

Sexual Behaviour in Frogs and Toads.—In certain of the tailed amphibians it has been recognised that the chief rôle in sex recognition is played by chemical sense, but as regards the frogs, opinion has been by no means sure. Now Ch'eng-Chao Liu has made a study of the Siberian toad (*Bufo raddei*) and the pond frog (*Rana nigromaculata*), both natives of north-eastern Asia; and the result is his rejection of the chemical sense as the basis of sex recognition in these species (*Peking Nat. Hist. Bull.*, 1931–32, vol. 6, p. 43). In this he confirms the observations of Noble and Farris on the American wood-frog. The author finds, regarding the frog and toad, that males appear first during the breeding season, and females ready for egg-laying are attracted by the calling croak of the males. The males appear to mate indiscriminately with whatever individual they come across, but should that happen to be a male, a new note, a croak of warning, is sounded by the lower male and this, sometimes combined with repulsive action, leads to sex recognition. When the eggs have been laid, the females escape by elongating their bodies, and thereafter they move to the land. The persistence of the male embrace is matter for wonder—on several occasions the bodies of dead males and females were offered to normal males; often the males clasped the dead bodies, and sometimes they retained their hold until the grasped bodies began to decay.

***Spirula* from the *Dana* Expeditions.**—Prof. Graham Kerr has given us a very beautiful and intensely interesting account in his "Notes upon the *Dana* Specimens of *Spirula* and upon Certain Problems of Cephalopod Morphology" (Oceanographical Reports edited by the "Dana" Committee. No. 8, Copenhagen). The *Dana* was fortunate in obtaining ninety-five specimens of *Spirula* in the Atlantic Ocean between 10° and 35° N. lat., most of the catches being in the west Atlantic, whilst others occurred in the eastern Atlantic from the Canaries to north of the Cape Verde Islands. The live specimens have already been described by Prof. Schmidt (NATURE, Dec. 9, 1922). In the orientation of the body the cephalopodium theory is definitely abandoned, and the head is regarded as anterior, the tip of the body posterior, the funnel surface ventral, and the surface opposite to the funnel dorsal. *Spirula* is in no sense a primitive form and it should be placed high up in the scale of cephalopod evolution. It is argued that the primitive cephalopod shell was spiral and not straight, and the shells of Cephalopoda—living or extinct—in which the nautiloid spiral is departed from are necessarily internal. The spherical initial chamber of *Spirula* is taken as indicating that at no stage in its life history is it external. The straightening out of the shell in its later formed portion is important as showing the beginning of progressive evolution towards a loss of the spiral, and its endogastric curve is interpreted as due to its having undergone rotation within the body. There is torsion of the posterior loop of the alimentary canal, which is believed to be a result of the rotation of the shell within the body during the phylogenetic history of *Spirula*. The radula is shown to be non-existent, the supposed radula teeth being tooth-like projections of the buccal lobes. The cœlom and the male

genital organs are described in detail, the renal sacs being fused together as in other dibranchs. The whole work is full of important information and carefully thought out deductions.

The Effects of Fixatives.—The principal conclusions of A. A. Tarkhan (*J. Roy. Mic. Soc.*, Dec. 1931) on the effects of fixatives and other reagents on cell-size and tissue-bulk are as follows: Exposure of fresh organs and tissues to air produces shrinkage, hence they should be placed in the fixative as soon as excised. Formol (5-10 per cent formaldehyde) over periods of 24-48 hours does not swell tissues, but the use of formol for longer periods should be avoided on account of the toughening of the tissues and consequent difficulty in sectioning. Mercuric chloride and picric acid, in saturated aqueous solutions, are powerful shrinking agents, as is absolute alcohol. Strong solutions of chromic acid (1 per cent) and potassium bichromate (4 per cent) are similar in effect. Clearing produces slow and progressive shrinkage, and this appears to be largely independent of the fixative originally employed. Xylol and toluol shrink tissues more than benzol, and oil of cedar wood (as is generally accepted) produces the least shrinkage. Embedding in paraffin should be reduced to the shortest time consistent with penetration, for it causes progressive shrinkage which is largely in direct proportion to the temperature.

Volume Tables for Timber of *Acacia Catechu*.—The utilisation of khair (*Acacia Catechu*) trees for the production of katha (which, mixed with betel and lime, forms the *pan* so commonly chewed by Indians), in the United Provinces of India, is effected by three different agencies. The general principle consists of reducing the black heartwood of the tree to chips and then boiling the latter. The three agencies are (1) the Chais: a special class of skilled katha workers from Gond and Bahraich districts who carry out their conversion of the timber in furnaces constructed near their camps situated on streams in the forest; (2) factories: the Indian Wood Products Company, with its factory at Izatnagar, has an agreement with the Forest Department for the supply of khair from the submontain forest divisions; its conversion is closer than that of the Chais; (3) the Paharis or hillmen: their method is wasteful, as they utilise only the best parts of the heartwood, leaving the rest to rot in the forest. In vol. 13, pt. 9 (1929), of the *Indian Forest Records* the first volume tables were prepared for commercial timber (katha) and heartwood for khair (*Acacia Catechu*) by members of the Forest Research Institute. These tables chiefly referred to areas worked by the Chais both in the United Provinces and in Bengal. In a recent part of the *Records* (vol. 15, pt. 3; 1931), H. G. Champion and Ishwar Das Mahendru supplement the former work by tables for factory working. A more regular method of working, and a more detailed knowledge on the subject of the volume likely to be procurable from definite areas, became necessary when a factory depended for its continued existence upon a constant supply of raw material. In view of the considerable range in value of trees of different sizes, volume data were desirable, and the investigations comprised in these two parts of the *Records* are of very considerable practical value.

The Isu (Japan) Earthquake of Nov. 26, 1930.—Since the earthquake, a line of precise levellings has been carried round the Idu peninsula, in the northern part of the route crossing the Tanna fault. This series has lately been compared by Prof. C. Tsuboi (*Earthq. Res. Inst. Bull.*, vol. 9, pp. 271–290; 1931) with that made towards the close of 1923, and the latter with a series made in 1903. It is assumed that the changes between the first and second series were due to the Kwanto earthquake of 1923, and those between the second and third to the Idu earthquake. During the latter earthquake, displacements occurred over 18·5 miles of the north-south Tanna fault. The crust on the west side of the fault, relatively to the other, was shifted about 3 ft. 3 in. to the south. The vertical movement was less simple, the western block being depressed relatively at the northern end and elevated at the southern (NATURE, vol. 128, p. 551). The line of levellings across the fault shows a V-shaped depression of 7·75 in. along the fault during the Idu earthquake, but very little change during the Kwanto earthquake. Along the western side of the peninsula, Prof. Tsuboi distinguishes six land-blocks, each of which moved separately during the earthquake, but with some order in their general displacement, for the directions of their tilts, beginning with the southern block, changed in a clockwise direction. This shows that the crust as a whole was twisted like a plate, and this is also indicated by the hinge-like vertical movement along the Tanna fault.

X-Ray Wave-Lengths.—Accurate measurements of X-ray wave-lengths are usually made with crystals or ruled gratings, and a small but important difference exists between the results. An account of an application of a third method is given by J. A. Bearden in the first January number of the *Physical Review*. He photographs the refraction spectra produced when the X-rays are dispersed by a quartz prism with an angle of 90°, obtaining remarkably precise records of the deviation, from which wave-lengths are calculated by the quantum theory of the effect. The results are almost identical with those obtained by the crystal method, but are definitely not in agreement with the ruled grating measurements. The conclusion is somewhat unexpected, as the results of different observers who have used ruled gratings appear satisfactory in most respects, and indicates a possible failure of the theory of diffraction at a ruled grating when applied to X-ray wave-lengths.

