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The National Museums at South Kensington.

WE dealt last week with the position of the Natural History Museum at South Kensington in relation to the Trustees of the British Museum at Bloomsbury, of which it is a branch. There are eventually to be three museums at South Kensington, and it seems to be desirable that these should be under a single authority interested in the advancement of natural knowledge and its utilisation for the good of the nation. The Interim Report of the Royal Commission on National Museums and Galleries leaves open the whole question of the governance of the national collections, both of museums and of public galleries. The internal control of such institutions and their staffs by directors is clearly a desirable arrangement, but their interrelationships, policy, and development are as certainly matters of public concern. The director is responsible to a Minister, where national funds are concerned, but there is usually some body between, either in a governing or in an advisory capacity. The collections include countless gifts and bequests to the nation, and the nation is the trustee for these. Each gift entails annual expenditure, be it book, picture, machine, or animal, and staffs have to be maintained to care for them, and to see that they are available for the study of experts and for the education and intellectual amusements of the public. Catalogues have to be printed, and special exhibitions arranged, and these do not usually pay for themselves. In addition, certain institutions are so clearly connected with industry and commerce, on which the country and empire so closely live, that annual expenditure is requisite for additions and for the study of these.

The Museum of Practical Geology is the central institution concerned with the mineral wealth of Great Britain and with the nature of the land on which we live and build, and off which we have to obtain our water. By its staff it conducts the Geological Survey in the field, and its Museum is open to the public for reference and advice. The practical application of science to engineering, mining, manufacturing of every sort, and to building construction is the charge of the Science Museum, and its exhibits are judiciously designed to help these. The British Museum of Natural History is, on one hand, of great intellectual value, while on the other, it deals with raw animal products both for food and industry. It is a central reference station for economic biologists and is deeply concerned with the insect and other animal pests which

attack plants and animals. It also has its plant department, while the practical institution for plant products is furnished by the Royal Botanic Gardens at Kew.

These institutions have one characteristic in common, namely, that they are connected with one class of mankind whose sole aim is the increase of natural knowledge, and with a second larger class whose business it is to apply that knowledge to the development of the world. In a word, they are scientific, and their directorates and staff belong to a group of men who are accustomed to act together in mixed societies, in particular in the Royal Society, and in universities. The secret of their successful co-operation lies in their common basic training in respect to natural phenomena, this resulting in a peculiarly impersonal mode of examining any problem presented to them. Year by year they become less separable, since most natural phenomena entail knowledge of two or more 'sciences,' and research year by year is shifting to border lines. The relation of these Museums to one another and to the State deserves careful consideration, for it is obvious that they must continue to grow and progress *pari passu* with the evolution of the country and of the Empire. They can no longer be considered as apart from national prosperity, for they are factors directed to assuring that prosperity, and the cost of their upkeep is a trifling premium. Ideally, they must be in contact with the highest minds in their sciences and with the most interested industrialists.

The position of these four foundations is that they report to and are under the financial control of four different Departments of State. The Royal Botanic Gardens, Kew, are included in the parliamentary vote of the Ministry of Agriculture and Fisheries, and there is no 'governing body' other than the Minister. They are not to be regarded as primarily connected with British agriculture and horticulture, for which other institutions specialise, but with the increase of the basal practical knowledge of plant growth. Their staff is largely concerned with economic interests and research that are imperial in character. Indeed, Kew is a central bureau in all such matters for all the dominions. The herbarium is largely built up of the type collections of colonies and is essential for reference in such work. Distinguished and wise directors have succeeded each other for so long that the director is as nearly independent as any Government servant can be. As plant products have to be grown with an understood relationship to their method of treatment or manufacture—the business of the Science Museum—there is a slight overlapping, but this is not altogether a disadvantage. We think, therefore, that Kew may be left independent of the scheme we have in mind for the Natural History, Science, and Geological Museums.

These three museums are to be topographically connected with each other in the same block at South Kensington, since the Geological Museum is to be removed to a site there in close communication with the other two. At present it is under the Department of Scientific and Industrial Research, which also has control of the National Physical Laboratory, as well as of numerous research boards connected with industry. A committee of the Privy Council, representing many State Departments and all political parties, constitutes this Department under the Lord President, and it is assisted by an Advisory Council, the members of which clearly are principally concerned with its activities in fields other than geology. The detailed supervision of the work is in the hands of a competent committee of the Department. The specimens displayed in this Museum are similar to those shown in the Natural History Museum, but they are arranged differently, as indeed is essential. The palæontological workers are experts of the same order, and clearly the freest possible interchange and the closest relationship between these Museums is likely to be to the advantage of both. The mineralogical collection of the Natural History Museum might be developed to illustrate more clearly the study of rocks, while it is surely the function of the Science Museum to elucidate physical geology.

The Science Museum was a most interesting experiment, which after a chequered existence for half a century, seems to be likely to have a brilliant future in respect both to pure science and to industry. It has a close connexion with the products of art, but clearly its fundamental relationship is in respect to the utilisation of the raw products, with which its neighbours are concerned. The Royal Commission is clearly in agreement, since it has suggested a grant for a conference hall for discussions between industry and science, while it is pointed out that a common lecture theatre is an important need. Here the Museum is under the Minister of Education, whose main interest obviously must be elsewhere and whose appointment must have been largely political. There is an Advisory Council of technical and scientific men, it is true, but the members of such *purely advisory* bodies can scarcely be expected to display

that personal responsibility, the sense of which to a large degree ensures impartiality.

The present seems the favourable moment for the consideration of these national museums as an organic whole. We have in being a Royal Commission, the Interim Report of which shows a rare appreciation of the educational and industrial scope of these institutions, together with a fearless handling of the financial problems related to the guardianship of the public purse. We believe that that essential to all governance, cheerful consent of the governed, would be found to exist were the Commission to propose a scheme which would bring the three scientific museums at South Kensington under one system of control. Thus most easily can uniformity in rate of pay and in promotion in relationship to other scientific posts in the country be obtained. The extraordinarily rapid changes in both science and industry necessitate the governance by experts from all sides in the closest relationship to one another, and they must be led to feel their personal responsibility. Such a result can scarcely be brought about by handing these museums to an overworked Government department, controlled necessarily by experts in one direction. The whole country, not one city, pays for these institutions, and their policy and development must be in the direction of national and imperial interests, the concern of many departments.

Our system demands a relationship to one Minister, and, failing the direct interest of the Prime Minister, which it is too much to expect, the connexion is perhaps closest with the Lord President of the Council, who is selected for his wisdom in affairs and for his wide sympathy with every phase of national development. Under this Minister there would have to be the governing body, with access to him, and with full power to report to him, and in practice to settle the policies of the museums so far as funds allow. It would act through committees for each institution, with perhaps a single annual meeting of the whole body. Only advantage can result from the freest discussion of policy between experts in science and industry—and unquestionably the greater and more practical men of science, as the directors of these museums must be, are happy in the discussion and justification of their views and desires for the advancement of knowledge. The success of such an authority depends on the intelligence and disinterestedness of its members, qualities well displayed by the Royal Commission, which can examine many precedents and will, we trust, make specific recommendations.

Greenland under Danish Rule.

Greenland. Published by the Commission for the Direction of the Geological and Geographical Investigations in Greenland. Editors: Prof. M. Vahl, Vice-Admiral G. C. Amdrup, Dr. L. Bobé, Prof. Ad. S. Jensen. Vol. 1: *The Discovery of Greenland, Exploration and Nature of the Country.* Pp. vii + 575. (London: Oxford University Press; Copenhagen: C. A. Reitzel, 1928.) 40*s.* net. 3 vols., 100*s.* net.

HANS EGEDE landed in Greenland in 1721: for three centuries the Norse colonies had been 'lost'; and Egede's landing was therefore the beginning of a new era of Scandinavian overlordship. The missionary himself wrote a description of the country and its native inhabitants, published in Danish in 1741, and translated into English four years later. There have been other general accounts, but the latest and perhaps the best known is Dr. Rink's "Danish Greenland," which appeared in 1877. Early in the following year the Danish Government authorised the formation of a Commission for the Direction of the Geological and Geographical Investigations in Greenland: publications under the title "Meddelelser om Grönland" began in 1879, and there are now no less than seventy volumes of this well-known series. In more recent years, therefore, the position has been that those wishing to obtain first-hand and up-to-date information could only do so by searching through the seventy volumes of the "Meddelelser." The work under review is definitely meant to remove this difficulty. Essentially it is a summary and co-ordination of the fifty years' research contained in the "Meddelelser." It is hoped to complete it in three volumes in 1929: the present deals with the discovery, exploration, and general nature of the country; the second with the past and present population; and the third with the colonisation and history.

Primarily the book is intended for officials and travellers in the country itself. As a work of reference it will be quite indispensable. Apart from this it is exceedingly well written, and abundantly illustrated with photographs and maps; few countries are so fortunate; it is not too much to say that this is a book to be recommended not only to those closely interested in Greenland, but also to those with slighter interests but appreciation of geographical literature well written and well produced. Its nature is general rather than detailed. In this connexion it should be noted that minute details, district by district, were published

in 1921 in Danish, under the title "Grönland i Tohundredaaret for Hans Egedes Landing," two volumes and atlas. The completion first of the Danish work and now of its English complement will thus round off the intention of the Danish Administration, which, by undertaking these two publications, desired to mark in the most suitable way the bicentenary of Danish rule.

The compilers of the present volume are for the most part well-known geographers, geologists, and biologists. To each has been assigned a particular division, either a physiographical account of one of the coasts, or articles on the flora, on the geology, and so on. To some of the latter articles the position of Greenland, as a bridge between Europe and America, gives important significance. For example, Prof. Ostenfeld traces the origin of the different flowering plants, and finds that about one-fifth are European, whilst the remainder (316 species) must be supposed to be of American origin, or for the smaller part to have survived the maximum of the Glacial Period in Greenland. He strongly favours the survival of the hardiest species throughout the maximum glaciation, and as evidence points to the present condition on certain of the nunataks.

In recent years the interest of geologists has been directed to the need of fuller knowledge of the stratigraphy and tectonics of Greenland, and this to English readers will give more than usual interest to the articles by Prof. Böggild on the geology of the country as a whole and by Dr. Lauge Koch on the physiography of the northern part. In Dr. Koch's article will be found an account of the Caledonian folds of the extreme north-west; from North Greenland these folds are marked as passing into Ellesmere Land, and their ultimate fate is therefore a problem for Canadian geologists. The folding is regarded as the continuation of our own Caledonian chain via Norway and Spitsbergen, a conclusion which most will accept, though it should be noted that, while the North Greenland folds are well authenticated by fossil evidence, such can scarcely be claimed as fully proved as yet in the Spitsbergen (Hecla Hook) portion of the chain. The further problem of the relationship of Koch's Caledonian Chain with the great thickness of disturbed Lower Palæozic rocks in East Greenland, which according to Prof. Böggild run for nearly 300 miles from Queen Louise's Land to Davy Sound, has yet to be settled. Here also there would appear to be Caledonian folds, and so disposed that their relationship to the Scottish North-west Highlands may be of considerable importance to the geological history of Britain.

It would perhaps be invidious to select special articles without stressing the exceptional value of the book as a whole: one is tempted, however, to refer to Dr. Birket-Smith's most able and interesting account of West Greenland physiography. The article may be cited as typical of the extreme care and judgment shown by all the contributors; rash conclusions and theories are almost entirely absent, and the body of the work is essentially a collection and marshalling into proper order of the data of scientific observation. By itself alone this first volume is evidence of the foresight and wisdom of the Danish Administration in Greenland, and, when complete, the work should constitute a most impressive proof of the disinterestedness of Danish rule during the last two hundred years.

J. M. WORDIE.

Cohesion, Viscosity, and Lubrication.

(1) *Cohesion and related Problems: a General Discussion held by the Faraday Society, November 1927.* Pp. 49-180 + 5 plates. (London: The Faraday Society, 1928.) 10*s.* 6*d.* net.

(2) *Studies in Molecular Force.* By Dr. Herbert Chatley. (Griffin's Scientific Text-Books.) Pp. xi + 118. (London: Charles Griffin and Co., Ltd., 1928.) 7*s.* 6*d.* net.

(3) *The Viscosity of Liquids.* By Emil Hatschek. (International Text-Books of Exact Science.) Pp. xii + 239. (London: G. Bell and Sons, Ltd., 1928.) 15*s.* net.

(4) *The Theory of Film Lubrication.* By R. O. Boswall. Pp. xi + 280. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1928.) 12*s.* 6*d.* net.

NO property of matter is more obvious, or of more continual importance, than cohesional force. These four volumes deal with many aspects of its study, and of the practical application of our knowledge.

(1) The Faraday Society "Discussion" presents fifteen papers, about half of which deal wholly or partially with the question of why matter in bulk breaks under a stress many times less than would be expected, from what is known about the force of attraction between molecules. There is general agreement that one of the causes of this weakness is the ease with which crystal planes can slip along adjacent planes, so that crystalline substances slide apart instead of resisting a direct pull up to the limit of strength of the molecular adhesions.

Whether surface cracks seriously diminish the strength is a question which receives much attention, but although at first sight there seems to be some evidence in favour of this view, it does not seem certain that the effects sometimes attributed to these cracks are not due to slip planes. The plasticity of wet crystals of rocksalt remains an intriguing mystery; two papers on fatigue and hysteresis in metals leave one with a sense of the importance of incipient cracks and localities of slip, as well as of the great complication of the problem.

Lennard-Jones and Miss Dent contribute another valuable paper on the macroscopic properties of crystals with a completely ionised lattice, calculating these from the electrostatic forces between the ions: this type of work will surely become of increasing importance. At present not much can be done except with the fully ionised lattices, where the interatomic forces are the simplest possible, but two short papers (Taylor, Rawlins) foreshadow avenues of future investigation. These papers represent the limit to which we can now go in deducing the properties of matter in bulk from those of individual atoms. Richards gives an abstract of his work on internal pressures, a conception which has the advantage of dealing just as readily with the effects of molecular motion as with the forces between molecules, but the disadvantage of being in all points decidedly remote from molecular theory.

Other papers include a qualitative deduction of the relative strengths of the adhesions round organic molecules, from observations on surface films (Adam); observations on soldered surfaces (Crow), and on a change in dielectric constant on solidification (Errera). The discussion is not, of course, a comprehensive treatise, but deserves close attention, especially by metallurgists and engineers.

(2) Dr. Chatley's little volume contains notes on a variety of subjects, ranging from the internal structure of the atom to surface tension, viscosity, lubrication, etc. It is scarcely thorough or accurate enough for the serious student, and seems unlikely to attract the general reader, on account of the amount of calculation introduced into the text.

(3) Mr. Hatschek deserves very hearty thanks for his excellent and readable survey of viscosity in liquids. The book is a model of what a monograph should be: the historical, mathematical, and experimental portions are thorough; a great mass of experimental results is admirably marshalled so as to show the bearings on other subjects; technical 'viscometers' have their failings succinctly described, and a comparison of their performance with that of instruments really measuring viscosity is given as far as possible. If all writers of scientific books did their work so conscientiously as Mr. Hatschek has here, students of all classes would have a much easier task than now faces them.

(4) Mr. Boswall's treatise deals with the complete, thick film of lubricant used, wherever possible, to separate the moving parts of machinery. It contains a full mathematical treatment of the hydrodynamics of films of lubricant, with very detailed applications to many types of bearings, including journal bearings and the new thrust bearings with tilting sectors: the effects of the motions of the metal parts are fully considered. The chemical properties of lubricants, although important in determining the adhesion of the oil films to the metal surfaces, and hence in making it easy or difficult to maintain a complete film, receive scarcely any attention, but are evidently considered outside the author's province. The book should be very useful to engineers with good mathematical equipment, engaged on the design of bearings. N. K. ADAM.

Non-Euclidean Geometry.

(1) *Vorlesungen über nicht-euklidische Geometrie.* Von Felix Klein. Für den Druck neu bearbeitet von W. Rosemann. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen mit besonderer Berücksichtigung der Anwendungsgebiete, herausgegeben von R. Courant, Band 26.) Pp. xii + 326. (Berlin: Julius Springer, 1928.) 18 gold marks.

(2) *Leçons sur la géométrie des espaces de Riemann.* Par Prof. E. Cartan. (Cahiers scientifiques, publiés sous la direction de Gaston Julia, Fascicule 2.) Pp. vi + 273. (Paris: Gauthier-Villars et Cie, 1928.) 60 francs.

THE two books under notice together constitute an excellent introduction to non-Euclidean geometry in all its aspects. The lectures of F. Klein now appear in print for the first time under the editorship of W. Rosemann, though a lithographed edition was published so long as thirty-six years ago. The present edition has been considerably changed as the result of prolonged consultation between the present editor and the distinguished author shortly before the death of the latter.

In its present guise, Klein's book is divided into three parts, the first of which constitutes an excellent introduction to projective geometry in three chapters. The first two of these, on fundamental notions of projective geometry and on forms of the second degree, are new; the third, on collineations or projective transformations, was already included in the lithographed edition. The second part deals with projective metric in six chapters, the last three being concerned more particularly with non-Euclidean geometry. These two parts together constitute four-fifths of the book, but there is a short third part in which the relations between non-Euclidean geometry and other branches of mathematics are considered very briefly, with references to Riemannian spaces and to the restricted theory of relativity. The general treatment is elementary, mainly algebraical, with scarcely any reference to differential geometry, and is admirably clear and profusely illustrated by diagrams, designed to assist the appeal to intuition.

(2) The second book, by E. Cartan, the author of a well-known book on integral invariants, is based on lectures delivered during 1925–26 at the University of Paris. It deals with the geometry of Riemannian spaces almost entirely by the methods of tensor analysis and of differential geometry, and in this respect forms a welcome complement to Klein's more elementary book. The treatment is based on the methods of Riemann and Christoffel, though the more recent work of Levi-Cività and others is fully considered.

The first five chapters are to a certain extent introductory, dealing with such topics as vector and tensor analysis, curvilinear co-ordinates in Euclidean geometry, Riemann spaces which are locally Euclidean, Euclidean spaces tangent to and osculating Riemann spaces and geodesic curves and surfaces. The results obtained are applied in the sixth chapter to non-Euclidean spaces. The seventh and eighth chapters deal with Riemannian and vectorial curvature, and the last is on normal co-ordinates and their applications.

This book is much more analytical than Klein's, but, considering the difficult nature of the subject matter, it is very clearly written and commendably free from misprints. The two books in their several aspects can be highly recommended to those who wish to become acquainted with recent developments in general geometry and to fit themselves for an intelligent comprehension of the geometrical basis of the general theory of relativity.

Biology for All.

The Science of Life. By H. G. Wells, Julian Huxley and G. P. Wells. To be completed in about 30 fortnightly Parts. Part 1. Pp. 32. (London: The Amalgamated Press, Ltd., 1929.) 1*s.* 3*d.* each Part.

A NEW educational venture of great attractiveness is "The Science of Life," an exposition of biology, by Mr. H. G. Wells, Prof. Julian Huxley, and Mr. G. P. Wells, a young physiologist, son of the senior author. The work aims at doing for biological science what Mr. H. G. Wells did for history in his famous "Outline," giving to the unlearned a vivid presentation of the essential data. It is to try to be "clear, complete, and correct"; and if the triumvirate cannot do this, who can? There is wisdom in having three authors (tres faciunt collegium); for there is always the possibility of a majority when opinions differ.

We cannot read Part 1 of this serial without envying those who are coming to biology in these days; for the presentation is so picturesque and gripping. Academic formalities have been thrown off without jettisoning accuracy, and everything is discussed in its bearing on everyday life. The increased availability of science promises well for the future, for it is one of the most hopeful lines of human progress that we should become more and more able to utilise our heritage of well-established knowledge.

If we were asked what every young student should know when beginning his voyage of life after schooldays, we should answer—(1) the most significant steps in the history of the human race; (2) how to find his way about in the world of Nature; and (3) the laws of health and happiness. We are not thinking at present of brain-stretching disciplines like mathematics, or of character-forming influences like poesy, but of sheer knowledge. We can see that this "Science of Life" is going to help powerfully towards an understanding of animate Nature on one hand, and towards an understanding of the conditions of health and happiness on the other. We wish it the success it deserves.

The present part begins with the nature of life, a difficult problem to start with. But it is treated very concretely and with an interesting historical background. In any event the reader feels that if this is biology, he wishes some more. Then the story turns to the everyday life of the body—in mouse and in man; and when this can be made vividly interesting, as here, we cannot have too much of it. It is tragic to think of the vast

number of young people who leave school without any understanding of their bodily functions. Such ignorance may have been bliss, though we doubt it, long ago, when all the ways of living were more natural, but to-day it often means disaster. We do not wish to suggest that the new book is particularly designed for young people—though they will welcome it—for it appeals to all who wish more science for more life. In spite of all the expositors, it has to be confessed that a large proportion of the population remain in the Dark Ages as regards the working of their bodies.

There are very effective and interesting illustrations, and the frontispiece shows a crowd of skeletons receding into the distance before the light of microscopy and biochemistry. This we take to mean that necrology will be recessive and biology dominant throughout this book. We trust that this will be so, but it has been our sad experience that the skeleton shows great persistence in its efforts to sneak back to the feast. But all success to the triumvirate!

Our Bookshelf.

British Chemicals, their Manufacturers and Uses: being the Official Directory of the Association of British Chemical Manufacturers (Incorporated); containing a Full List of Members, with a Classified List of British Chemicals and a Note of their Applications. Pp. 330. (London: Ernest Benn, Ltd., 1929.) 10*s.* 6*d.* net.

SALESMANSHIP, so far as it is regarded as a scientific art—one had almost been betrayed into writing 'artful science'—has of late been the subject of some discussion and doubtless of some new resolves. To judge by the general agreement with which certain observations recently made by H.R.H. the Prince of Wales have been received, salesmanship in the modern sense of the term is not one of the strong points of British commercial organisation, at least so far as markets overseas are concerned. All the more credit and publicity should be given to the foresight of those manufacturers who have gone some way towards anticipating at least one criticism—that deploring the lack of adequate presentation to possible purchasers of information in their own languages. Replacing the 1927 issue, a new edition of "British Chemicals, their Manufacturers and Uses," the official directory of the Association of British Chemical Manufacturers, Incorporated, has now been published. The new volume, fully revised, is modelled on the lines of the last edition, and it is intended to bring the book up-to-date every second year. The Association is not itself a trading concern, but exists to promote and facilitate business relations between manufacturing and chemical firms and purchasers all over the world, and to encourage legitimate international trade conditions.

The directory—a sturdily bound volume—is printed (in part sectionally, in part collaterally) in English, French, Spanish, Italian, Portuguese, and German; even the title-page and introductory information appear in sextuplicate. A directory of members of the "A.B.C.M." and of affiliated associations is followed by a classified list of products, their uses, and the names of British manufacturers. There is also a list of proprietary and trade names, the corresponding chemical synonyms or descriptions, and again the names of manufacturers. There is, for example, no longer any need for perplexity regarding the nature or origin of abralac, acrosyl, adalin, or even of westrosol, yarnite, or zinc formosul. Since the list of products is arranged in the alphabetical order of the English names, supplementary indexes in the other languages are provided. The reviewer understands that although the volume is offered for public sale by the publishers, Messrs. Ernest Benn, Ltd., the Association, the address of which is 166 Piccadilly, London, W.1, will nevertheless send a complimentary copy to any applicant who is actually concerned with work in pure or applied chemistry. A. A. E.

The Origins and the Growth of Chemical Science. By J. E. Marsh. Pp. x + 161 + 10 plates. (London: John Murray, 1929.) 5*s.* net.

MR. MARSH endeavours to show that chemistry has advanced, not through haphazard experiments and discoveries, but by a gradual development of accepted knowledge with the application of logical reasoning to explain established facts. Thus, when Boyle found that mercury calx was re-converted into the metal by heating alone, he was unable to explain the fact. When the phenomenon was rediscovered a century later, science was ready for it. Joseph Black had observed the fixation of a gas in carbonates and the genius of Lavoisier enabled him to establish and explain the fixation of another gas in calxes.

In tracing the growth of chemical science, the author has discarded the practice initiated by Kopp of dividing the development into epochs, since he considers this allows the dominant views of the time to obscure many important tendencies. He instances the phlogiston epoch, which Kopp dates from 1650 to 1775. The discoveries of Boyle and Black are thus made to fall within the same period, yet Boyle never heard of the theory, which was only promulgated in 1702 and, moreover, did not come into prominence until Lavoisier began to attack it in 1775.

The book opens with an account of the early views on the phenomena associated with fire, a study of which led to many important observations. This section, and those dealing with alchemy, the fixation of gases, and some of the later ones cursorily tracing the theories of structure, are well written. In dealing with the philosopher's stone, Mr. Marsh has, however, accepted the doubtful view that Talbot and Kelley are the same person.

The section devoted to the discovery of the elements, which follows an account of Mendeléeff's periodic law and other generalisations under the title "Atoms and Ions," is perhaps not so useful as it might have been. Here the references to the literature are quoted in a confusing manner. Frequently the year, volume, or page (sometimes two) are omitted, and German titles are occasionally misspelt (*e.g.* Poggendorff's *Annalen der Physik*), and the reference (p. 144) for 'the octet theory of valency' (Abegg. *Zelt. An. Org. Chem.*, **39**, 330) will irritate those who desire to consult the original.

In spite of this minor defect, the book presents a useful survey of the origins and development of chemical science. J. G. F. DRUCE.

Introduction à l'étude de la physique théorique. Par Prof. René Fortrat. Fascicule 6: *Mécanique statistique.* Pp. ii+100. (Paris: J. Hermann, 1927.) 10 francs.

IT is always rather difficult to estimate the value of one detached section of a larger work, for the scale and plan of the whole work can only be guessed. This difficulty is particularly noticeable in attempting to review on its own merits this section of Prof. Fortrat's work entitled "Statistical Mechanics."

To write a successful fairly elementary account of statistical mechanics in a hundred small pages is a task requiring great delicacy of judgment in selecting material. On such questions of taste one need not ask for complete agreement, but the reviewer is forced to admit that he finds the author's judgment poor. In the first place, the last forty pages of the book are devoted to two chapters on the older quantum theory of the atom, too slight to be of much value in themselves and entirely irrelevant to the professed subject matter. They contain, incidentally, statements about the discrepancy between the magnetons of Bohr and of Weiss which might lead an unwary reader to suppose, contrary to the facts, that there is a real difficulty and that the Weiss magnetism is still of some theoretical importance.

The remaining relevant sixty pages are rather good and rather unusual. The subject is treated from the conventional probability point of view, but the ideas and computations of the theory of probability are presented in detail and well illustrated in a way which owes much to Langevin. The applications of the theory have the pleasing and unusual feature of being mainly to magnetic phenomena. There are good short accounts of Langevin's theory of paramagnetism and Weiss's theory of ferromagnetism. If the rest of the book were of the same standard, it could be warmly praised. R. H. F.

The Mechanics of Rowing. By W. B. Coventry. Pp. viii+70. (London: E. and F. N. Spon, Ltd.; New York: Spon and Chamberlain, 1928.) 4*s.* 6*d.* net.

THIS is an interesting addition to the literature of rowing, and the work is soundly based on Newtonian mechanics. The terms used are carefully explained, as is also the fundamental problem of connecting the equation of motion of the blade of the oar with the equation of motion of the boat. The variable nature of the effective propelling force is dealt with by the introduction of a constant 'mean effort' operating from the catch to the finish of a stroke.

In the application of the theory to definite examples, it is rightly recognised that, in the last resort, the solution depends on the 'personal equation' of the oarsman. Discussion of such subjects as the length of the stroke, the sliding seat, the weight of the crew and of the coxswain, indicates the practical interest in the racing 'eight' round which the book centres. The effect of the density of the water is dealt with, and perhaps reference might have been made to Thomson's theorem and its application to the hydrodynamical problem of rowing a boat in shallow or deep water. The book concludes with emphasis on stamina and quickness as more valuable assets than big muscles. H. D. A.

Eutychus: or the Future of the Pulpit. By Winifred Holtby. (To-day and To-morrow Series.) Pp. 142. (London: Kegan Paul and Co., Ltd.; New York: E. P. Dutton and Co., 1928.) 2*s.* 6*d.* net.

MISS HOLTBY'S clever book, which reminds one occasionally of Oscar Wilde, is well worth reading. Students of science are perhaps not much interested in the future of the pulpit, and may agree with Anthony, the young intellectual, that "the pulpit has no future because religion has no future." But the book does, among other things, present an accurate picture of a certain type of vulgar sentimentality which pervades large sections of a modern community. Men of science for the most part are quite unaware of its existence, since their work only brings them into touch with intelligent people. In this dialogue, Eutychus is the exponent of popular religious notions, the devotee of what we may call 'Abide-with-me' religion, with its cinema mentality and vulgar emotionalism. Moreover, Eutychus feels that he holds all the cards. "Whatever the sermon is to be you may be sure that it depends upon just how much I and my friends can stand . . . you've got to pay attention to what we stand for," says he. No wonder that Fénelon, the exponent of Catholic orthodoxy in this dialogue, sums up the situation by saying, "It is the influence of Eutychus which alarms me most." J. C. H.