Absorption of Hydrogen by Metals.—In various papers, recently published, Franzini has advanced the hypothesis that hydrogen which has been absorbed by metals exists therein in the dissolved and dissociated state. It seemed possible, therefore, that displacement of this hydrogen into the mass of the metal might be effected by the influence of an electric field, and such possibility has been realised in experiments made on palladium by Coehn and Specht. Further investigation of this question has now been carried out by Franzini (*Rend.*, Roy. Lombardy Institute, vol. 64, parts 11-15, 1931). Wires of nickel and iron, hydrogenated by being heated in an atmosphere of hydrogen, were employed, and the subsequent displacement of the hydrogen was determined by observing the variations in the electrical resistance of the metal caused thereby. With nickel, quantitative data were obtained, but with iron only qualitative evidence of the displacement of the hydrogen towards the extreme negative, when the electric field was established, was forthcoming. The increase in resistance following absorption of the hydrogen is probably due to the setting up of an e.m.f. arising by polarisation of the hydrogen protons with respect to the molecules or groups of molecules of the metal. The linking is ruptured by the electric field and the gas migrates into the metal.

Transport Numbers.—According to the modern theory of strong electrolytes, the mobilities of the ions vary with concentration, and since this variation

is not relatively the same for all ions, but depends on the radii and valencies, the transport numbers of salts will vary with concentration. Jones and Bradshaw (*J. Amer. Chem. Soc.*, Jan.) show that a method of calculation previously applied by Jones and Dale in 1929 to barium chloride can be applied to lithium chloride, and they have determined the transport number at many different concentrations between 0·023 and 2·95 normal at 25°, finding values from 0·3272 to 0·2575 over this range. They show that the transport number t can be represented as a function of concentration c by an equation of the form $t=[A/(1+B\sqrt{c})]-1$, where A and B are constants, as was the case with barium chloride. They also recalculate the electromotive force measurements of MacInnes and Beatty with lithium chloride and show that these results can be expressed by a similar equation, the actual figures given by MacInnes and Beatty having been calculated by another, empirical, method. The activity coefficient of the ions of lithium chloride varies with the concentration according to an equation derived by Hückel. Jones and Bradshaw's paper is an important one in relation to the modern interpretation of transport numbers.

Determination of Nitrogen in Yeast.—It is well known to analysts that certain substances such as meat, urine, and milk, and especially those high in nitrogen, resist the oxidising action of sulphuric acid in the original Kjeldahl method for the determination of nitrogen, and that, consequently, low results are obtained. Modifications of Kjeldahl's method have therefore been proposed, such as that of Gunning, in which the sample is digested with sulphates of potassium and copper, with or without potassium permanganate, and the Christiansen and Fulmer methods, where hydrogen peroxide is the oxidising agent. In certain cases these methods also give doubtful results, and yeast, especially if dried or pressed, is a particular offender in this respect. In connexion with his work on nitrogenous metabolism in yeast, R. S. W. Thorne (*J. Inst. Brewing*, **38**, 23; 1932) therefore found it necessary to run comparative tests by the various methods—the Dumas method, a somewhat laborious and difficult procedure, being taken as giving the true nitrogen content. The Kjeldahl-Gunning method gave the same results, though after a shorter period of digestion than Kjeldahl's original procedure, but the results showed that only 91·2-95·9 per cent of the total (Dumas) nitrogen present was determined, the actual magnitude of the error being influenced by the specific character of the yeast examined. The Christiansen and Fulmer method, however, gave 99·4-99·8 per cent of the true nitrogen, but only when the optimum quantity of hydrogen peroxide (30 c.c. of 50-volume solution for 0·5 gm. of yeast) was taken. A rather surprising feature of the work is the fact that ter Meulen's method, in which the sample is heated with a nickel catalyst in a current of hydrogen and the resulting ammonia absorbed in acid and titrated, also gave low results.

Astronomical Topics

Photographs Measuring the Intensity of Moonlight.—Dr. Frederick Schembor, Vienna XI, Grillgasse 31, III/37 Austria, has sent a request that observers who possess film cameras should take pictures of the moon out of focus on the nights March 21-22 and March 22-23, that is, the nights immediately preceding and following the almost total eclipse of the moon; the eclipse occurs about 1 P.M. on March 22, and is, of course, invisible in Europe. The object is to compare the moon's illumination before and after eclipse, in order to see whether the lowering of temperature during the eclipse leaves any discernible effect some hours later. Dr. Schembor wishes a screen to be prepared with a central aperture of the same size as the object glass. The screen is to be placed close to the film, with the aperture central. The distance from lens to film is to be one-third of the focal length. Many exposures can be made on a single film, moving it sufficiently between exposures to prevent overlapping of images. Varying exposures may be given from 1/100 of a second to 1 second, but the length of each and their order must be carefully noted, also the Greenwich time (to seconds) of each exposure, with notes on the clearness of sky, the make of film and of objective, the focal length, and the distance from film to objective. The film is to be sent undeveloped to Dr. Schembor at the above address. The name, address, and longitude and latitude of the sender are also to be noted.

Solar and Terrestrial Relationships.—In June 1924 the International Research Council appointed a special committee to study the relation between solar and terrestrial phenomena. This committee has now published a third report of its activities, to which are attached numerous memoranda, written by members and other leading authorities, on various aspects of the subject. Several of these memoranda deal with the meaning and value of the daily character figures of various solar phenomena which have been published during the last few years in quarterly bulletins by the International Astronomical Union. The methods employed, reasons for discrepancies between the character figures from different co-operating observatories, as well as suggestions for their improvement, are all discussed; and indications are given as to the ultimate value of results to be obtained from them. The memoranda are too many to enumerate in detail, but several that deal with changes in the ultra-violet solar radiation as related to various terrestrial phenomena (such as the amount of ozone in our atmosphere) are perhaps of special importance. The whole report affords evidence of the considerable amount of useful research accomplished by the committee since its formation, and supplies a condensed summary of the present state of knowledge in those subjects which fall within the scope of the committee.

Mass of Neptune's Satellite.—The recent investigation at Mount Wilson of the mass of this satellite has already been noted in this column. A paper by Prof. H. N. Russell (*Scient. Amer.*, Feb.) now gives fuller details of the research: it is illustrated by photographs of the satellites of Uranus and Neptune taken at the Yerkes Observatory. The delicacy of the research is brought home by the fact that careful allowance had to be made both for the shift in the earth's centre due to the attraction of the moon and the displacement arising from the earth's rotation. The most probable value of the mass is five times that of the moon, or $1\frac{3}{4}$ that of Mercury (using Backlund's value for the latter, which is $\frac{1}{7}$th of the earth's mass) and $\frac{5}{8}$ of that of Mars. Prof. Russell conjectures that its diameter may be 2500 miles. Unless it is larger than this, it must have a high density if the mass found is near the truth. He calls the satellite "nameless": the name *Triton*, suggested by the late Camille Flammarion, is very appropriate. It has already been accepted by many astronomers, and might well receive general recognition.

University College, Exeter

THE WASHINGTON SINGER LABORATORIES

THE Washington Singer laboratories at University College, Exeter, the erection of which was rendered possible by the munificence of Mr. W. Washington Singer, contain the departments of chemistry and physics, and form the first instalment of an extensive scheme of university buildings intended to be erected on the Streatham site—a magnificent setting, amid delightful surroundings, and commanding views of valley and hill unsurpassed in the country. The lay-out of the scheme is governed by the slope of the site, the new laboratories facing almost due south. The front elevation, overlooking the Exe valley, is severely plain and bears nothing approaching the ornate, the only feature of a decorative nature being the coats-of-arms of the counties and principal boroughs in the region which the College serves. These take the form of unobtrusive mural tablets.

There are three main entrances to the building, which is approximately 300 ft. long and 55 ft. wide. It is faced with a fine brick of inconspicuous colour, and the long span of roof carries about 100,000 Cotswold stone tiles, forming a unique feature in the south-west. Like the facing bricks with which they tone, the tiles are less conspicuous than those commonly in use, and have a much longer life. A pleasing feature of the back elevation is the Tudor windows of Portland stone, which open upon a terrace.