A First Book of Experimental Science. By W. A. Whitton. (First Books of Science Series.) Revised and enlarged edition. Pp. vii+194. (London: Macmillan and Co., Ltd., 1928.) 2*s.* 6*d.*

A WELCOME will be given to this enlarged edition of a school book which has already proved its worth. As to standard, it suits candidates for the junior local examinations; and as to scope, it deals with hydrostatics, mechanics, heat, and a little chemistry.

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.*]

The Equivalent Heights of the Atmospheric Ionised Regions in England and America.

IT was recorded in NATURE of Sept. 3, 1927, that, in experiments carried out for the Radio Research Board of the Department of Scientific and Industrial Research, evidence had been obtained of the existence of at least two ionised regions in the upper atmosphere. This evidence was derived, in the first instance, from observations made at night using wireless waves of medium length as the atmospheric exploring agency, but, more recently, the use of short waves has made it possible to carry out similar experiments during the daylight hours. The results of these experiments confirm the earlier conclusion as to the existence of the two ionised regions while the use of short waves, as was anticipated, markedly lengthens the period during the twenty-four hours when the lower region is penetrable and the upper region accessible. Using a wave-length of just under 100 metres, it is found that even about mid-day the lower region is penetrable on some days. On other days it is found that, due to the inhomogeneity of the lower region, waves of this length are 'reflected' by it one moment and a short time later get through. This is illustrated by a typical series of observations made at King's College, London, on Jan. 13, 1929, using 99·8 metre waves emitted by the National Physical Laboratory transmitter at Teddington, for which the following equivalent heights (km.) of 'reflection' were recorded at 10-minute intervals between 1000 and 1400 G.M.T.: 229, 229, 236, 244, 217, 229, 229, 230, 204, 196, 229, 100, 99, 93, 98, 99, 96, 98, 232, 99 (and 220), 99, 229, 229, 99.

It will be seen that these heights fall into two definite series, of mean values 226 km. and 98 km.

Now measurements of the equivalent height of the ionised layer have also been made in America, and it is of interest to compare the English and American results under similar conditions. For example, Breit, Tuve, and Dahl (*Proc. Inst. Rad. Eng.*, vol. 16, 9, p. 1236; 1928), employing their elegant group-retardation method, have recorded that, at Washington, using 75 metre waves, they obtained evidence of multiple reflections in that effective heights in the ratio 1 : 2 : 4 had been measured. The actual heights recorded were 105 km., 225 km., and 450 km.

Now we may identify the value of 105 km. in America as corresponding to the 98 km. (lower region) in England. But in considering whether the remaining rays are multiply reflected rays from this region or not, we may note that, in terms of such an explanation, the triply reflected ray is missing and that the photographs show that the doubly reflected ray is often of greater intensity than the singly reflected ray. Both of these difficulties disappear if we adopt the double-layer hypothesis for the American results as well as for the English observations. According to this explanation, singly reflected rays were obtained at Washington from regions at heights of 105 km. and 225 km., and a doubly reflected ray was also obtained from the upper region. A close correspondence with the English mean values of 98 km. and 226 km. is thus obtained.

E. V. APPLETON.

Wheatstone Laboratory,
King's College, London,
Mar. 6.

Solutions and Heat Engines.

IT is not usual for an author to complain of a review of his book; but I confess that the theory of osmotic pressure put forward (in place of an account of my own reasoning) by the reviewer, in NATURE of Feb. 16, of my book "Gases and Liquids," almost took my breath away. As the reviewer's reply, in NATURE of Mar. 9, to Prof. Armstrong's criticisms of this theory seems to me totally inadequate, perhaps I may be allowed space for some remarks.

The reviewer says that in a solution "the effect of the bombardment [by solute molecules] is to tend to expand the volume of the solution, and that therefore if water can flow in through a membrane it will do so." This theory implies that a net positive expansion pressure acting from within on the walls of the containing vessel is produced owing to the presence of the solute, and at the same time a net negative pressure causing water to pass in. Any less coherent theory I am unable to conceive. In a solution, no appreciable pressure towards either the outside or inside of the solution exists until the semi-permeable partition is brought into contact on the outside with pure solvent or a solution not isotonic with the solution in the osmometer. There is no pressure because, though the solute molecules exercise pressure, the pressure of the solvent is correspondingly diminished, just as, with gas at constant volume and pressure, there is no change of pressure when we substitute an equal volume of another gas at the same pressure for part of the original gas. The 'osmotic' pressure which develops in an osmometer is quite evidently due to the fact that the more concentrated molecules of the pure solvent diffuse through the semi-permeable membrane faster, until the full osmotic pressure is developed, than the diluted solvent molecules in the solution. It is thus to the solvent, and not to the solute molecules, that the pressure is due, as Prof. Armstrong has pointed out.

In my book I have developed this theory quantitatively, and shown, as I think, that it gives the actual experimental figures for depression of freezing-point, elevation of boiling-point, and osmotic pressure, though not what van 't Hoff wrongly thought were the figures. While I am sorry that the review has given no account of the reasoning in the book, I must not complain; but I think I am justified in joining my protest to that of Prof. Armstrong against what seems to us and many others the incoherent theory put forward by the reviewer.

I have tried in my book to be fair to the memories of van 't Hoff and Carnot, both of whom were men of outstanding genius. But where they were in error they were just in error, like other mortals.

J. S. HALDANE.

DR. HALDANE considers my statement of van 't Hoff's theory (it is not mine) as incoherent. I cannot do better than quote, as an alternative statement, from the account of osmotic pressure in the book under review (p. 109): "Let us imagine pure hydrogen and pure nitrogen at ordinary atmospheric pressure and contained in two equal gas-tight chambers separated from one another by a rigid septum permeable to the hydrogen but completely impermeable to the nitrogen. The hydrogen contained in chamber 1 will immediately begin to diffuse into the nitrogen in chamber 2, and will continue to do so until the pressure of the hydrogen is the same in the two chambers. . . . If the pressure in the first chamber is kept constant, by reducing its volume or letting in hydrogen as required, the pressure in the second chamber will be two atmospheres."

No better illustration than this can be given of osmotic pressure, which in this case is one atmosphere (*i.e.* the difference of pressure between the two sides of a semi-permeable membrane when equilibrium exists). This extra pressure is due entirely to the fact that on both sides there is now hydrogen at one atmosphere pressure, but in No. 2 there is nitrogen as well. Thus there is the extra bombardment inside, and in this simple case (assuming the gases perfect), it is calculable exactly from the expression $pV = nRT$. The nitrogen bombards also the semi-permeable membrane, but this does not prevent the hydrogen from coming in (though with actual molecules, presenting a broad front for attack, it will slow down its *rate* of coming in). It maintains a space extended to receive the hydrogen molecules. If the vessel can stretch, it will do so in consequence of this extra bombardment, and fresh hydrogen will come in to equalise the pressure of the hydrogen once more.

Now, whether we are dealing with gases at low or at high pressures, this kinetic pressure is the same at any given temperature. Perrin's experiments make it certain that it is so even for a condensed gas (*i.e.* a liquid). Serious complications then come in, however, which make exact calculations impossible, but the kinetic pressure is there all the time, and for solutions so dilute that the solute molecules are out of each other's way most of the time, it is found from osmotic measurements to be practically that which a gas would exert if of the same molecular concentration and occupying the same space alone. It is no use, therefore, trying to drag in other causes to explain the existence of osmotic pressure, and in any case it is inexcusable to neglect the kinetic effect.

Dr. Haldane attempts to attribute the *whole* phenomenon to certain volume relations depending upon the replacement of little molecules of solvent by big molecules of solute (thus ignoring the forces which govern the affair); the van 't Hoff school treats these simply as complications, and recognises at the same time that questions depending upon the sizes of molecules and of the attracting forces between them are problems of such extraordinary difficulty that the accurate allowance for their influence has not yet been effected. In dilute solutions their effect is certainly very small.

Dr. Haldane is not at all clear on this part of his subject, and since his whole theory depends upon the precise assumptions made, I thought it best in my review to be content with indicating that the theory was a superfluity, a *vera causa* having already been recognised and successfully developed. Since, however, he evidently desires me to do more, I must mention that on p. 25, where he introduces the volume relations which are the basis of his 'theory,' the results deduced are algebraically wrong. So that, even assuming that the fairly simple gas-law which he takes is good enough, the conclusions that he draws are unfortunately incorrect. I sympathise with him for, also unfortunately, I am personally acquainted by experience with many of the pit-falls which abound.

THE REVIEWER.

Perturbations in the Band Spectrum of Helium.

RECENTLY Kronig put forward a theory of perturbations in band spectra (*Zeit. f. Phys.*, **50**, 347; 1928). He found that if two molecular terms with the same j, which have besides to fulfil certain other conditions, come close together, their mutual influence has the effect that they seem to repel each other. Hitherto no band spectrum has been sufficiently known to permit of testing Kronig's predictions.

In the helium band spectrum a great number of electronic terms is known, and it is therefore especially well suited for a test of the theory of the perturbations. In Fig. 1 the empirical differences between the $4s(j)$ and $4z(j)$ states are represented as a function of j. We see that for $j = 17$ the corresponding energy levels come very close together, and as the two levels fulfil

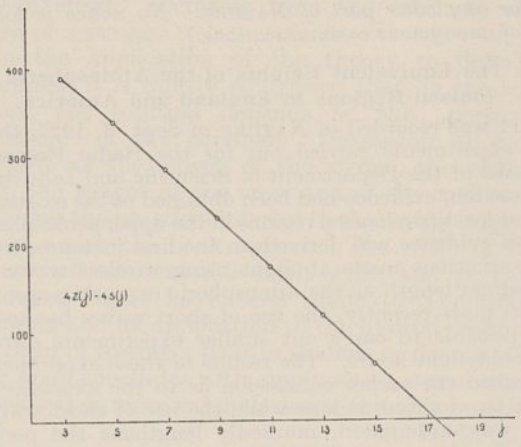

FIG. 1.

all the requirements of Kronig's theory, we must expect that they will be shifted from their normal positions. Fig. 2 shows how the empirical terms are distributed in the vicinity of the critical point. The dotted lines give the positions which the terms would have if there was no perturbation. The actual term values derived from the analysis of the bands $2p - 4s$ and $2p - 4z$ show just the expected deviations. (The absolute value of the perturbations has been exaggerated in the figure in order to make it better visible.) The exact position of the terms with $j = 19$ and higher is not yet quite sure, as there is a choice of several unclassified lines in that region. It is certain, however, that although the intensity of the preceding lines is large enough, so that we can also expect with appreciable intensity the lines having the terms $4s(17)$ and $4z(17)$, etc., as initial levels, they are not present in the extrapolated positions. Therefore it seems certain that we have indeed here a mutual interaction between the corresponding s and z terms. Similar perturbations seem to exist for the five quantum terms, but as the situation is not so unambiguous as in the case mentioned above, their communication is reserved for a later occasion. In the case of three quantum terms, a similar approach of terms with the same j does not take place, and accordingly perturbations have not been found.

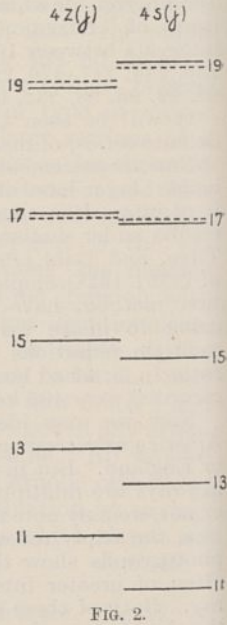

FIG. 2.

The perturbation of the $4p(9)$ term first found by Curtis in the Q-branch of the band $\lambda 367$ mμ, seems to be of a somewhat different nature. A term which might interact with the $4p$ term so as to give perturbations is not yet known. It does not seem impossible that the initial term of the band $\lambda 535$ mμ analysed by Fujioka (*Zeit. f. Phys.*, **51**, p. 657; 1928), which shows a perturbation for the same value of j, is

the term which is responsible for them. The perturbation of the $4p(9)$ term shows a doubling of the corresponding Q-line into two components with unequal intensity. This might be explained in the following way. The spectrum of the helium molecule must consist of single and triple electronic terms. But as the interaction of the electronic spin with the rest of the molecule is very small, the triplets are not resolved and thus have the appearance of single levels. It seems possible that in the case of a perturbation the interaction with the spin gets an abnormally large value, so that the corresponding term is split up. We must imagine, then, that the more intense component of the corresponding line is, as in the case of the atomic lines of helium, an unresolved doublet.

Full particulars of these and other properties of the terms of the helium molecule will be given elsewhere.

G. H. DIEKE.

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Groningen.

Cosmic Rays.

IN an earlier communication [NATURE, Feb. 16, p. 241] it was stated that an examination had been made of the results of experiments on cosmic rays. The experiments referred to were those of Millikan and his colleagues. In a recent paper (*Physical Review*, October 1928), Millikan and Cameron divide the rays into four bands with absorption coefficients per metre of water, 0·30, 0·08, 0·04, and 0·02 respectively. There is very little, if any, evidence for the existence of the last band, and I find that their results are fitted just as well by the division of the rays into two bands only, with absorption coefficients 0·30 and 0·051 respectively, rays of type A and type B, say. The experiments of Millikan and Otis and others show that there is a third type of radiation present, type C, say. Rays of this type are of local origin and consist, in part at least, of β-rays with an energy of the order of 100,000,000 electron volts.

Rays of type B are probably γ-rays. If so, according to the Klein–Nishina formula, which, for large values of $\alpha = h\nu/mc^2$ reduces to

$$\sigma/\rho = \frac{4\cdot17}{\alpha}(1 + 2\log 2\alpha) \quad \ldots \text{ per metre of water.}$$

α for these rays equals 173, corresponding to an energy of 88,000,000 electron volts.

Rays of type C are doubtless γ-rays, with a value of α equal to 1330 and an energy of 675,000,000 electron volts.

The energy presumably released when an oxygen nucleus is formed in a single step from protons and electrons is 116,000,000 electron volts, and that when a proton is destroyed 940,000,000 electron volts. I believe that the formula used gives values of α which are too small, so that rays of type B may correspond to the radiation emitted when an oxygen nucleus is formed in a single step and those of type C to that when a proton is destroyed. Incidentally, it has been tacitly assumed that rays of both types exert no appreciable action on hydrogen and oxygen nuclei. The evidence that rays of either type have any effect on atomic nuclei is not conclusive.

An analysis of the results of experiments showing the variation of intensity of cosmic rays with depth below the surface of the atmosphere affords, then, no evidence of rays corresponding to the formation of helium nuclei from protons and electrons. This renders it difficult to accept the attractive hypothesis of Millikan and Cameron that atom building is taking place in outer space, following the transformation of radiation into protons and electrons. Another difficulty that occurs is this. If all the energy in starlight is so transformed, less than eight-tenths of one per cent of it can be re-radiated as cosmic rays. As the radiation from the sun apparently has no effect on the intensity of the rays, this amount seems too small to account for the large intensity of cosmic rays, estimated by Millikan and Cameron to be about one-tenth that of starlight.

Rays of type C are not easy to classify. Their intensity in air is approximately proportional to that of the rays of type B, although it is difficult to estimate the exact value of either. They are not produced in water or in lead, and are therefore not recoil electrons. Many methods of explaining their origin have been tried, one being that they are photoelectrons ejected from the nuclei of atoms, such as nitrogen, but this explanation is not altogether satisfactory.

We have assumed that rays of type A and C are cosmic in origin, the greater part of the evidence favouring this view, but one experiment carried out by Millikan and Otis indicates that a part at least of these rays may be of terrestrial origin and also that rays of type C may be more penetrating than is usually assumed. They measured the ionisation in an electroscope before and after a snowstorm. When the electroscope was shielded by 4·8 cm. of lead, the ionisation per c.c. per sec. (corrected for natural leak) dropped from 4·9 to 3·6. If this result is not due to experimental error, it would appear that something had occurred in the atmosphere to diminish the intensity of the rays of one or more types.

A more complete discussion of the questions raised above will be given later. In searching for an explanation of the results, equations of the following type have been used, namely:

$$14\cdot008x + 4\cdot0022x + \alpha_k = 17\cdot000x + 1\cdot0078x + p_k + A_k + h\nu.$$

This is an energy equation representing the ejection of a proton from a nitrogen nucleus by an α-particle, the α-particle being captured by the recoil atom forming an oxygen isotope of mass 17 (the number 17 being assumed). x represents the energy in electron volts radiated when unit mass is destroyed (the mass of an oxygen nucleus being taken as 16 units), α_k, p_k, A_k, and $h\nu$ representing the kinetic energies in electron volts of the α-particle, ejected proton, recoil atom, and assumed radiation respectively.

$$h\nu = 0\cdot0024x + \alpha_k - p_k - A_k.$$

As $x = 930{,}000{,}000$ electron volts and $p_k + A_k$ is less than α_k, $h\nu$ should be greater than $0\cdot0024x$, that is, than 2,230,000 electron volts.

It should be possible to detect radiations of this type. Similar equations have been written down for the other atoms from which protons can be ejected, but the results are somewhat indefinite, as we do not know the mass of the recoil atom.

J. A. GRAY.

Queen's University,
Kingston, Ontario,
Feb. 7.

The Ice Age and General Drayson's Theories.

I AM sure your able contributor H. C. P. did not intentionally misrepresent Drayson in his article in NATURE of Dec. 29, p. 1002, but it would seem that some initial unfamiliarity with Drayson's writings, or possibly lack of sympathy with his claims, has led to misapprehension, and I would ask you to be so good as to permit me to direct attention to the more serious mistakes.

(1) "Everywhere in the Draysonian literature nutation is simply ignored."—Nowhere, and at no time, did Drayson ignore nutation; in proof, see "Untrodden Ground in Astronomy and Geology," p. 83; "Motion of the Fixed Stars," p. 23, etc.; though, in common with Sir John Herschel and all other astronomers, when tracing the path of the pole, he had, inevitably, to deal with the *mean* path. The greatest amplitude of nutation, that is, the whole nodding movement across the *mean* path, in direction towards the centre of the circle traced by the pole, is only 18½ seconds of arc. It would need to be 1167 (one thousand one hundred and sixty-seven) times that amount to explain the 6 degrees remove of the precessional centre from the ecliptic pole which Drayson discovered on examination of the records for the previous fourteen hundred years.

(2) "Further than this, the description, such as it is, is devoid of any dynamical basis."—Over and over again, in all his writings, for example in "Untrodden Ground," pp. 256-259, Drayson directed attention to the existing terrestrial conditions that would appear to necessitate a precession different from that assigned to the earth by the mathematicians; a difference he demonstrated by actual experiment with the gyroscope. It is not quite correct, therefore, to say that the movement he described is devoid of any dynamical basis. While it would be out of place to question the calculations of the master mathematicians who have determined the precession dynamically, may it not be reasonable to suggest that the data on which their workings are based are necessarily in the nature of assumptions, difficult, if not impossible, to verify and liable to modification?

May I add that, while it is not necessary to contend for every word that Drayson has written (and he himself was frank to own the limitations of his single-handed research), the need all through has been for simple recognition of the fact that he was offering to science something well worth the trouble of bona-fide examination; and the need to-day is as great as ever for co-operation of friendly team-work, in place of aloofness, to thresh out the question in all its bearings and harvest for science all that is of permanent value.

T. C. SKINNER.

Reigate.

THE moderation of Lieut.-Col. Skinner's letter, in marked contrast to the tone too often adopted by the advocates of Drayson's theory, entitles it to a reply, though without any hope of changing settled convictions. The invitation to join in friendly co-operation under the banners of Laplace, Poisson, and General Drayson is touching and deserves to be appreciated.

Casual mention of a matter like nutation is quite consistent with ignoring it in practice. Col. Skinner denies that it has been ignored, and at the same moment seeks to justify that course on the plea that nutation is very small. But the problem which Drayson approached was that of the motion of the earth about its centre, and in that problem dynamical astronomy has to deal with precession and nutation together. From this point of view the relative magnitude of the latter is irrelevant. As well might one leave out of sight the loops in a row of knitting on the ground that very fine needles were used.

This failure to grasp the integrity of the problem in itself betrays the lack of any dynamical basis in the treatment of it. Col. Skinner refers to mistakes, and has had an opportunity of correcting them. It will be observed that in the one case he has failed to indicate what part, if any, nutation plays in the Draysonian scheme, and in the other he has not suggested in what way, if any, the scheme derived support from dynamical reasoning of any kind. Drayson may have alluded to nutation and toyed with gyroscopes (most people have spun tops in their time), but what remains as obscure as ever is what part these things played in a theory the purely geometrical and empirical character of which is as clear as day.

An attitude of Athanasius *contra mundum* may be impressive, but the majority is not invariably wrong. The work of the master mathematicians, so far from being sacrosanct, has received repeated and critical study. The unfortunate thing is that Drayson and his followers have never shown the slightest inclination to come to close grips with it. When they have undergone this arduous discipline, they will have formed a juster view of the situation. H. C. P.

Compressibility of Crystals and the Exponent of the Force of Repulsion between Atoms.

IT is recognised that a real crystal does not have a perfectly uniform structure, but that it consists of a large number of small perfect crystals with a system of submicroscopic cracks between them. The average size of the perfect unit is, according to A. Smekal (*Zeitschrift für technische Physik*, p. 535; 1926), about 10,000 molecules. The presence of the submicroscopic cracks is made responsible for the tremendous difference between the experimentally determined values of tensile strength and those computed from theoretical considerations. As is known, the latter are several hundred times larger.

M. Born ("Atomtheorie des festen Zustandes," pp. 734-735) calculates the exponents of the forces of repulsion between the ions in a crystal lattice from the compressibilities of the crystals. In this way he arrives at the well-known value 9, from which certain conclusions of importance are drawn as to the symmetry of electronic arrangements in the ions (resp. atoms). The fundamental implicit assumption of all calculations of such a kind is that the coefficient of compressibility, as determined by the usual methods, is characteristic for the ideal crystalline space lattice.

Are we justified in making this assumption? If the tensile strength of a crystal is reduced several hundred times due to its loose structure, should we not expect that the compressibility, as usually determined, is also a characteristic, not of the ideal perfect crystal, but of the real loose crystal? It is easily seen that if the above-mentioned structure of the real crystal should have any influence at all on its compressibility, the effect should be one of increasing the latter. When subject to compression, the real, loose crystal may decrease in volume solely due to closer packing of the perfect units, that is, due to a decrease of the volume of the system of submicroscopical cracks. The compressibility of the individual crystallites may be very small, even zero, and still the crystal as a whole may show a considerable reduction of volume under pressure.

It is difficult to estimate how large such an effect may be. But the following considerations may give some indications. According to Siedentopf, the width of the submicroscopic cracks is of the order of 10^{-7} cm. (W. Rogowski, *Archiv für Elektrotechnik*, vol. 18, p. 147; 1927). Assuming the crystallites to be cubical, we find that there are about 21 atoms along the edge of the cube. If, furthermore, we

assume that the width of the crack given above represents the average spacing between the adjacent crystallites, we find that the total volume of the cracks is of the same order of magnitude as the volume actually occupied by the perfect crystallites. This is certainly much too high an estimate. But it now becomes not improbable to assume that the total volume of the cracks equals within a few per cent the volume of crystallites. The compressibilities being of the order of 10^{-6} cm.^{2}/kgm., we see that even at pressures of about 10,000 atmospheres the relative change of volume is only a few per cent. Hence, it is not impossible that practically the whole change of the volume is due to the decrease of the size of the cracks.

Hence we see that the measured compressibilities may be considerably larger than those which would be found if we dealt with a perfect crystal. But this means that the exponents of the forces of repulsion between the ions are considerably higher than 9. If this should be confirmed, it would necessitate also a revision of some of the conclusions drawn from previous data. It is perhaps worth noting that J. E. Jones (*Proc. Roy. Soc.*, A, vol. 106, pp. 441, 463; 1924; and vol. 107, p. 157; 1925) finds for some gases considerably higher exponents from different considerations.

Since the system of cracks in a real crystal is of prime importance also for a great number of other properties, such as conductivity of dielectrics, optical phenomena (Smekal, *l.c.*), and electrical break-down strength (Rogowski, *l.c.*), it may perhaps be possible to investigate this question by the study of the above-mentioned properties under high pressures.

N. RASHEVSKY.
Research Department,
Westinghouse Electric and Manufacturing Co.,
East Pittsburgh, Penn.,
Jan. 16.

The Beta-Hormone.

THE œstrous cycle is but one phase, and the less important phase, of the whole sexual cycle. There are *no* mammals in which the reproductive phase of the cycle (pseudo-pregnancy) does not also occur —either regularly or under given conditions. But there are *some* (the primates) in which no œstrous phase appears, since the whole cycle consists of a pseudo-pregnancy. Pseudo-pregnancy depends upon a hormonic function of the ovary, and is entirely independent of the presence of ova, fertilised or unfertilised, mature or immature (Wiesner, 1927). It becomes necessary, therefore, to decide whether pseudo-pregnancy is caused by the same hormone or hormones as that which invokes the œstrous cycle.

Alpha hormone (œstrin—the cornifying factor) in particular must be tested. But Wiesner has shown that alpha does not produce the typical changes of pseudo-pregnancy. Moreover, an already existing pseudo-pregnancy can be interrupted by injections of alpha.

In an attempt to explain the mechanism of the sexual cycle, the assumption was made that there existed a second ovarian hormone which was required to act in two ways: (*a*) to prevent alpha causing œstrus (in animals where alpha occurs during the second phase—be it pseudo-pregnancy or pregnancy); (*b*) to produce the typical changes of pseudo-pregnancy which cannot be produced by alpha.

Recent work done by Wiesner in 1927–28 and by ourselves aimed at the isolation of this hormone or the factors of which it consists. Now we have found that the corpus luteum contains a substance which can be extracted and causes at least some of the effects ascribed to this hypothetical beta-hormone.

The method of extraction was one of those which were used in the preparation of rho-one (ρ_1)—that particular 'pituitary'-hormone which causes œstrus and ovulation in the diphasic animal (Wiesner and Crew, 1928). The simplest method is that of shaking an aqueous suspension of finely divided substance of corpora lutea (cattle) after addition of sulpho-salicylic acid (conc. about 15 per cent). A precipitate forms, and filtration leaves a large part of the beta in the liquid; the evaporation of this extract at 56° and the removal of the sulpho-salicylic acid from the residue by means of alcohol leaves a water soluble substance the injection of which can produce effects required of beta by the working hypothesis. For it prevents the atrophy of the uterus in ovariotomised mature mice, a phenomenon appearing normally in all castrated animals; the muscular layers of the uterus of the experimental animals showed full development. The epithelial cells are increased in number and size; high epithelial activity prevails. The uterus never appears to be dilated by fluid (as it is after injections of alpha). The vaginal epithelium is *not cornified*, but forms *a layer of high mucous cells*—as in pregnancy or pseudo-pregnancy.

The effects caused by this substance, the beta-factor of the ovarian hormone, permits one to conclude that it is one, if not the factor, which is responsible for the second phase of the sexual cycle (pseudo-pregnancy) in diphasic animals and for its equivalent (premenstruum) in monophasic animals.

Further purification of the extracts and a study of the effects of beta is the object of experiments now in progress; the formation of that particular vaginal epithelium which can be recognised in a small excised piece of the vaginal wall and is characteristic for the second phase is used as the test for the presence of this ovarian hormone, which is the second, but most probably not the last one to be extracted and described.

B. P. WIESNER.
JASHBHAI S. PATEL.
Animal Breeding Research Department,
The University, Edinburgh,
Feb. 24.

Practical Television and its Problems.

THOUGH I see that it is largely taken from a foreword written by so high an authority as Sir Ambrose Fleming, I should like to put on record my strong dissent from a sentence in the review of A. Dinsdale's book "Television," in the supplement to NATURE for Mar. 9. The statement that I object to is: "The great obstacles to radio television to great distances at present are the disturbances caused by fading, Morse signals, atmospherics, and all the other causes which mutilate the broadcasting of speech and music."

On the contrary, as a matter of fact, if the difficulties occasioned by all these troubles were entirely eliminated, there would remain two fundamental, and, so far as present methods are concerned, insuperable difficulties against obtaining really successful practical radio television.

The first, which applies to all television, either by radio or by wire over distances either long or short, is, that with present mechanical methods it is only possible to produce transmitting or receiving apparatus with which the pictures can be divided into numbers of units which, for real success, would have to be multiplied at least by hundreds, if not by thousands.

The second difficulty applies only to television by

radio and not by wire, but applies obviously to broadcasting, and consists in the fact that where television is made by radio, such broad bands of frequencies must be used in order to get the necessary details to form really successful images, that these bands must cause unbearable interference with all other wireless systems in the neighbourhood.