There are three floors, the ground and first floors being devoted mainly to physics and the second to chemistry. Each floor is divided by a corridor 8 ft. wide, and in general the rooms are arranged in units, or multiples of units, in width 10 ft. between centres. On both sides of the corridors, most of the rooms are 20 ft. deep. The ferro-concrete floors have intermediate support on a double row of concrete pillars coinciding with the lines of the corridor walls, which are of brick, 4½ in. thick. Occupying a central position is a large examination hall, about 100 ft. long and 35 ft. wide. It rises to the top of the first floor and will accommodate about five hundred students.

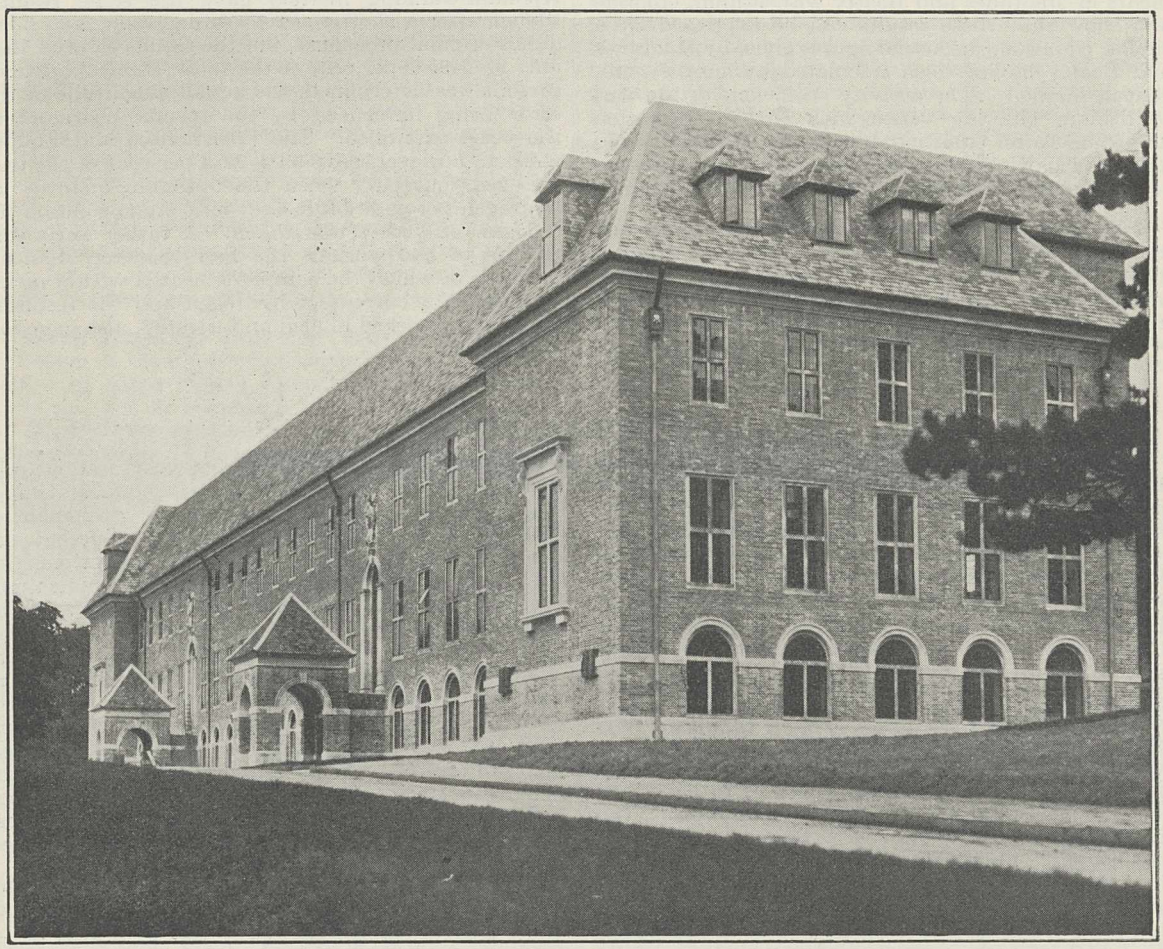

FIG. 1.—Washington Singer Laboratories, University College, Exeter.

In the provision of gas, water, and electricity in the various rooms the floor-duct system has been adopted. Horizontal ducts are also provided in the first and second floors, which not only serve the purpose of a vitiated air duct in the ventilation system, but also give means for laying rapidly any temporary cable, or piping, as required, to any room.

The supply of direct electric current to the laboratories is obtained from a 250 ampere-hours battery of 110 volts, a 150-ampere 110-volt charging generator being also available for the distribution of heavy currents. The battery is subdivided at the fifth, fifteenth, twentieth, and thirtieth cells, and is intended for the supply of small currents at reasonably constant

voltages. There is a substation on the ground floor, and the Corporation of Exeter supplies 210 volts two-phase alternating current, which is distributed for light and power. In addition, there is a 200 volts direct current generator and an alternator, the latter supplying alternating current of variable voltage and frequency.

For the supply of compressed air and of vacuum the unit system has been preferred to that of general distribution, and any worker who requires either of them has it thus under his own control. The machines in the workshop are entirely unit driven, and there is a small furnace for casting. An automatic domestic telephone service is installed in a number of rooms.

The ground floor contains the workshop, battery and dynamo rooms, a small magnetic laboratory, two theatres, preparation and research rooms, a spectroscopy laboratory, and cloakrooms. The larger theatre, which has seating for 150 as a minimum, is fitted with electrically controlled light-tight blinds, and the smaller theatre, which adjoins it, is provided with a minimum seating for 80. The acoustic properties of both theatres have received particular consideration, and the demonstration benches are anti-vibrational, being supported on a layer of concrete, 2 ft. thick, embedded in the ground and separated from the floor. The fixed slate benches in the spectroscopy laboratory and in some of the research rooms are also anti-vibrational.

The first floor is similar in construction and contains a large laboratory for advanced students, intermediate and advanced optics rooms, honours laboratory; private, research, glass-work, apparatus, and store rooms; together with a large laboratory for intermediate students. There is also a writing-room and a library, jointly used by the students of chemistry and physics. Except in the intermediate laboratory, there are no fixed benches on the floors, those around the walls being built on brick piers which rest on the concrete floor. These wall benches are of solacite—an acid- and heat-resisting material similar to slate. A special feature of the physics department is the provision of numerous electrical panels in all rooms, so that each student has available, on one and the same panel, lighting, power, and direct current (variable voltage) circuits. This arrangement has already proved of the greatest value and convenience.

The chemistry department occupies the whole of the second floor. A feature is the junior laboratory—a spacious room about 80 ft. long and 35 ft. wide—for intermediate and pass degree students. It has places for forty-eight students. There are also laboratories for physical, analytical, and organic chemistry, two lecture theatres—similar to those on the ground floor—together with preparation and store rooms. In addition, there is a number of small rooms which have been especially adapted for research.

Flats above the second floor are provided for the caretaker and resident engineer, while a portion of the roof is flat and available for special experiments. An automatic lift completes the equipment.

Owing to the national situation, no official opening has been held, but last December the Physics Department, in conjunction with representatives of the electrical industry, organised a three-days' Faraday exhibition, at which Sir William Bragg gave the inaugural lecture. This exhibition, which was attended by some five thousand people, enabled the general public to inspect the laboratories, the erection of which emphasises the rapid progress and development of the College, situated as it is in a non-industrial area.

Developments of Electric Lighting

IN the February number of the *G.E.C. Journal* there is an interesting article by H. W. Richardson on the progress and development made by the General Electric Company in 1931. Considerable progress has been made in perfecting striated discharge tubes for lighting. In all ordinary discharge tubes containing rare gases, the glow in the main part of the tube is continuous. When, however, common gases such as air or nitrogen are used, the discharge, under certain conditions, breaks up into a number of separate sections. This effect is known as the striated discharge. Formerly it was only possible to get this effect momentarily. As a result of recent work in the G.E.C. laboratories, this type of discharge can now be produced at will in neon, and the effects are very striking and beautiful. It is still in the experimental stage.