I may add that I have received both a letter, dated Mar. 1, and a copy of an article in the *Elektrotechnische Zeitschrift* for Nov. 29 last, from Prof. Arthur Korn, of Charlottenburg, the well-known pioneer in the transmission of pictures by telegraph, that fully bears out these views of mine. He says in his letter, "In reality, I think that all the present trials of television are without great practical value, and only when it will be possible to receive many hundreds of thousands of elements per second practical television will begin."

A. A. CAMPBELL SWINTON.

MR. CAMPBELL SWINTON loses few opportunities of attacking mechanical methods of television. We have seen what we and many experts, including Sir Ambrose Fleming, consider excellent pictures transmitted by mechanical television. It is somewhat late in the day to point out difficulties in the way to experts. As Mr. Campbell Swinton has quoted Prof. Korn, we may be allowed to quote the following extract from a letter dated Feb. 19, by Commandant Brenot, Chief Engineer of Radio Paris, one of General Ferrié's most brilliant pupils: "What Mr. Baird has done is far ahead of what the most optimistic spirits could have dared thinking only a year ago at the International Wireless Conference held in Washington."

Six or seven stations in America are already broadcasting television pictures by various methods with a somewhat limited amount of success. Experimental transmissions on the Baird system will shortly be tried in various continental countries. The matter is being considered at present by the Post Office officials in Great Britain and we are quite content to leave the question of broadcasting television in their hands, as we know that they are competent and quite unbiased.

THE REVIEWER.

Magnetic Storm of Feb. 27-28.

ON Feb. 27–28 occurred one of the greatest magnetic storms recorded at this Observatory in the present solar cycle. The range in declination (100′) has been exceeded once only, on Oct. 15, 1926 (>164′), in the cycle, and that in horizontal force (530γ) has been exceeded on three occasions only, namely, on July 8, 1928 (>600γ), Oct. 15, 1926 (>717γ), and April 14–15, 1926 (585γ). In both the recent storm and that of last July the minimum of H.F. was beyond the limits of registration, so that it is not possible to give the exact value of the range.

The recent storm was not marked by a 'sudden commencement,' but was preceded by slight and moderate disturbances respectively at about the same hours on the two previous days. The duration of the storm was approximately from 15 h. 30 m. on Feb. 27 to 4 h. on Feb. 28, but the more violent phase was confined to the interval between 18 h. 30 m. on Feb. 27 and 1 h. 30 m. on Feb. 28. The character of the record strongly suggests that the violent phase of the disturbance was due either to a different cause from that responsible for the more moderate disturbances at the beginning and end of the storm, or to a marked discontinuity in the conditions under which a common cause operated. This is especially observable in the declination record, in which all the maxima and minima of the violent phase are sharply pointed, whereas in the initial and final stages they tend to be rounded. Further, the beginning and end of the central phase are very sharply marked, especially the end, which is as abrupt as if it had been brought about by the opening of a switch on an electric circuit.

It is worthy of note that the most violent movement of the storm was centred at about 20 h. on Feb. 27, at which time, according to reports in the Press, telegraphic services were seriously disorganised. Between 21 h. 42m. and 21 h. 57 m. there was a rise of 72′ in declination, followed by a fall of 80′ between 21 h. 57 m. and 22 h. 2 m., whilst between 21 h. 53 m. and 22 h. 8 m. there was a rapid fall and rise in H.F. of over 370γ, the trace being off the sheet from 21 h. 58 m. to 22 h.

There were a few insignificant groups of spots near the central area of the solar surface, but nothing which would lead one to anticipate any notable magnetic disturbance, nor does the storm appear to be in sequence with any previous ones at about the 27-day interval. It will, however, be interesting to see if it is followed by another at about Mar. 26, and, if weather conditions are favourable, it would be well if observers would be on the look out for aurora at about that date.

J. P. ROWLAND, *S.J.*

Stonyhurst College Observatory,
Nr. Blackburn, England,
Mar. 7.

The Presence of Sulphur in the Gaseous Nebulæ.

MANY of the strongest lines in the spectrum of the gaseous nebulæ have been explained (NATURE, **120**, p. 473; 1927. *Astrophys. J.*, **57**, p. 1; 1928) as forbidden transitions from low metastable states in oxygen and nitrogen. The analysis of the S II spectrum by Ingram (*Phys. Rev.*, **32**, p. 172; 1928), combined with the intercombination lines recently classified by L. and E. Bloch (*C. R.*, **188**, p. 160; 1929), makes possible the prediction of the position of lines due to similar jumps in singly ionised sulphur as follows:

Transition.	λ Calculated.	λ of Nebular Lines.
$a^4S - a^2P_2$	4068·39	4068·62
$a^4S - a^2P_1$	4076·45	4076·22
$a^4S - a^2D_3$	6717·04	—
$a^4S - a^2D_2$	6731·30	6730·0

The last column of the table gives the wave-length of lines found in the nebulæ. The agreement in every case is within the error of the calculated wave-lengths, which depend on frequencies of lines in the extreme ultra-violet. 4068·62 and 6730·0 were listed previously among the unclassified nebular lines (*loc. cit.*), while 4076·22 was provisionally assigned to O II, although its intensity was much stronger than the intensities of other O II lines would lead one to expect, and consequently the identification was indicated as being doubtful. Judging by the behaviour of the homologous lines in O II, 6717 should be weaker than 6731, and consequently its failure to appear is not surprising.

It may be noted that all of the elements thus far found in the nebulæ, namely, hydrogen, helium, carbon, nitrogen, oxygen, and sulphur, are gases or have stable compounds that are gases at low temperatures.

I. S. BOWEN.

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British Oyster Fisheries.

By Dr. J. H. ORTON.

THE present depleted state of the British—and indeed also of most European—oyster fisheries, with the resultant scarcity of marketable oysters, is the main cause of the current high price of this delicacy. The high value of the native oyster (*O. edulis*) especially, has attracted attention to the probable values of old and neglected former oyster fisheries, and to the possibility of beginning new fisheries in localities where such have not previously existed. Any attempt at improvement of our inshore fisheries may be welcomed, and particularly when directed towards the culture of sedentary animals, which promise more definite economic returns for effort expended than most other fisheries. A broad view of the problems in oyster-culture should, however, be regarded as a necessary preliminary to all new schemes, for, as Hoek insisted, "Oyster-culture *is* a culture and not a manufacture."

One of the chief difficulties in oyster culture is the fluctuation in the supply of small stock—which is the equivalent of raw material in a manufacturing trade. On many English oyster beds recurrent periods of relative scarcity of small stock occur not infrequently, while at longer intervals great scarcity of all kinds of stock may occur. The cause of these minor and major fluctuations has been in the past undoubtedly mainly the failure of the crops of young oysters for successively few or many seasons. In a good season many millions of young oysters may be obtained, in contrast with a very small fraction of this number in a bad season. One good season in about five would ordinarily be sufficient to maintain a bed in a flourishing condition, provided an adequate breeding stock be always maintained.

The present scarcity of oysters on English oyster beds is due to several causes, of which the failure of good crops of young oysters since 1921 is probably the predominant one. Other factors of importance in this regard are (1) an unusual mortality in the Thames Estuary area in 1920, (2) over-fishing, and (3) the possible occurrence of increased pollution in inshore waters with a resultant lethal effect on larval and young oysters. These matters, along with a consideration of enemies, pests, local effects of unfavourable weather conditions, in addition to the purely economic factors, need to be considered in ventures upon oyster culture.

The condition of British oyster fisheries is, however, intimately related to that existing in Holland and France, since these countries have in the past furnished a source of cheap young oysters for stocking British grounds. In France, depletion of the beds (of *O. edulis*) has occurred contemporaneously with and from causes the same as or similar to those operating on British beds. Conditions in Holland have recently been more favourable, but have resulted here also in fluctuating periods of relative scarcity. Thus at the present time stocks of small oysters are low throughout western Europe. Table I., however, shows that stocks of all kinds of oysters, as judged from statistical returns, are relatively low over

TABLE I.—THE WORLD'S OYSTER PRODUCTION FOR 1912–1926[1] (*according to statistics*).

Country.	Chief Species Cultivated.	Unit of Quantity Stated in	Total Value in Most Recent Year.	Production in							
				1926.	1925.	1924.	1922.	1920.	1918.	1914.	1912.
U.S.A.	*O. virginica*	1000 bushels[2]	$14,000,000	..	..	**20,000**	..	..	..	**30,000**[6]	..
Canada	*O. virginica*	Barrels each	$152,073	22,255	21,428	28,982	19,427	14,526	13,916	26,545	23,377
	O. lurida	=*c.* 3 imperial bushels									
France	*O. angulata*	Millions	francs 107,463,624[4]	*1083·7*	*889·7*	*660·4*	*439·6*	*378·4*	*546·2*	*692·6*	*1064·5*
France	*O. edulis*	Millions	francs 6,565,580[4]	*10·87*	*7·98*	*29·28*	*208·1*	*463·3*	*414·1*	*739·7*	*944·6*
Holland (Zeeland Rivers)	*O. edulis*	Millions	gulders 1,967,850	*17·07*	*18·23*	*24·85*	*27·54*	*36·37*	*41·65*	*30·35*	*45·13*
Zuider Zee	*O. edulis*	Thousands	..	..	..	nil	13·6	953·0	421·0	8495·0	..
England and Wales	*O. edulis*	Millions	£101,480[5]	*15·86*	*16·74*	*16·97*	*23·67*	*39·44*	..	..	*33·39*
Ireland	*O. edulis*	Thousands	£7,619	1,622	2,065	2,410	151	3,621	2,099	1,866	2,909
Scotland	*O. edulis*	Thousands	£579	83	96	89	144	254	..	705	1,328
New Zealand	*O. Angasi*	Bags, each = *c.* 3 bushels	£19,479	27,828	26,039	23,796	27,280	26,703	22,827	24,793	..
New Zealand	*O. cucullata*	Bags, each = *c.* 3 bushels	£8,344	6,771	8,297	6,841	7,323	6,797	10,422	8,361	7,728
N.S.Wales	*O. Angasi*, *O. cucullata*	Bags, each = *c.* 3 bushels	£85,141	..	..	28,380	24,811	25,021	22,337	21,526	..
Natal	*O. cucullata*, *O. prismatica?*	Dozens	£762	17,288	22,855	24,876	17,859	21,909	15,172	13,433	19,000
Japan	*O. cucullata*, *O. gigas*, *O. densilamellosa*	Thousands of kwan,[3] each = 8·267 lb. or 3·75 kgm.	yen 551,039	**3,070**	**1,874**	**2,033**	**3,277**	**10,677**	**9,278**	**330**	..

[1] These statistics are given as stated in the various Government reports in the pre- and post-War periods, but as they relate to overlapping seasons are not all strictly comparable in the same year. The figures for France relate only to the total output by oyster culture, and those for England do not include the output from the Fal Estuary. In each country the statistics are apparently comparable from year to year, and thus afford an index of the varying prosperity of the oyster industry in each region.

[2] One bushel may contain any number of American oysters from 200 to 500, according to size.

[3] One kwan = the weight of about 66 medium-large English oysters.

[4] Values for 1927 for respectively 1452·3 and 6·39 millions. [5] Value for 9·71 millions in 1927. [6] For the period 1911–1918.

most parts of the world. The true significance of these figures could be better estimated by comparison with a longer series, but nevertheless in themselves indicate the operation of some common factor or factors. Of these factors, frequent failure of the young oyster crops and overfishing are probably the most important, with increasing pollution as a factor of least but possibly increasing importance.

The occurrence of good crops of young oysters on English beds is closely correlated with warm summers, and on natural grounds there is little doubt that heavy falls of oyster-spat are dependent directly or indirectly upon a more or less sustained temperature of the sea-water at 60° to about 64° F. or above. In some seasons a good spatfall may be obtained, but even so, the yield of young oysters in the following spring may be slight; in other seasons, in spite of the demonstration of abundant larvæ in the waters over the beds, there may be little or a negligible spatfall. It is advisable, therefore, to distinguish (*a*) the summer settlement of larvæ, as the spatfall, and (*b*) the product in the following spring, as the young oyster crop. The best crops occur after long warm summers,[1] *e.g.* 1913, 1921, or from an early spatfall. A complete scientific explanation of the factors concerned—which may be biological or purely biophysical—is still awaited, hence the need for prosecuting with vigour the investigations at Conway (referred to in NATURE, **123**, 208) on the factors controlling spatfall and the survival of spat. In the meantime, good crops of young oysters can only be expected on oyster beds either after long warm summers or when a warm period occurs in summer at about the time when a good proportion of the season's larvæ are ready to settle.

Thus although researches on improved methods of spat-catching in the sea [2] may improve the oyster cultivator's probabilities of better crops, he is nevertheless dependent upon suitable weather, which is an unpredictable factor, for maintaining a succession of crops. In this matter the steady production of millions of young oysters in artificial ponds at a cheap rate would immediately extend the possibility of oyster cultivation in Great Britain. The English Fishery Department has already had considerable success in obtaining oyster crops in artificial tanks at Conway,[3] and it is suggested, could now attempt a *commercial* experiment on a grand scale, namely, prepare for and secure a crop of millions of young oysters; then, either sell the crop, or arrange to relay the product on existing oyster beds and cultivate them to a marketable size. In the former case a demand sustained over a period of years would prove success, as would a satisfactory balance sheet in the latter. In either case the Government might prove the value of its scheme empirically, before scientific assurance arrives.

In the unusual mortality of oysters in the Thames Estuary in 1920, it was found impossible [4] to incriminate as the agent, trinitrotoluene, which had previously been dumped in this area in large quantities. Nor was it possible to assign the mortality to any other lethal substance known to have been dumped in the sea in the post-War epoch. Thus the cause of the unusual mortality was necessarily left an open question: it might have been due to unknown poisons, or to unrecognised parasitic disease. The occurrence of heavy mortality in oysters at Taranto, Italy, in 1919, and on French beds, especially at Arcachon in 1920, renders it more likely that some parasitic organism was the common cause, though no suspicious parasitic form has yet been found. As oysters are known to die from constitutional disorders brought on by extreme variations in external physical conditions, a determination of the cause of death in any given case is rarely possible. The physiology of the oyster is thus extremely interesting from an academic as well as from an economic aspect. For this reason—and others—it was strongly recommended [4] (1923) that a post-graduate scholarship should be permanently founded for continuous researches on the physiology and biology of the oyster. Such a scholarship was awarded to Dr. C. M. Yonge for two years—and resulted in a valuable contribution to our knowledge of the physiology and anatomy of the oyster [5]—but has now unfortunately been allowed to lapse. It may be again emphasised that the continuance of researches of this nature will add to our knowledge both of general biology and the special biology of the oyster in relation to culture.