In addition, new colours in cold cathode tubes such as are used for advertising purposes have been developed. Hot cathode tubes, the intensity of the light from which is much greater than that of the older cold cathode type, have not yet reached the commercial stage, but development is proceeding very satisfactorily. Owing to their high efficiency as sources of coloured light, they possess special attractions for use in coloured flood-lighting and for coloured lighting generally. By suitable combinations of coloured sources, light for general illumination can be produced. In combination with ordinary incandescent lamps they give light almost indistinguishable from daylight. The absolute efficiency of the conversion of light into power is now very high. The new so-called 'ripple' effect was described in the *Journal* two years ago. At the time, this effect could only be obtained in blue or green colours. It has now been possible to produce it in neon gas so as to give the well-known orange hue.

The G.E.C. laboratories have carried out a large amount of work in connexion with aviation lighting equipment. A reflector type air beacon has been developed which on trial gave results closely approximating to the predetermined calculations. In the new aerodrome flood-light there are nine reflectors of parabolic trough formation each equipped with 1000 watt tubular lamps. With the help of a specially developed focusing device, the unit can be set up in daylight. The results obtained by tests at night are very satisfactory.

During the past three years commercial photometry has been passing through a transition stage. All the visual methods used during the last forty or fifty years are steadily being superseded by photoelectric methods of measurement. Three photoelectric photometers are at present in use at the G.E.C. Research Laboratories which are capable of being used for several purposes. They can, for example, measure the lumens on a direct reading lumen scale over a range of colour temperatures extending from 2400° K. (absolute) to 2800° K. approximately. The lumens and colour measurements are both measured on direct reading scales, and so also are the measurement of lumens and lumens per watt. These improvements save a great deal of time and greatly reduce the risk of error. At the Osram lamp works a photoelectric photometer utilising a cubical photometric integrator of eight-foot side has been installed. It has been designed more especially for the measurement of the very large lamps used in lighthouses, which often require 10,000 watts each.

Life and Work of William Henry Perkin

THE special honour and affection in which the late Prof. W. H. Perkin was held by the Chemical Society is reflected in the publication of a special number of the Society's *Journal* (price 3*s.* 6*d.*) giving an account of the life and work of "this great master in organic chemistry". Prof. Perkin, who was Longstaff medallist, first Pedler lecturer, and a past president of the Society, and had been most closely associated with the development of chemical studies and knowledge in the Universities of Manchester and Oxford, died on Sept. 17, 1929.

The story of Perkin's life from the personal point of view has been written by Mr. A. J. Greenaway, a life-long friend, and formerly editor of the Society's *Journal*, in which the results of most of his researches were published. His scientific work has been described by two of his old associates, Prof. J. F. Thorpe, who confines himself to the Würzburg, Munich, Edinburgh, and Manchester periods, 1880–1912, and Prof. R. Robinson, who discusses a selection of the subjects in the study of which Perkin was actively engaged: the constitution of berberine; brazilin and hæmatoxylin; harmine and harmaline; cryptopine and protopine. There is appended a bibliography of 271 papers published by Perkin and his collaborators; there are four posthumous papers on strychnine and brucine yet to be published. The book also includes three photographs of Perkin, and one of the memorial plaque presented in triplicate to the Society and the Universities of Manchester and Oxford by his colleagues and pupils.

William Henry Perkin was born on June 17, 1860; he was first sent to preparatory schools at Harrow, and later to the City of London School, chosen by his father, Sir William Perkin, founder of the coal-tar dye industry, not merely because it was his old school, but also because it was then "the only one he could find where science was taught". The science master was Henry Durham, who gave courses in chemistry, botany, and physiology alternately, and there was a practical chemistry class on Saturday afternoons, when the boys worked at the lecture table. In the garden of his father's house at Sudbury there was a hut fitted as a laboratory where the Perkin boys, W. H. and A. G., were brought up in an atmosphere of research but without systematic instruction. In 1877, Perkin entered the Royal College of Chemistry at South Kensington and studied under Prof. (later Sir Edward) Frankland and Dr. W. R. E. Hodgkinson; in 1880 he went to Würzburg, studying chemistry under Wislicenus, physics under Kohlrausch, and mineralogy under Sandberger, and in 1882 he went to Munich to work under Baeyer. Here he established a claim to be regarded as one of the most promising of the younger chemists.

In 1887, Perkin was appointed the first professor of chemistry at the newly founded Heriot-Watt College at Edinburgh; his work on ring compounds was continued, much work on other subjects, including camphor, was undertaken, and the alkaloid investigations were commenced. The University of Manchester secured him in 1892; he then entered on what he once described as his 'golden age' of research, and his school established a world-wide reputation. Tempting offers of chairs elsewhere were refused, but in 1912, Perkin accepted the Waynflete professorship of chemistry at Oxford and a fellowship of Magdalen College. At Oxford he completely transformed the chemistry school, liberating a flood of new knowledge. Admirers of the man himself, genial and warm-hearted, and of his immense services to organic chemistry, will prize this triple tribute to his memory.

University and Educational Intelligence

CAMBRIDGE.—Dr. A. G. Hutchison, of Emmanuel College, has been appointed University demonstrator in mineralogy and petrology.

Dr. R. S. Hutton, director of the British Non-Ferrous Metals Research Association, has been appointed the first Goldsmiths professor of metallurgy. Dr. Hutton, who was educated at Blundell's School, Tiverton, Owens College, Manchester, and the Universities of Leipzig and Paris, was lecturer in electro-metallurgy in the University of Manchester in 1900–8.

APPLICATIONS are invited by the University of Wales for five fellowships, each of the annual value of £200 and tenable for two years. The fellowships are open only to graduates of the University of Wales. Applications must reach the Registrar, University Registry, Cathays Park, Cardiff, by at latest June 1.

SCHOLARSHIPS for the encouragement of original research in sanitary science are again being offered by the Grocers Company. The value of each is £300 a year, plus an allowance for expenses in connexion with the work undertaken. Applications, upon a form supplied on request, must be received before the end of April by the Clerk to the Grocers Company, Grocers Hall, E.C.2.

THE Board of Education announces that it is prepared to consider applications for full-time studentships from teachers with at least five years' teaching experience who desire financial assistance to follow courses of advanced study at universities or other institutions at home or abroad. Particulars of the awards and application forms are obtainable from the Board of Education, Whitehall, S.W.1.

MEXICO'S Department of Education offers to a world, wrestling to balance its budgets, a signal example of how to achieve equal or better schooling with less outlay. In that country, it appears, rural schools are based on the idea of building up the community economically, socially, and spiritually, and there is consequently a prejudice against residential schools as alienating children from their home surroundings. However, an exception was allowed in the case of Indians afflicted with a certain disfiguring but evidently not disabling disease (mal del pinta), and a party of thirty-five, ranging in age from ten to eighteen years, was assembled last April on a forty-acre site at San Gabrielito and set to work to make a residential school. Arriving with nothing but a blanket each and the clothes they stood up in, they were made to construct for themselves, sleeping the while on the bare ground, with clay and timber found on the spot, a sufficient and attractive building with necessary furniture, and to make shoes, belts, hats, chairs, and other articles for sale to obtain the wherewithal to buy such clothing as they needed and could not make, and instruments for a school orchestra. Within three months, the school was in successful operation. These facts are recorded in an article contributed by Mrs. Cook, chief of the special problems division of the Office of Education, Washington, to the October number of *School Life*. The same number contains a significant excerpt from an address by the Secretary of the Interior, the general drift of which is summed up in the following words: "Never was there a time when studies and experiments in the vocational training of our youth were more necessary than to-day. . . . We must not let the fetish of cultural education interfere with an up-to-date and effective training of our children."

Calendar of Geographical Exploration

March 14, 1864.—Lake Albert Nyanza

Sir S. W. Butler discovered Lake Albert Nyanza. He had set out in March 1861 upon his first tour of exploration in Central Africa " to discover the sources of the Nile, with the hope of meeting the East African expedition under captains Speke and Grant, somewhere about the Victoria Lake". He spent a year on the Sudan-Abyssinian border, and explored the Atbara and other tributaries of the Nile, proving that the Nile sediment came from Abyssinia. In 1863 he met Speke and Grant, who had discovered the sources of the Nile, but whose information suggested the possibility of the discovery of the above-mentioned lake. Though he was unable to explore its coasts fully, he examined its eastern shore and discovered the Murchison Falls.

March 15, 1846.—Huc's Travels

Évariste Régis Huc and Joseph Gabet were sent back from Lhasa by order of the Chinese Ambassador, under escort, by the rugged route to Szechwan, finally reaching Canton. Huc remained there three years and then returned to Europe. Europeans were, so far as possible, excluded from Tibet in the nineteenth century, though an English traveller, Thomas Manning, reached Lhasa in 1811–12, but left no useful records. The Abbé Huc set out for China in 1839, spent some time in the southern provinces and in Peking, and finally settled in the Valley of the Black Waters or He Shuy, just within the borders of Mongolia. There he studied the dialect and customs of the Tatars. In 1844, accompanied by J. Gabet and a converted Tibetan, all three disguised as lamas, they started for Tibet from Dolon Nor. They crossed the Hwang-ho and the terrible Ordos desert, reached Kansu, recrossed the flooded Hwang-ho, and in January 1845 arrived at Tang-kiul, where they stayed eight months studying the language. A large Tibetan embassy returning from Peking allowed them to join it and they penetrated to Lhasa via the Koko Nor desert and the snow-clad mountains. They stayed in Lhasa from January to March and opened a little chapel. Huc's " Souvenirs d'un voyage dans la Tartarie, le Thibet et la Chine" is one of the most delightful travel books ever written.

March 17, 1796.—Japan and Sakhalin

W. R. Broughton, in the *Providence*, reached Nootka Sound. He had accompanied Vancouver in 1791, but had been sent back with dispatches and had obtained a commission to complete the outline of the north Pacific coast on the Asiatic side. Finding that Vancouver had returned home, Broughton returned to the Sandwich Isles, which he left in August, and sighted Japan on Sept. 7. Before his return to England in 1799, Broughton surveyed the east coast of Yezo, touched at several of the Kuriles, sighted Fujiyama, examined parts of Nippon and Sakhalin, and crossed the channel which now bears his name. His voyage supplemented the work of La Pérouse, though like the latter he failed to traverse the narrowest part of the strait between Sakhalin and the main land and to reach the mouth of the Amur.

March 19, 1870.—Schweinfurth's Travels in Africa

G. Schweinfurth reached the Welle River, south of the Niam Niam country. He had started from Khartum in 1868, intending to explore the western tributaries of the Upper Nile and to record the botany of the region. He had also heard rumours of a great river that flowed to the west, south of the Niam Niam land, which was not connected with the Nile and upon the shores of which lived a race quite distinct from the usual type of negro. When he reached the river he found that the rumours were correct. He did not realise that it was an affluent of the Ubanga, but thought that it was the upper course of the Shari, or possibly that it joined the Benue. Schweinfurth had previously explored the coasts of the Red Sea and reached Khartum through Abyssinia (1863–66). His fine descriptions of the regions through which he passed and of the people dwelling in them have become classics for the study of this part of Africa. The relation of the Welle River to the Ubanga was demonstrated in 1885 through the work of Junker and Grenfell.

Societies and Academies

LONDON

Royal Society, March 3.—**J. C. McLennan, A. C. Burton, A. Pitt, and J. O. Wilhelm**: The phenomena of superconductivity with alternating currents of high-frequency. With currents of frequency $1{\cdot}1 \times 10^7$ per second a coil of lead wire showed an abrupt loss of resistance, of relatively large amount, at a temperature that appeared to be slightly lower than the critical temperature 7·2° K. characteristic of the transition to superconductivity, found for the same wire with direct current. With a coil of tin wire, drawn to a diameter of 0·3 mm., it was found that with direct currents the resistance of the coil began to decrease abruptly at 3·76° K. and disappeared completely at 3·70° K. Experiments with the same coil with currents of frequency $1{\cdot}1 \times 10^7$ per second gave for the corresponding temperatures 3·67° K. and 3·61° K. Further experiments with higher frequencies revealed depressions of the critical transition temperature increasing in amount with the frequency. Extrapolation of the transition temperature-frequency curve, which appeared to be linear for the higher frequencies, gave 10^9 per second for the frequency corresponding to 0° K. With tantalum wires results were obtained similar in character to those found with wires of tin and of lead. Polarisation and orientation phenomena are involved in the production of the superconducting state in metals. This electrical state appears, in part at least, to be somewhat analogous to the saturated magnetic state obtainable with ferromagnetic metals. (See also NATURE, **128**, p. 1004; 1931.)—**G. I. Taylor**: The transport of vorticity and heat through fluids in turbulent motion. The theory that the dynamics of turbulent motion should be regarded as an effect of diffusion of vorticity rather than as a diffusion of momentum was put forward by the author in 1916, and the particular case when the whole motion is limited to two dimensions was then discussed. The analysis is now extended to three-dimensional motion, and it is shown that the 'momentum transport' theory of Reynolds and Prandtl agrees with the 'vorticity transport' theory in one case only, namely, when the turbulent motion is of a two-dimensional type, being confined to the plane perpendicular to the mean motion. When the turbulent motion as well as the mean motion is confined to two dimensions, the vorticity transport theory yields results which are quite different from those predicted by the momentum transport theory. The distribution of temperature and velocity in the wake behind a heated obstacle for the case of two-dimensional motion, when the turbulent motion is confined to the plane of the mean motion, is in accord with the vorticity transport theory.—**A. Fage and H. C. H. Townend**: An examination of turbulent flow with an ultramicroscope.

Minute particles present in tap water were intensely illuminated and viewed against a dark background. These particles were small enough to show the Brownian movement when the fluid was at rest. The illuminated particles were used to follow the motion of the fluid, and enabled the maximum values u_1, v_1, and w_1 of the three components u, v, and w of the velocity disturbance at any point and the distribution of the mean velocity U across the pipe to be made without introducing any instruments into the fluid. At the centre of the pipe, u_1, v_1, and w_1 were approximately equal. As the wall was approached, v_1/U obtained from the velocity disturbance normal to the wall decreased to zero, whilst u_1/U and w_1/U increased. At the wall itself, whilst the flow tended to the laminar type, the motions of particles in the laminæ were sinuous, even to within a distance of 1/40,000 in. from the wall. No particle was seen to move in a rectilinear path.