The effects of over-fishing in the falling off of oyster production are, in the opinion of the writer, frequently underrated. On a question of this kind, in which adequate scientific facts are not available, it is necessary to fall back on general principles. One oyster can produce one million larvæ at a time, just as a codfish or a sea-urchin may produce several million eggs, and it is often argued that quite a few individuals in a favourable season would be sufficient to produce a big stock of young. The matter is important generally, and not merely confined to the oyster. It is true that in extremely favourable circumstances a few individuals of one marine animal may produce a large population in the succeeding year or years, hence the view—especially held in oyster culture—that a stock may be reduced (over-fished) to very small dimensions with impunity. Fisheries in America, Australia, Scotland, and the German Bight have probably died out from acceptance of this doctrine. It is, on the other hand, a generally accepted doctrine that the number of eggs produced per individual in a species is directly proportional to the probable rate of mortality before the attainment of full maturity, therefore when a stock is reduced to a few individuals, few young will survive, except in very favourable circumstances. If such circumstances do not arise during the life of a surviving small stock, that stock will die out in that locality, whether it be oysters, sea-urchins, sea-hares, ascidians, or other sedentary or semi-sedentary forms; fishes—not being sedentary animals—fall in a different category.

In order that a stock may be maintained in a certain locality, it would seem that a certain minimum number of individuals, which may be relatively large, is necessary. It may reasonably be assumed that a fairly constant proportion of larvæ will

perish either from a multitude of enemies or unfavourable physical conditions, whether the total number be high or low ; but if the number of larvæ be very low, there is a greater chance that all will perish. The conception that a minimum stock is necessary to maintain a species in a given locality thus arises. In the absence of any data on the problem, the economic limit of dredging has been suggested [1] as a practical minimum in the case of the oyster. The economic limit on the poorest English grounds works out at that state of the beds when about 50 to 100 adult oysters may be dredged per man per boat per day. With lower standards of living, or with very high prices, the economic limit may fall below this density. To-day the minimum stock necessary to ensure survival may therefore be estimated above rather than below the economic limit of dredging, as stated above, especially in localities where pollution is an increasing menace, since in the past the economic limit has not sufficed to ensure revival. In any event the careful cultivator will endeavour to maintain as large a stock as possible on the beds during the spawning season.

At the present day the spectre of pollution as a factor in diminishing or even preventing a spatfall, by destroying the larvæ, is probably in the background of the minds of most oyster producers. Oils are especially regarded with grave suspicion ; but the small quantities of these substances relative to the volume of water with which they are mixed, and the small quantities of toxic ingredients in oils, renders it extremely doubtful that they alone can have any poisoning effect in *sea*-water. There is, however, the broader aspect of general pollution to be considered. The additive effect of all the poisonous substances in the drains and sewers from industrial effluents especially—besides which tar and oils may be relatively unimportant—may be that of producing a very slightly unfavourable environment at first in a very small zone near the source of the effluent. This slightly unfavourable environment may be such as cannot be detected by any known method, and may result in forcing seawards the more delicate of the marine organisms. In many estuaries there can be no doubt, as Hautreaux (*Bull. Soc. de Géog. Comm. de Bordeaux*, II, 18, Bordeaux, 297, 455 ; 1895) long ago suggested, that the water oscillates up stream and down to a great extent as a result of the piston-like action of tidal waters outside ; [6] the movements of shoals of estuarine crops of the jelly-fish, *Aurelia*, for example, in the Hamoaze, Cornwall, and R. Blackwater, Essex, offer a simple means of observing this oscillation. Thus polluting substances or their products will tend to increase in such an oscillating body of water, especially between spring tides. Whether such a net pollution ever attains to lethal importance for the more delicate animals, such as oysters, in any particular locality is a legitimate subject for research, which, however, involves fundamental studies of the constitution of sea-water. All coastal waters must be regarded as polluted—using the word in a general sense—in comparison with oceanic water, and the degrees of pollution of coast and estuarine waters may be more readily determined by comparison of their fundamental properties with the purer medium. The oyster cultivator will therefore welcome all schemes for the investigation of pollution and the maintenance of purity in estuarine waters.

Indeed, economic problems regarding oysters and oyster cultivation are so bound up with those in general biology that extensive co-ordinated researches prosecuted on the lines advocated in NATURE, **122**, p. 311, would serve both biological and economic aims, and might be the beginning of a new phase in British marine biological research.

On the economic side, it will be obvious from the account given above, and in NATURE, Feb. 9, that the oyster cultivator requires a long lease of the ground it is proposed to cultivate. Existing fishery rights must be acknowledged, and if necessary dredging rights of local fishermen may be accommodated by an allotment of shares in the new schemes.[7] In ventures in which the cultivator cannot expect to produce young oysters, that is, on purely fattening beds, State assistance cannot reasonably be expected. But where conditions are deemed favourable for the development of a new area for the production of young oysters, State aid in the early period of development may perhaps be reasonably asked for. In beginning a scheme for the production of oysters in a new locality, a fresh attempt is in fact being made to supply the raw material of an industry. In this respect oyster production is roughly analogous to beet production.

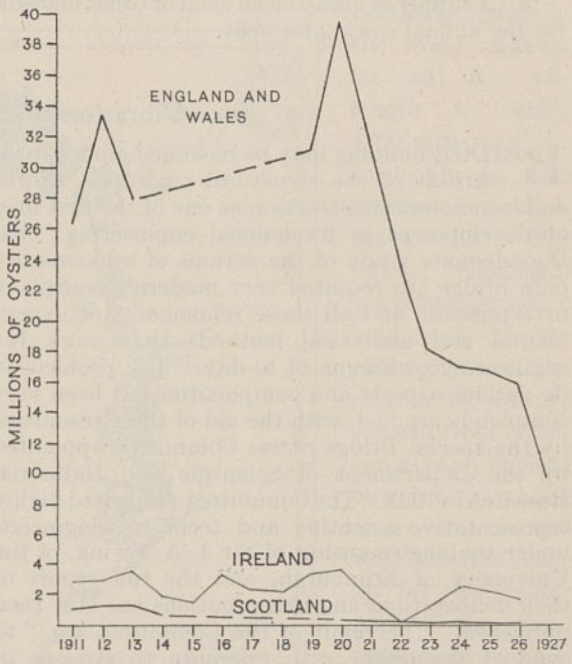

FIG. 1.—Output of oysters (mainly *O. edulis*) from oyster beds in the British Isles for the period 1911–27 (according to statistical returns). No records were kept in Great Britain during the European War.

New ventures which aim merely at fattening oysters will have to compete with well-established merchants, who on one hand are expert in their business, but on the other hand do not appear

to be able to meet the demand. In new producing areas the essential characters of the grounds include :

(1) Estuarine waters sufficiently enclosed—in a technical sense—to ensure the retention of the larvæ and spat in a maximum area under cultivation.

(2) A local seasonal temperature range giving frequent probabilities of a maximum temperature in the bulk of the sea-water of 64° F. or more, and a minimum rarely below 34° F.

(3) A large area of moderately clean ground, and moderately pure water which should not fluctuate greatly, nor fall much or often below 2·5 per cent, in saltness.

(4) A sufficient stock of large oysters to supply probabilities of an increasing spatfall year by year.

(5) A supply of cheap clean shell or other material for the annual sowing for spat.

(6) Reasonable shelter from gales, if much sandy or fine gravelly ground occurs in the locality.

(7) Immunity from gross sewage or industrial pollution now and in the fairly distant future.

(8) Absence of an abnormal amount of enemies or pests.

A review of these characters indicates that the southern regions of England and Ireland are most likely to yield new producing grounds, whilst a glance at Fig. 1 suggests that potentialities for production in Ireland are undeveloped to a greater degree than in England.

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Vibration in Bridge Structures.[1]

BRIDGE building may be reckoned amongst the earliest of the structural engineers' efforts, and locomotive construction as one of the first lines of development in mechanical engineering ; but the adequate study of the actions of a locomotive on a bridge has required very modern resources in investigation, and all those refinements of experimental and analytical methods that mark the engineering technique of to-day. The problem in its various aspects and complexities has been very completely studied, with the aid of these resources, by the special Bridge Stress Committee appointed by the Department of Scientific and Industrial Research in 1923. The Committee comprised highly representative scientific and technical engineers, under the chairmanship of Sir J. A. Ewing, of the University of Edinburgh, and the full report of their deliberations and investigations has now been published. The remit of the Committee was "to conduct researches with reference to stresses in railway bridges, especially as regards the effects of moving loads." These comprehensive terms of reference have been very adequately interpreted, and the work of the Committee constitutes an invaluable study of the vibration of bridge structures under impact influences. Work with a somewhat similar motive had previously been attempted—notably by the American Railway Engineering Association in 1910, and by a special committee of the Indian Railway Board in 1917—but the present report goes much further and deeper into the subject.

The previous investigations had made fairly clear that the main cause of serious augmentation of bridge stresses arose from the unbalanced vertical forces developed by the locomotive. Certain effects could be traced to rough and flat wheels, irregularities of track, or to heavily loaded freight cars, but these were usually small in relation to the direct consequence of the pulsating force—or 'hammer blow'—due to the 'balance' weights on the locomotive wheels. While this was recognised, it has not been very effectively embodied in bridge stress rules ; and, as in the well-known Pencoyd formula, the influence of impact is generally covered by a proportionate increase, varying with span length, of the live load stress. If impact is mainly due to locomotive actions, this process of making allowance on total live load is scarcely rational. It is the achievement of the Bridge Stress Committee that it has not only clearly elucidated the nature and cause of impact, but that the investigation is so complete as to permit of the standardisation and rationalisation of impact allowances in general.

An ordinary two-cylinder locomotive is balanced by the locomotive engineer by the addition of weights to the rims of the driving wheels. But this is merely a process of reducing the inertia force effects in the engine lines. What is eliminated in those lines is transferred by the so-called 'balance weights' to the vertical plane ; and hence variation of horizontal force is changed to a vertical fluctuation giving rise to a pulsating force on the rails. The magnitude of this force is all-important. The report repeatedly refers to it ; and it is recorded that the locomotive engineers of Great Britain are prepared to limit its value to a total per locomotive of $12\frac{1}{2}$ tons at 5 revolutions per second of the wheels. It is, therefore, clear that the importance of the absolute value of this force as a factor in girder stresses is established and accepted. The context also explains that, while in some centres special care is taken to test the balance of locomotives after construction, in other cases more attention is required in this matter. It is also obvious that three- and four-cylinder, and electric locomotives, in which a much higher degree of balance is possible, have distinct advantages over the more common two-cylinder type.

The Committee's work consisted of the actual observation of bridge vibrations and the analysis

(*Continued on p.* 463.)

[1] Department of Scientific and Industrial Research. Report of the Bridge Stress Committee. Pp. vii+215. (London : H.M. Stationery Office, 1928.) 18*s.* net.

Supplement to NATURE

No. 3099 MARCH 23, 1929

Greenland: as it is and as it was.[1]

By Prof. A. C. SEWARD, F.R.S.

IT would not be inappropriate to take as a text for this lecture words borrowed, with a slight modification, from one of Thomas Hardy's novels: "The past seizes upon us with its shadowy hand and holds us to listen to its tale." One of my aims is to recall a few scenes—in particular, one scene—from a past separated from the present by an interval measured in millions of years, and by so doing to illustrate an impressive contrast between what is and what was. A comparison of a small area of Greenland as it appears to-day with the same district as it was at a time roughly corresponding to the stage in geological history represented by the chalk cliffs of England, affords a startling proof of the changing face of the earth and illustrates the fascination and the stimulus inseparable from every honest endeavour to read the secrets of the rocks.

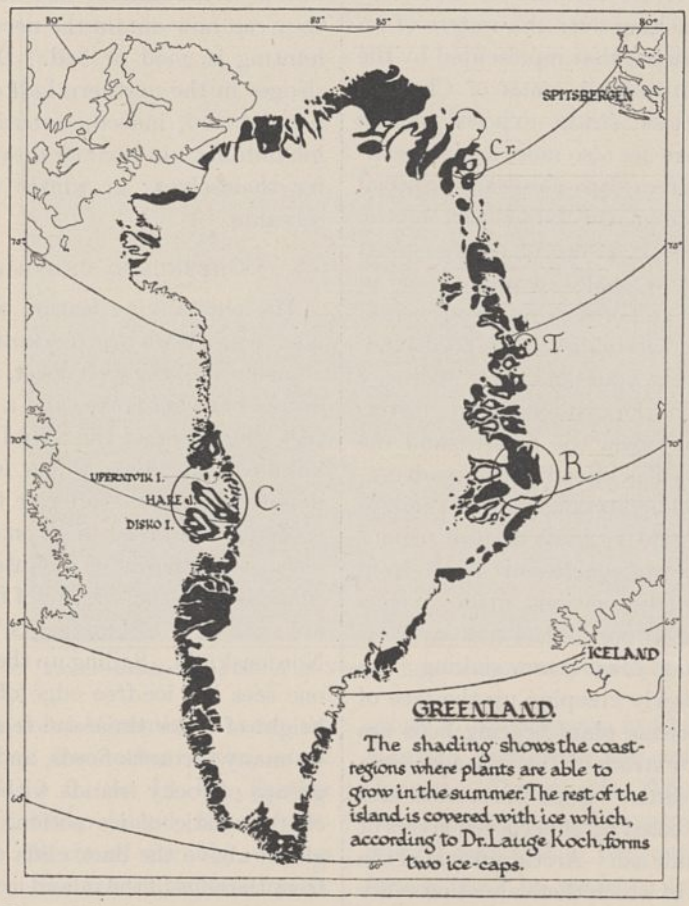

FIG. 1.—Greenland. C, region where Cretaceous and Tertiary plant-bearing beds are exposed. Cr, locality where a few Lower Carboniferous plants have been collected; T, Sabine Island (Tertiary plants); R, Rhætic plant-beds in the Scoresby Sound district.

PHYSICAL AND GEOLOGICAL FEATURES.

We will first look at Greenland as a whole. Cape Farewell, the southern apex of the wedge-shaped island, an island large enough to rank as a continent, is approximately on the same parallel as the southern part of the Shetland Islands and as Finland. The broad base of the inverted triangle, the most northerly land in the world, reaches lat. 83° N.; the length is nearly 1700 miles and the breadth in the middle is rather more than 600 miles. Greenland is a relatively stable land, one of the oldest pieces of the earth's crust severed from an inconceivably ancient continent which once united the west and the east. By far the greater part of the island consists of crystalline rocks of the type we see in the Norwegian mountains and in the north-west Highlands of Scotland. In the course of ages, Greenland rose and sank with recurrent pulsations of the crust, but the movement was comparatively slight; the sea only partially transgressed the land and advanced farther towards the feet of the mountains.

Of these oscillations there is evidence in sandstones and other sedimentary rocks which at several places on the coastal fringe lie on the eroded platform of the original foundations. The cliffs of Washington Land on the north-west coast are rich

[1] Friday evening discourse delivered at the Royal Institution on Jan. 25.

in marine fossils; in places the abundance of corals led the Danish geologist Lauge Koch to describe them as veritable 'coral reefs.' Near the north-east corner of Greenland some fossil plants were found in sediments deposited in the early days of the Carboniferous period. Farther south, at Sabine Island, other sedimentary rocks have yielded impressions of leaves scarcely distinguishable from those of the existing maidenhair tree (*Ginkgo biloba*), with fragments of other plants of Tertiary age. Still farther south in the district of Scoresby Sound a rich Rhætic flora has been discovered, a flora no less luxuriant than floras of the same age from much more southern countries. The plant fragments were transported by rivers turbid with sand and mud to a delta encroaching over the waters of an estuary at a period between that represented by the still older Triassic salt-bearing marls of Cheshire and the younger Jurassic strata exposed on the Yorkshire coast. There are also more ancient sedimentary rocks not far from Cape Farewell. Special attention will be given in the latter part of the lecture to the remains of a vegetation scattered through sandstones and shales deposited in an estuary during the first half of the Cretaceous period and now accessible in the cliffs of Disko Island, Upernivik Island, and the mainland about half-way up the west coast. This flora is selected in illustration of the contrast between the present and the past to which reference has already been made.

The solid land is seldom stationary; we think of it as permanent, but intensive study of most regions demonstrates the fallacy of conclusions drawn from general impressions. Observations made over a series of years in the latter part of last century show that a section of the west coast is now sinking; the brown seaweeds are slowly creeping up the face of the cliffs. The Cretaceous plant-bearing beds are occasionally overlain by strata of Tertiary age, some of which are rich in plants. Both Cretaceous and Tertiary rocks are protected by superposed layers of basaltic lava and volcanic ash—Arctic outliers of the great volcanic plateau of which there are other relics in the Giants' Causeway and on islands off the west coast of Scotland. Such are some of the documents, differing widely in geological age, which tell of recurrent changes of level and supply the means of interpreting the "ghostly language of the ancient earth."

A word on the human inhabitants: there are about 20,000 Eskimo, most of whom live on the west coast. There is a fairly large colony a short distance from Cape Farewell on the east coast, and in 1925 one or two new settlements were established in the neighbourhood of Scoresby Sound. More than 900 years ago, Eric the Red, taking with him about a hundred companions, with sheep and oxen, sailed from Iceland and founded colonies near the south end of the west coast of Greenland. In 1721 Hans Egede sailed from Bergen and accomplished what has been called the re-colonisation of Greenland; he went there as a missionary in the hope of finding some descendants of the earlier Norse colonists; he found only graves and ruined buildings. In recent years many other traces of the early settlers have been discovered by Danish antiquarians. In addition to the Eskimo there are a few Danish officials. Under Danish rule the condition of the natives has been greatly improved; they can now obtain the necessaries of life whether hunting is good or bad. Dogs used for drawing sledges in the northern half of the country are important and, indeed, essential companions to the inhabitants; in summer they are usually left to fend for themselves; in winter they become efficient servants.

Greenland under an Ice-Sheet.

The outstanding feature of Greenland is the inland ice. With the exception of a coastal strip along most of the west coast, a relatively broad strip on the extreme north, and a narrow margin on the east, the whole of the island is hidden under ice of unknown thickness which forms a gently sloping dome rising in the interior to a height of at least 9000 ft. Here and there on the lower slopes of the ice-sheet, summits of mountains project as solitary islands above the "waste of frozen billows." These are spoken of as 'nunataks,' a name suggested by Nordenskjöld. Sailing up the west coast in summer, one sees the ice-free edge of a plateau rising to a height of a few thousand feet, the cliffs intersected by many tortuous fiords, and, on the seaward side, groups of rocky islands with the rounded contours characteristic of ice action. An occasional white gleam above the dark cliffs of the mainland comes from the edge of the inland ice. Some glaciers creep into the open sea; others enter the deep water of fiords several miles from the coast. From one glacier at the head of the ice fiord near Jakobshavn (lat. 69° N.) are calved many of the icebergs which are carried by currents to the Newfoundland banks and much farther south; many are stranded on shallows off the Greenland coast. Near the land the sea is littered with icebergs of all shapes and sizes; their sunlit sides and pinnacled summits are radiantly white, and near the surface of the water a brilliant blue-green. In the stillness of the night

the sudden booming of breaking bergs recalls Coleridge's description in "The Ancient Mariner": "the ice did split with a thunder fit." Some of the larger icebergs reach a height of 200 ft. above the water, and the submerged portion is approximately eight times as deep as the height of the visible berg.

The jagged Alpine peaks of the higher mountains of crystalline rock, which are especially impressive as seen off Upernivik Island, are in marked contrast to the flat-topped basaltic hills of Disko Island and the adjacent Nugsuak Peninsula (Fig. 2). Before passing to the consideration of the fossils preserved in the sediments below the basalt, we will take a general view of the vegetation which partially clothes the ice-free coastal belt.

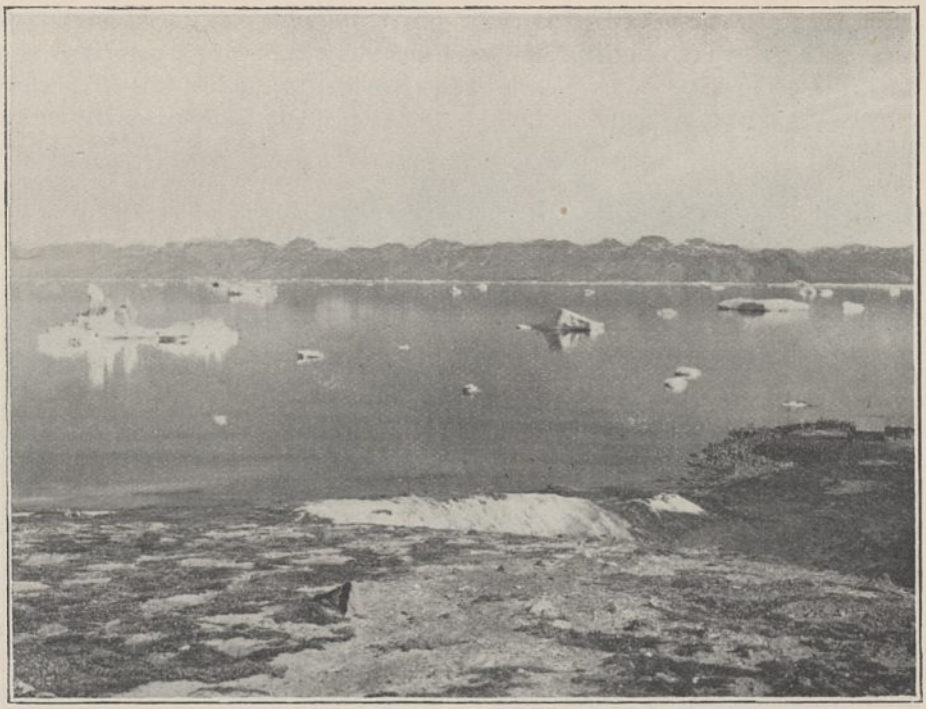

FIG. 2.—Basalt-capped hills of the Nugsuak Peninsula seen from Disko Island. (Photo. by R. E. Holttum.)

THE PRESENT VEGETATION OF GREENLAND.

From the whole of Greenland, 390 species of vascular plants, that is, flowering plants, conifers, and members of the class to which the ferns belong, have been recorded. The tree-limit, which is taken as the southern boundary of Arctic vegetation, is close to Cape Farewell; in south Greenland there are birches, alders, and a few other trees, some reaching a height of 12 ft. or 18 ft. Farther north in the region of Disko Island, the only representatives of trees are dwarf shrubby willows and the dwarf birch; the tallest willows rarely exceed three feet. The prostrate shoots bear an amazing number of catkins; their roots spread far in a horizontal direction through the shallow soil (Fig. 3). The ground is permanently frozen at a depth of rather more than a yard. A reflection of the severity of the life conditions is seen in the internal structure of a willow stem; in a section of a stem less than an inch in diameter fifty rings were counted. Lichens play a prominent part in the landscape and in preparing the ground for higher plants; tufts of white, yellow, and grey, with splashes of vermilion, give colour to tundra and rock. It is worthy of note that about half of the lichens obtained from the Antarctic continent belong to species recorded also from Arctic lands; these wind-borne plants are probably the greatest travellers of the plant kingdom. The green ribbons marking the course of streams owe much of their brilliance to mosses.

There are a few ferns, some growing in rock fissures, some in company with flowering plants in favoured situations: *Cystopteris fragilis*, the brittle fern, is one of the most cosmopolitan of plants; it grows in Spitsbergen, in Chile, Abyssinia, on Kilimanjaro, and in the sub-Antarctic island of South Georgia. There is also the holly fern *Polystichum Lonchitis*, a European species which flourishes in central Asia and in the southern hemisphere. Reference may be made to two other plants which belong to the fern class and are very widely distributed: *Equisetum arvense*, the common horse-tail, and a club moss, *Lycopodium Selago*.

Turning to the flowering plants, which give to the Arctic landscape an unexpected brightness, a few examples must suffice. The Monocotyledons include several grasses, sedges, and rushes; species of pondweeds (*Potamogeton*) and a few forms of cotton grass (*Eriophorum*). On a sunny slope on the shore of Disko Island there are a few orchids (*Habenaria* and *Listera*) and other plants which have been able

to occupy this exceptionally favoured station many miles north of their normal range. The tallest flowering plant is *Archangelica*, an Umbelliferous genus prized as a delicacy both by the Eskimo and sophisticated Europeans. The large rounded leaves of an *Alchemilla*, closely allied to the British lady's mantle, come next in size to those of *Archangelica*.

There is much heath land, but the heather and ling which we associate with heath moors are absent; their place is taken by *Cassiope tetragona*, characterised by the grooved leaves in four crowded ranks and yellow flower bells. *Cassiope* grows in Scandinavia, though not elsewhere in Europe, in the Rocky Mountains, and in central Asia. The crowberry, *Empetrum nigrum*, associated with the bilberry, is a common Arctic plant which has wandered as far as the southern end of South America. Saxifrages are abundant; the flowers of the purple saxifrage, *Saxifraga oppositifolia*, are an exception to the prevailing white. This species, one of many common to Greenland and Britain, occurs with other plants on the north coast of Greenland up to lat. 83° N.; it grows also on the higher slopes of the Himalayas. *Dryas integrifolia*, an American species differing but little from the British *Dryas octopetala*, is a conspicuous member of the west coast flora: *Dryas octopetala* is characteristic of the north coast and eastern Greenland. The familiar and always attractive hare-bell, *Campanula rotundifolia*, seems to be as much at home on the hills of Greenland as it is in England, in North Africa, and the Far East. Among other plants are the mountain sorrel *Oxyria digyna*; the moss campion, *Silene acaulis*, which is one of several cushion plants characteristic of rocky places; a closely allied plant, *Melandrium apetalum* (or *Lychnis apetala*); the yellow poppy; a species of *Pyrola* (the Labrador tea); *Ledum*, with its white sweet-scented flower heads, exceptional in a flora composed almost entirely of scentless flowers; also a willow herb with flowers larger and handsomer than those of our British species.

FIG. 3.—Willows and other plants on a delta below the cliffs of the Nugsuak Peninsula. (Photo. by R. E. Holttum.)

My main object is to give a general impression of the more obvious features of the present vegetation, not to describe many individual plants. A Scottish mountain with many immigrants from Arctic lands reproduces in broad features the Greenland landscape; but there is this difference: the mountain flora in Greenland reaches the coast and there is no intervening belt of forest and meadow. The mean temperature for July in lat. 69° N. on the west coast of Greenland is 47° F.; the corresponding temperature in the London district is 60° F.; in February the mean temperature in Greenland is 36° below freezing-point; in London it is 10° above the freezing-point. It is not until the temperature rises above the freezing-point that the plant world becomes active: in the extreme north the growing season lasts barely two months; it is only in July that rain takes the place of snow. In the region of Disko Island the summer season is not much longer. The summer is a period of concentrated effort; there is no time for the leisurely sequence of plants that bloom early and plants that bloom late. The unfolding of buds prepared in the previous year before the incidence of the winter sleep heralds the rush of new life with an almost explosive suddenness. Short

as the summer is, the plants succeed in spreading a parti-coloured carpet over hill slopes and valley, and in decorating rock ledges and fissures. A brilliant summer display is followed by a "rich autumnal melancholy": the ground is strewn with deep red and orange-yellow leaves which are soon to form a welcome blanket, aided by the snow which quickly follows, above the shoots entering on the long winter's rest.

Of the 390 vascular plants, Prof. Ostenfeld of Copenhagen thinks that about 13 per cent may have been introduced by the early Norse colonists; of the remainder, by far the greater number came from North America by way of the narrow channels separating the American archipelago from the north-west corner of Greenland. A smaller number travelled from Europe, some driven by wind, the passage probably facilitated by a frozen sea, others carried by birds.

Greenland as it is enables us to picture the British Isles in the grip of the Ice Age, at a time separated from the present by a comparatively short interval as geologists reckon time—say 40,000 years. We know that the flora of Britain, as also that of northern Europe generally, was much richer in Arctic forms than it is now. To give one example: from thin layers of peaty material in a gravel pit close to Cambridge, several Arctic species associated with more southern types have been identified, a mixture very similar to that in the present Greenland flora. When the Glacial period was at its height, the conditions in Greenland were even more severe than they are now; it is believed by some botanists that the whole of the vegetation colonised the land after the Ice Age had passed its climax. The entire vegetation, it is suggested, must have been destroyed. On the other hand, the occurrence of flowering plants on the northern border of Greenland and of some species on wind-swept island peaks above the level of the inland ice, gives support to Prof. Ostenfeld's view that a small proportion of the present flora survived the great ordeal. It is highly probable that, as in Greenland to-day, a comparatively rich flora is able to exist on the ice-free margins and on nunataks; so also when the British Isles were as Greenland is now, there must have been sheltered places which served as refuges for the hardier member of the pre-glacial vegetation.