Mineralogical Society, Jan. 19.—**L. J. Spencer**: A new pallasite from Alice Springs, Central Australia. A fragment weighing 1084 grm. was collected by Dr. Herbert Basedow in 1924 on the north side of the MacDonnell Ranges about ten miles north of Alice Springs, and has been generously presented by him to the British Museum collection of meteorites. It is a typical pallasite, consisting of 40 per cent of olivine (with FeO : MgO = 4·6) and 60 per cent of nickel-iron (Fe : Ni = 12·7) with a little troilite. Small angular fragments of olivine are embedded in the kamacite, suggesting that the olivine had been broken up before the kamacite crystallised out. The granular texture of the metal also suggests that the kamacite had been broken up with the development of Neumann lines before the separation of the taenite and plessite, and that the fragments had been partly re-dissolved in the residual melt, giving the reaction-rim of taenite. The plessite eutectic separated out in the small interspaces.—**Arthur Russell**: An account of British mineral collectors and dealers in the seventeenth, eighteenth, and nineteenth centuries (contd.). Short biographies dealing with Robert Were Fox (1789–1877), Wilson Lowry (1762–1824), and Thomas Hogg.—**M. H. Hey**: Studies on the zeolites (3). Natrolite and metanatrolite. Natrolite is shown by nine new analyses and new X-ray measurements to have a constant Si/Al-ratio and a unit-cell formula of $Na_{16}Al_{16}Si_{24}O_{80} \cdot 16H_2O$, in agreement with previous results. $Na_2 \rightarrow Ca$ replacement may occur up to about 4, and $Na \rightarrow K$ replacement up to about 2 atoms per unit-cell. Natural etch-figures in natrolite from Benallt, Carnarvonshire (a new locality for natrolite), show the symmetry to be didigonal polar (C_{2v}). A detailed study of the optical properties of natrolite has been made. Some observations have been made on the effects of partial dehydration on the optical properties. The vapour pressure has been studied at various temperatures and degrees of dehydration, and a discontinuity in physical properties at a water content of 15 mols. per unit-cell observed. Some experiments have been carried out on the base-exchange of natrolite. Optical and X-ray examinations of metanatrolite have been made.

Royal Meteorological Society, Feb. 17.—**W. H. Pick**: Visibility at sea. The open ocean in the eastern North Atlantic is a region of singularly good visibility, both in summer and in winter. The highest percentages of good visibilities occur with the air temperature less than the sea temperature; but the fact that high percentages of good visibilities are also obtained with air that is warmer than the sea beneath is noteworthy. With regard to wind force, the lowest percentages of good visibilities occur with the strongest winds. The large majority of fogs occur with air temperature either greater than or equal to the sea temperature, but there is an appreciable residue that occur when the air temperature is lower than the sea temperature.—**M. G. Bennett**: The visual range of lights at night and its relation to the visual range of ordinary objects by day. The visual range of a point source of light is given by the formula: (Intensity × Transmission)/(Distance)^2 = constant. Experiments are described from which an empirical formula connecting this constant and the brightness of the background is derived.—**S. E. Ashmore**: The occurrence of fog with unsaturated air at Grayshott, Hants. The relation of such fogs to accompanying meteorological factors, such as wind and cloud, has been analysed. The results appear in some degree to contradict the smoke theory of unsaturated fogs.

PARIS

Academy of Sciences, Jan. 25.—**Maurice Hamy**: The equation obtained by equating to zero the distance of two planets which do not meet at real points.—**Charles Nicolle** and **Charles Anderson**: The sensibility of the pig to African strains of *Spirochæta hispanicum*. The pig can contract recurrent fever from the African strains of spirochæte, but there is no appreciable symptom. No spirochætes can be detected microscopically in the blood, but this blood is virulent to sensitive animals.—**Emile Cotton**: Integrals dependent on variable parameters.—**C. Gutton** and **G. Beauvais**: The high frequency discharge. Experimental study of the relation between the distance of the electrodes and the effective potential difference at which the discharge ceases.—**Constant Lurquin**: The generating functions of Laplace.—**J. Favard**: A definition of length and of area.—**D. Pompeiu**: Functions of two real variables.—**R. Gosse**: The integration of a partial differential equation.—**Pasquier**: The equations $s = f(x, y, z, p, q)$ integrable by the method of Darboux.—**Vladimir Bernstein**: The analogy between the distribution of Julia's right lines of holomorph functions and that of the singular points of analytical functions.—**Nikola Obrechkoff**: A generalisation of the Mittag-Leffler summation.—**Thadée Banachiewicz**: The calculation of the hypotheses in the Gauss-Encke method of the determination of orbits.—**W. Swietoslawski, A. Zmaczynski**, and **J. Usakiewicz**: The boiling point of ethyl alcohol. Three specimens of ethyl alcohol, dehydrated by different methods, gave boiling points 78·320°, 78·318°, and 78·319° C., as measured with an electrical resistance thermometer. This is appreciably lower than the figure given by Darbaudy and Lalande (78·385°).—**G. A. Beauvais**: A point of potential stability of an isolated electrode of a triode valve.—**Jean Thibaud**: The production of positive ions of high velocity by multiple accelerations.—**Mlle. Y. Cauchois**: Luminous spectra by transmission of non-canalised X-rays through a curved mica sheet.—**Marcel Dufour**: The astigmatism of the oblique pencil refracted by the spherical diopter.—**J. P. Mathieu**: The rotation of naphthylene-bisiminocamphor and the theory of Werner Kuhn. Correction to an earlier communication. There is no disagreement between the figures calculated from the author's experiments and those deduced from W. Kuhn's theory.—**Roger Servant**: The rotatory dispersion in the ultra-violet of the α- and β-pinenes in solution in ethyl alcohol.—**Lucien Mallet**: Ionisation chambers of very small dimensions designed for the local measurement of the γ-radiation. The small size of the ionisation chamber described and illustrated, and its complete independence with respect to the measuring instrument, allows measurements of radiation received in a well-defined region.—**A. Michel-Levy** and **H. Muraour**: The influence of

diphenylamine, of aniline, and of certain of its derivatives on the double refraction of the nitrocelluloses.—**Gaston Charlot**: The catalytic oxidation of toluene. As an indication of the course of a catalytic reaction, a gaseous mixture of air and toluene, of known composition, is passed over the catalyst at varying temperatures, and the proportions of carbon dioxide and oxygen in the issuing gases determined by the ordinary methods of gas analysis.—**A. Perret** and **A. M. Krawczynski**: Some complex peroxides of hexamethylene-tetramine. A description of addition products to hexamethylene-tetramine with benzoyl peroxide and with acetyl-benzoyl peroxide.—**Marcel Godchot** and **Maurice Imbert**: Some syntheses of glycols with ether oxide function.—**M. Battegay** and **H. Silbermann**: The anthraquinonylguanidines.—**A. Marin** and **P. Fallot**: The transgressive *Flysch* on the Riffian Palæozoic.—**M. Mascré** and **H. Génot**: The influence of various manures on the development and alkaloid content of *Lobelia inflata*.—**E. Lobstein** and **J. Grumbach**: The study of an alkaloid extracted from the root of *Stemona tuberosa*, a Chinese-Annamese drug. The name 'stemonine' is given to a new alkaloid extracted by the Stas-Otto method from this root. Its composition is $C_{22}H_{33}NO_4$: its physical, chemical, and biological properties are described.—**E. Roubaud**: The phenomena of postnymphal larval histolysis and autotrophous imaginal nutrition in *Culex pipiens*.—**V. Pachon** and **R. Fabre**: The functional rôle of the stomach gas bubble.—**D. Auger** and **A. Fessard**: The isochronisms of the action potentials of the electric nerve of the torpedo and of its effector.—**Maurice Fontaine**: The relation in marine and river fish between the proportion of inorganic phosphorus in the serum and the ossification of the skeleton.—**Jean Régnier** and **Mlle. Alice Kaplan**: Contribution to the numerical study of microbial multiplication. The influence of the number of micro-organisms planted on the velocity of their multiplication.—**Marcandier** and **Robert Pirot**: The presence of a virus, similar to that of exanthematic typhus, in rats from warships at Toulon.—**Pierre Lépine**: The presence in the encephalus of rats caught at Athens of a virus assuming the experimental characters of exanthematic typhus (Mexican typhus).

LENINGRAD

Academy of Sciences—*Comptes rendus*, No. 9, 1931.—**V. Mitkevitch**: Practical magnetic units. In addition to the 'pro-maxwell', which is a unit of magnetic flux adopted by the International Electrotechnical Commission at its meeting in Stockholm in 1930, the author proposes the following units: 'pro-gilbert', for magnetomotive force; 'pro-hopkins', for magnetic resistance (the name given in honour of J. Hopkinson); 'pro-gauss', for magnetic induction; and 'pro-oersted', for magnetic power.—**N. Malkin**: A solution of the magnetometric problem in the case of a single surface of separation (the case of schistous deposits).—**N. Filipjev**: Lepidopterological notes (10). Specific independence of *Gracillaria betulicola* Hering. The species differs in the structure of the male genitalia from *G. elongella*, L.—**V. Kistiakovsky**: Methods of studying the problem of corrosion of metallic parts of oil tankers. Theoretical principles of the corrosion are discussed and a preliminary recommendation is made to cover the metallic parts with liquid glass, composed as follows: 1 gm. liquid sodium silicate, 2 gm. sodium chloride, and 100 gm. water.—**A. Martynov**: The suborder *Permanisoptera*, nom. n. (Odonata), and its systematic position. The name *Protanisoptera*, given by the author to the suborder including his family *Permæschnidæ*, proved to be preoccupied, and a new name is proposed instead.

Forthcoming Events

FRIDAY, MARCH 11

ROYAL ANTHROPOLOGICAL INSTITUTE (Sociological Research Committee), at 4.—Miss C. H. Wedgwood: Stages of Economic Development in Melanesia.

ROYAL SOCIETY OF ARTS, at 4.30.—Indian Meeting.

SOCIETY OF CHEMICAL INDUSTRY (Newcastle-upon-Tyne Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Annual General Meeting.

SATURDAY, MARCH 12

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford of Nelson: Discovery and Properties of the Electron (3).

MONDAY, MARCH 14

BIOCHEMICAL SOCIETY (at University College), at 3.—Annual General Meeting.

KING'S COLLEGE, LONDON, at 5.30.—Prof. Julian S. Huxley: Travels and Politics in Tropical East Africa (Lecture).

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section—London), at 6.45.—Dr. W. H. Hatfield: The Strength and Behaviour of Steels at High Temperatures (Annual Lecture).

INSTITUTE OF METALS (Scottish Local Section) (Annual General Meeting) (at 39 Elmbank Crescent, Glasgow), at 7.30.—J. Stirling: Condenser Tubes and their Packing.

ROYAL SOCIETY OF ARTS, at 8.—A. E. L. Chorlton: Oil Engine Traction (Howard Lectures) (2).

TUESDAY, MARCH 15

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. E. Lakin: The Borderlands of Medicine (Lumleian Lectures) (2).

INSTITUTE OF INDUSTRIAL ADMINISTRATION (at Institute of Hygiene, 28 Portland Place, W.1), at 6.30.—T. G. Rose: The Management Audit (Address).

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Albert Hall, Leeds), at 7.30.—Prof. J. K. Catterson-Smith: Everyday Uses of Electricity (Faraday Lecture).

INSTITUTE OF METALS (North-East Coast Local Section) (Annual General Meeting) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—R. D. Burn: Refining of Copper.

ROYAL SOCIETY OF MEDICINE (Pathology Section), at 8.30.—Annual General Meeting.

WEDNESDAY, MARCH 16

SCHOOL OF ORIENTAL STUDIES, at 5.15.—J. H. Driberg: African Systems of Education (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Liverpool Section) (Annual Meeting) (at Liverpool University), at 6.—Dr. H. A. Harrison: The Evaluation of Wood Pulp for Strength.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Dr. B. A. Keen: Soil Physics in Relation to Meteorology (G. J. Symons Memorial Lecture).

ROYAL SOCIETY OF ARTS, at 8.—Dr. E. F. Armstrong: Hydrogen and its Uses (Lecture).

THURSDAY, MARCH 17

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. C. E. Lakin: The Borderlands of Medicine (Lumleian Lectures) (3).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. B. S. Haldane: Heredity in Man (5).

FRIDAY, MARCH 18

GLASGOW CHEMICAL SOCIETY (Annual General Meeting) (at Glasgow University), at 4.—Prof. G. G. Henderson: Publication of Chemical Literature (Presidential Address).

PHYSICAL SOCIETY (at Imperial College of Science and Technology), at 5.—Annual General Meeting, followed by an ordinary meeting.

UNIVERSITY COLLEGE, at 5.30.—Prof. A. J. Toynbee: The Turks (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Thomas' Café, Swansea), at 7.30.—Annual Meeting.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Lord Rutherford of Nelson: Recent Researches on the Gamma Rays.

SATURDAY, MARCH 19

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College for Women), at 3.—F. C. Boon: Teaching the Method of Ratio (Lecture).

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford of Nelson: Discovery and Properties of the Electron (4).

Congresses

MARCH 14 AND 15

GERMAN SOCIETY FOR THE INVESTIGATION OF THE CIRCULATION (at Tübingen).

Prof. O. Müller: The Blood Pressure Disease in Swabia.

Prof. von Skramlik: The Blood Pressure in Animals.

Dr. M. Nordmann: The General Pathology of the Peripheral Circulation.

Prof. E. Gabbe: The Circulation and Utilisation of the Blood in the Periphery.

MARCH 15 TO 18

INTERNATIONAL SOCIETY OF SURGERY (at Madrid).—Subjects for Discussion: Non-tuberculous Pulmonary Suppuration; The Diagnosis and Treatment of Intraspinal Tumours; The Surgery of the Œsophagus; and Recent Progress in Surgical Anæsthesia.

MARCH 16 TO 18

INSTITUTION OF NAVAL ARCHITECTS (at Royal Society of Arts), at 10.30 A.M.—Reading and Discussion of Papers.

Official Publications Received

BRITISH

The Kent Incorporated Society for Promoting Experiments in Horticulture. Annual Report (Eighteenth Year) 1930. 1: General. East Malling Research Station, Kent, 1st January 1930 to 31st December 1930. (A. 13.) Pp. 162. 3*s*. 6*d*. Annual Report (Sixteenth, Seventeenth and Eighteenth Years) 1928, 1929 and 1930. 2: Supplement. East Malling Research Station. (A. 14.) Pp. 221+19 plates. 6*s*. (East Malling.)

Proceedings of the Royal Society of Edinburgh, Session 1931–1932. Vol. 52, Part 2, No. 2: The Employment of Intracardiac Injection of Adrenaline in Asphyxia. By Sir E. Sharpey-Schafer and William A. Bain. Pp. 139-151+6 plates. 4*s*. Vol. 52, Part 2, No. 3: The Absorption Spectra of Cyanogen and the Cyanogen Halides. By Dr. R. B. Mooney and H. G. Reid. Pp. 152-158. 6*d*. (Edinburgh: Robert Grant and Son; London: Williams and Norgate, Ltd.)

Empire Cotton Growing Corporation. Reports received from Experiment Stations, 1930–1931. Pp. xi+242. (London.) 2*s*. 6*d*.

The Institution of Mechanical Engineers. Annual Report of the Council for the Year 1931. Pp. 44. (London.)

University of London: University College. Report of the University College Committee (February 1931–February 1932), with Financial Statements (for the Session 1930–31), and other Documents, for Presentation to the Court and the Senate. Pp. ii+164. (London: Taylor and Francis.)

The Controversy between Determinism and Vitalism in Biology: the Third Lister Lecture delivered to the Quaker Medical Society, November 5th, 1931. By Prof. A. J. Clark. Pp. 22. (Leominster: The Orphans' Printing Press, Ltd.)

The Linen Industry Research Association. Report of the Council, 1931. Pp. 23. (Lambeg, Belfast.)

Association of Technical Institutions. Paper read at the Annual General Meeting, February 26th and 27th, 1932, on Technical Education and the Bakery Trade. By W. H. Quinn. Pp. 22. 6*d*. Paper read at the Annual General Meeting, February 26th and 27th, 1932, on The Teaching of Modern Languages in Technical Colleges. By P. G. Wilson. Pp. 18. 6*d*. Paper read at the Annual General Meeting, February 26th and 27th, 1932, on Technical Education in Canada. By Prof. Robert W. Angus. Pp. 7. 6*d*. Agenda Paper and Report of Council (1931) for the Annual General Meeting to be held on Friday, February 26th, and Saturday, February 27th, 1932, at the Leathersellers' Hall, St. Helen's Place, London, E.C. Pp. 34. (Loughborough: Hon. Secretary, Association of Technical Institutions, Loughborough College.)

Association of Technical Institutions and Association of Principals of Technical Institutions. Report on Policy in Technical Education, by a Joint Committee. Pp. 44. (Loughborough: Hon. Secretary, Association of Technical Institutions, Loughborough College.)

Chemistry and the Community. By Sir Frank E. Smith. (The Third S. M. Gluckstein Memorial Lecture, 1931.) Pp. 22. (London: Institute of Chemistry of Great Britain and Ireland.)

Asiatic Society of Bengal. Annual Report for 1931. Pp. 36. Presidential Address, 1932. By U. N. Brahmachari. Pp. 34. (Calcutta.)

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 55: The Basal (Standard) Metabolism of the Australian Merino Sheep. By E. W. Lines, with the assistance of A. W. Prince. Pp. 34. Pamphlet No. 23: Refrigeration applied to the Preservation and Transport of Australian Foodstuffs; a Survey and a Scheme for Research. By Dr. J. R. Vickery. Pp. 40. (Melbourne: H. J. Green.)

Transactions of the Mining and Geological Institute of India. Vol. 26, Part 2, October. Pp. 69-168+6 plates. 4 rupees. Vol. 26, Part 3, November. Pp. 169-275+plates 7-26. 4 rupees. (Calcutta.)

The Indian Forest Records. Silviculture Series, Vol. 16, Part 7: Notes on *Pinus longifolia* Roxb.—The Plantations in Dehra Dun and the Central Provinces and Miscellaneous Seed Studies. By H. G. Champion and B. D. Pant. Pp. v+25+9 plates. (Calcutta: Government of India Central Publication Branch.) 1.10 rupees; 2*s*. 9*d*.

Royal Botanic Gardens, Kew. Bulletin of Miscellaneous Information, 1931. Pp. iv+512+105+15 plates. (London: H.M. Stationery Office.) 15*s*. net.

University of Leeds. Publications and Abstracts of Theses by Members of the University during Session 1930–31. Pp. 28. Twenty-seventh Report, 1930–31. Pp. 169. (Leeds.)

FOREIGN

Columbia University Bulletin of Information. Thirty-second Series, No. 18: Announcement of Professional Courses in Optometry for the Winter and Spring Sessions, 1932–1933. Pp. 31+3 plates. (New York City.)

Conseil Permanent International pour l'Exploration de la Mer. Rapports et procés-verbaux des réunions, Vol. 77: Rapport atlantique 1930 (Travaux de Comité du Plateau Continental Atlantique) (Atlantic Slope Committee). Publié avec l'aide de Dr. Ed. Le Danois et Rafaël De Buen. Pp. 88. (Copenhague: Andr. Fred. Høst et fils.) 3.50 kr.

Académie des Sciences de l'Institut de France. Les membres et les correspondants de l'Académie Royale des Sciences, 1666–1793. Pp. xvi+265. (Paris.)

Department of Agriculture, Straits Settlements and Federated Malay States. Scientific Series, No. 8: The Control and Economic Importance of the Greater Coconut Spike Moth (*Tirathaba rufivena* Walk.). By G. H. Corbett. Pp. 14. (Kuala Lumpur). 50 cents.

Merentutkimuslaitoksen Julkaisu Havsforskningsinstitutets Skrift. No. 73: Strom- und Windbeobachtungen an den Feuerschiffen in den Jahren 1928 und 1929. Von E. Palmén. Pp. 58. 20 F.mk. No. 74: Vedenkorkeusarvoja 1928 (Vattenståndsuppgifter 1928). Av S. E. Stenij. Referat: Wasserstandsangaben 1928. Pp. 51. 20 F.mk. No. 75: Regelmässige Beobachtungen von Temperatur und Salzgehalt des Meeres, Juli 1929-Juni 1930. Herausgegeben von Gunnar Granquist. Pp. 47. 25 F.mk. No. 76: Water Level Records from Finland previous to 1913. By Henrik Renquist. Pp. 176. 60 F.mk. No. 77: Havsforskningsinstitutets värksamhet år 1930. Redogörelse avgiven av Rolf Witting. Pp. 14. 10 F.mk. No. 78: Croisière thalassologique et observations en bateaux routiers en 1930. Rédigé par Risto Jurva. Pp. 48. 20 F.mk. No. 79: Översikt av isarna vintern 1930-31. Av Gunnar Granquist. Referat: Übersicht der Eisverhältnisse im Winter 1930-31 an den Küsten Finnlands. Pp. 54. 25 F.mk. (Helsinki.)

Societas Scientiarum Fennica. Commentationes Physico-Mathematicae, V, 12: Untersuchungen über die Strömungen in den Finnland umgebenden Meeren. Von E. Palmén. Pp. 94. (Helsingfors: Akademische Buchhandlung.)

State of Connecticut: State Geological and Natural History Survey. Bulletin No. 51: The Minerals of Connecticut. By Dr. John Frank Schairer. (Public Document No. 47.) Pp. 121. (Hartford, Conn.: State Library.) 75 cents.

Smithsonian Miscellaneous Collections. Vol. 85, No. 11: Supplementary Notes on Body Radiation. By L. B. Aldrich. (Publication 3131.) Pp. 12. Vol. 87, No. 1: The Botanical Collections of William Lobb in Colombia. By Ellsworth P. Killip. (Publication 3133.) Pp. 13. Vol. 87, No. 4: The Periodometer, an Instrument for Finding and Evaluating Periodicities in Long Series of Observations. By C. G. Abbot. (Publication 3138.) Pp. 6+1 plate. (Washington, D.C.: Smithsonian Institution.)

The University of the State of New York: The State Education Department. Tentative Syllabus in General Biology. Pp. 62. (Albany, N.Y.: University of the State of New York Press.)

Mémoires de la Société de Physique et d'Histoire Naturelle de Genève. Vol. 44, Fasc. 1: Les Sporozoaires (Cycles chromosomiques et sexualité). Par André Naville. Pp. 224. (Genève: Georg et Cie.) 15 frs.

Journal of the Imperial Agricultural Experiment Station, Nishigahara, Tokyo. Vol. 1, No. 4, March 1931. Pp. 263-422+plates 27-35. (Tokyo.)

Japanese Journal of Mathematics. Transactions and Abstracts, Vol. 8, No. 3, December. Pp. 113-236. (Tokyo: National Research Council of Japan.)

Instituts scientifiques de Buitenzorg: "'s Lands Plantentuin". Treubia: recueil de travaux zoologiques, hydrobiologiques et océanographiques. Vol. 13, livraison 3-4, décembre. Pp. 293-482. (Buitenzorg: Archipel Drukkerij.) 5.00 f.

Proceedings of the American Philosophical Society. Vol. 70, No. 5. Pp. xviii+399-410. (Philadelphia.)

Proceedings of the United States National Museum. Vol. 80, Art. 5: Echinoderms from the Islands of Niuafoou and Nukualofa, Tonga Archipelago, with the Description of a New Genus and two New Species. By Austin H. Clark. (No. 2905.) Pp. 12+8 plates. (Washington, D.C.: Government Printing Office.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Fourth Series (Biology), Vol. 6, No. 4, December. Pp. 573-809+plates 19-21. (Tokyo and Sendai: Maruzen Co., Ltd.)

CATALOGUES

Books on various Subjects in new Condition at much reduced Prices. (No. 463.) Pp. 24. (Cambridge: Bowes and Bowes.)

Verzeichnis der Werke und Zeitschriften der Akademischen Verlagsgesellschaft m.b.H., Leipzig. Pp. 87. (Leipzig: Akademische Verlagsgesellschaft m.b.H.)