Many Greenland plants have a circumpolar distribution; some are exclusively or mainly Arctic; others, though widely spread in Arctic regions, are established also in more southern stations. A southern migration from the far north was caused by the gradual extension of the ice; the majority of the plants, unable to endure the increasing hardships, were driven to alien lands and a few crossed the equator. When the ice retreated and the temperature rose, some of the travellers returned to the north; others found congenial habitats in the colder climate on mountain slopes. A few of the Arctic plants held on to life in their original homes as a small nucleus-company in sole possession of a territory temporarily deserted by most of the former occupants.

We have noticed the circumpolar range of many members of Arctic floras, and we have seen that some species are able to exist even on the northernmost edge of Greenland which looks out over the abysmal Polar sea. Turning to the Antarctic continent, we find an amazing contrast: flowering plants are unrepresented on the great mass of land surrounding the South Pole, even though its coast-line occupies a position where in the northern hemisphere there is a comparatively rich flora. Two flowering plants have been found south of lat. 60° S., in South Georgia (corresponding roughly in latitude with the British Isles), the South Shetlands, and Graham Land.

The Cretaceous Vegetation of Western Greenland.

We will now visit the cliffs and ravines of Disko Island, Upernivik Island, and the adjacent mainland, and glance at some of the fragmentary samples of the Cretaceous flora embedded in the mud and sand of an old river delta. We pass over the ages intervening between the maximum glaciation during the Ice Age, which antedates the present by some 40,000 years, to the early days of the Cretaceous period, separated from us by perhaps a hundred million years. Among the fossil ferns, by far the most abundant genus is *Gleichenia*, or *Gleichenites*—to use the name generally applied to extinct species. Many of the fronds are fertile, and it is possible to examine under the microscope the structure of the spore-capsules. The habit of the leaves and the structure of leaf-stalks and sporangia afford convincing evidence of close relationship with species of *Gleichenia* which are now among the more familiar ferns in the tropics. *Gleichenia* is unknown in Europe. Another type of fern (*Laccopteris*) is represented by fronds characterised by spreading finger-like branches set with long and narrow leaflets which agree closely with those of the Malayan genus *Matonia*. Similarly, a few specimens have been obtained which present a striking resemblance, in form and venation, to fronds of another Malayan and Indian genus, *Dipteris*, a plant described by

Alfred Russel Wallace as growing, in company with *Matonia*, on the higher slopes of Mount Ophir in the Malay Peninsula.

Leaves, twigs, and occasional petrified stems of conifers are fairly common. To-day there are no conifers in Greenland north of lat. 67° 50′ N., the northernmost limit of the juniper. Petrified stems of conifers rival in size the trunk of a well-grown fir, and the annual rings, in marked contrast to those in the dwarfed stem of an Arctic willow, are comparable in breadth with the rings in an English tree. Some conifers are represented by innumerable fallen leaves recalling the leaf carpet in a modern forest. Imperfectly preserved leaves are untrustworthy as criteria of precise affinity, but such characters as can be made out suggest relationship with the umbrella pine (*Sciadopitys*) of Japan. Twigs and occasional cones bear testimony to the occurrence in the Greenland forests of trees akin to the redwoods and mammoth trees which are now restricted to a narrow territory in California. Other conifers resemble cypresses ; and there is some evidence of the presence of trees allied to existing Araucarias.

Two other groups of naked-seeded plants (Gymnosperms) are represented : broad, wedge-shaped leaves with the blade cleft into two or more segments differ in no essential respect from the foliage of the maidenhair tree, the solitary survivor, and that only through the care of man, of a class which once overspread the world. The second group is the Cycadophyta, another branch of the plant kingdom which for long ages, in the Mesozoic era, was one of the ruling dynasties and is now represented by a comparatively small family, the cycads or sago palms, which are mainly tropical and reach their northern limit in Florida. It is unlikely that the Cretaceous fossil fronds, despite their general similarity to those of living genera, were borne by plants closely related to the true cycads ; they probably belonged to species of a wholly extinct section of the group.

Finally, we come to the flowering plants : the Cretaceous representatives of the class which is now dominant in the plant kingdom were trees, not low-growing shrubs or perennial herbs. By far the commonest tree, or at least the tree which has left the most abundant traces, seems to have been the plane, represented by several forms. It must be remembered that the available material, largely consisting of detached leaves, is a small collection of scraps ; a random choice of the winds which swept broken twigs and leaves into the waters of a river carrying to its delta a burden of sediment and vegetable debris, records destined to serve as a source-book for historians of a future age. Our conclusions are based on scraps of evidence, and the only plants we know are such as came within the reach of the agents which caused their preservation. In form, in venation, and in size, the leaves of the Greenland planes are scarcely distinguishable from those of trees now living in Mexico, in Greece, and Asia Minor. A type of leaf that is abundant at certain localities was for many years believed to belong to a tree nearly related to the tulip tree (*Liriodendron*) of North America and China.[2] The examination of more recently collected specimens has confirmed a previously expressed suspicion that the supposed *Liriodendron* leaves are not complete leaves but leaflets from the foliage of trees nearly related to the tropical genus *Dalbergia*, a member of the Leguminosæ. Some years ago the late Prof. Nathorst of Stockholm described specimens of large leaves and pieces of inflorescence presenting an unmistakable resemblance to the leaves and flowers of *Artocarpus*, the tropical bread-fruit tree. Some smaller examples of the same type were collected in 1921. The Cretaceous vegetation included other broad-leaved trees : magnolia, oak, trees related to members of the Laurel family and to species of the family Menispermaceæ now mainly tropical in distribution.

It is possible with the help of a little imagination to reconstruct a scene in Cretaceous Greenland. Across a broad estuary in summer, a range of mountains on which patches of winter snow are still unmelted ; in the foreground maidenhair trees, conifers foreshadowing pines, cypresses, araucarias, and other surviving members of the Gymnosperms. There are also many ferns, a few with erect stems, many with creeping rhizomes bearing long-stalked and repeatedly forked fronds, others with leaves divided into long, narrow arms. Among the broad-leaved trees are several planes, an oak, a magnolia in flower, trees with the foliage of dalbergias, the cinnamon, and trees belonging to families which since the Cretaceous period have wandered through Europe and the greater part of the North American continent, some surviving only in the southern tropics.

Fossil Plants as Evidence of Climatic Change.

An uncritical or superficial comparison of the Cretaceous vegetation with that in the Arctic regions at the present day would seem to necessitate

[2] In a book, "A Summer in Greenland," published by the Cambridge University Press in 1922, I referred to these leaves as *Liriodendron*; this mistake was corrected in the description of the Cretaceous flora published in the *Philosophical Transactions of the Royal Society* in 1926.

the inference that the Cretaceous climate must have been tropical. Some of the ferns and other plants obtained from the Greenland rocks have been compared with species that are now mainly tropical in distribution. Let us consider more closely the evidence and the conclusions which may legitimately be drawn from it. It is true that the existing species of the fern *Gleichenia* are for the most part tropical; on the other hand, the genus occurs in the Far East north of lat. 30° N. and extends a short distance north of lat. 20° N. in North America. Moreover, the occurrence of species at an altitude of more than 12,000 ft. in New Guinea and above 10,000 ft. on Ruwenzori in tropical Africa shows that the genus is able to tolerate conditions that are by no means tropical.

One of the most remarkable instances of the presence in the Cretaceous flora of a plant that is now tropical is furnished by *Artocarpus* (Fig. 4). The genus *Dalbergia* affords an almost equally striking contrast in geographical range. The present distribution of *Magnolia* in both the Old and New Worlds is far to the south of its former range. The plane tree (*Platanus*) now flourishes in temperate regions, in Greece and Asia Minor, and in America it passes north of lat. 40° N. The genus *Ginkgo* flowers freely in the south of France; in England it is comparatively hardy. The present geographical distribution of such Greenland Cretaceous genera as are now represented by existing species would seem to indicate a climate in the Arctic regions not less genial than that in southern Europe at the present day. The important point is the value to be attached to this kind of comparison. We know that closely allied species often grow in regions differing considerably in mean temperature.

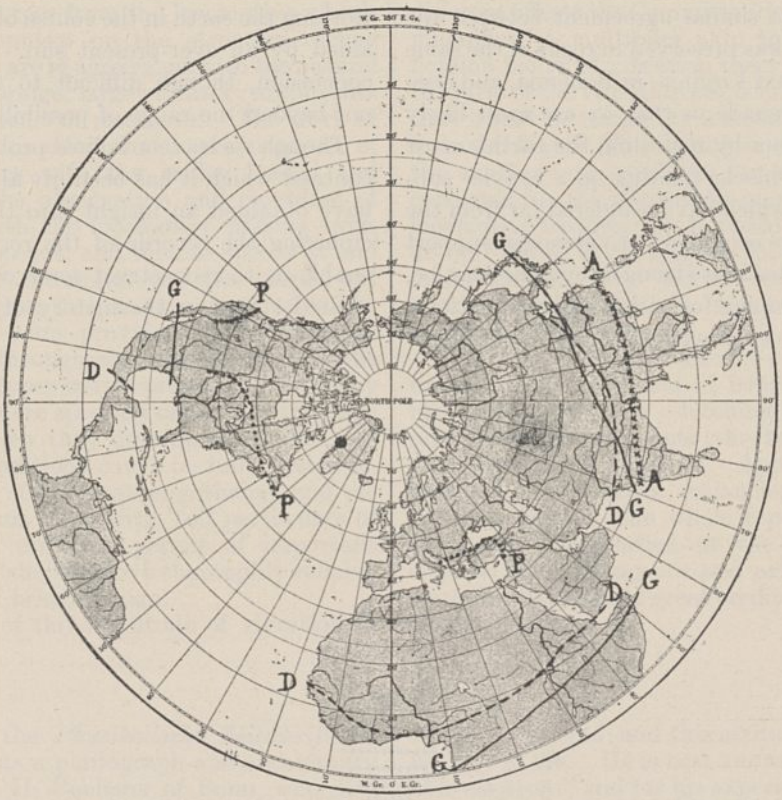

FIG. 4.—Map showing the approximate northern boundary of the area of distribution of living species of the following genera: A, *Artocarpus*; D, *Dalbergia*; G, *Gleichenia*; P, *Platanus*.

A further point is, ought we to assume that plants have remained unaltered in their constitution, in the sensitiveness of their living protoplasm, to the effects of cold and other external influences? It is surely rash to assume that in the course of ages there has been no change in the degree of response to factors which govern existence. My own view is that the practice of employing plants, especially extinct plants, as guides to temperature in the past, has been carried too far. There can be no doubt that, when the Cretaceous vegetation covered the western glens of Greenland, the climate must have been very much more genial than it is now; we cannot usefully attempt to estimate the difference in degrees of temperature. How can the difference be explained? The often-repeated proposal to assume movements in the position of the earth's axis—a shifting of the poles—even were there adequate grounds for the assumption, would not provide a satisfactory solution. Astronomers offer no encouragement to geologists prepared to take liberties with the axis of the earth. It is certain that the boundaries of land and sea, the height of the land as well as the area, have changed from age to age and that climatic conditions have correspondingly fluctuated. Changes in the relative position of land and water, such as we can legitimately postulate, would go some way towards provision of the environment demanded by the Cretaceous vegetation; but it is the opinion of some meteorologists that we cannot solve the problem on these lines.

The publication of Wegener's views on continental

drift, the shifting of continental masses by the slow drifting apart of slabs of land detached from a once continuous surface, seemed to offer a possible way out of the difficulty created by the occurrence of fossils in places where their presence has long been a puzzle to geologists. We may hope before long to have trustworthy data by which to test the value of Wegener's hypothesis. It is tempting to imagine Cretaceous Greenland lying many degrees south of its present position. The close correspondence between the Rhætic flora obtained from Scoresby Sound and that discovered some years ago in southern Sweden, and a similar agreement between the Arctic flora and floras preserved in rocks of the same age in Maryland and Virginia, in Bohemia, and elsewhere, almost persuade us that we are most likely to solve the problem by regarding the earth's crust as a collection of blocks floating on a heavier substratum, some of which have wandered far from the positions they once occupied. Evidence in support of changing climates is as strong as evidence can be, but we are still groping for satisfying explanations. It may be that no explanation can be found unless we adopt the Wegener hypothesis or some modification of it.

On the other hand, it is difficult to believe that the greater part of Greenland in the Cretaceous period was not, as it is now, well within the Arctic circle. Until we have convincing evidence of drifting continents, the question of how the problem of climatic change is to be solved must be left unanswered. Assuming an Arctic Cretaceous Greenland, it follows that the luxuriant vegetation must have been able both to lie dormant during the long winter night and to accomplish the miracle of reclothing the earth in the course of the short summer aided by an ever-present sun. This unavoidable conclusion, though difficult to accept, is perhaps not beyond the range of possibility.

Though we leave unsolved problems raised by the contrast which it has been my aim to illustrate, we have obtained an insight into the methods of deciphering the records of the rocks, records which enable us to reconstruct some of the sharply contrasted stages in the history of an ever-changing world.

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of the records therein obtained. The gross total of the work in the field and in the office is enormous; but the subsidiary work called for in the study of vibration instruments and their accuracy, special small-scale laboratory tests, the development of a bridge-oscillating machine, and the theoretical investigation of bridge vibrations, are all of considerable scope and important in themselves. Indeed, the analytical work of Prof. Inglis is already well known as a research of special distinction; but although it had been, in the main, separately and previously published in special papers, its function in guiding the investigation is only now clearly seen through its relation to the complete report.

The pulsating forces from the locomotive wheels create regular impulses on the structure during passage. If these are in agreement with the natural frequency of the bridge, large vibratory amplitudes may ensue as a result of resonance. The work of investigation, then, entailed the measurement of natural frequencies with the bridge loaded and unloaded; and the observation and recording of the deflections with the locomotive passing over, first at very low speeds, and then at speeds at and around resonance. Examinations were carried out on 52 bridges varying in span from 16 ft. to 345 ft. The locomotives were provided by the railway companies, who throughout co-operated with the Committee. All types were represented. In many cases the engines were specially chosen for the large hammer blow which they developed, so that the worst possible conditions could be fully observed. The total amount of information gathered, and the wide range of spans dealt with, full particulars of which are given, certainly permit of important conclusions which should prove thoroughly reliable in the guidance of bridge design.

The limitation of the amplitude of vibration in any case is partly an effect of damping; and in this connexion the interesting work on the influence of the locomotive springs should be noticed. There is apparently a pair of critical speeds depending on whether the suspension springs are in play or not, the probability depending on whether the oscillations of the bridge are sufficiently great to overcome the spring friction. Apart from damping, however, the span length is an all-important factor. With short spans the natural frequency is too high to be equalled by the locomotive speeds. With very long spans, on the other hand, the natural frequency agrees with low locomotive speeds, when the impulses are relatively small. To deal with these different effects the Committee develops a 'dynamic magnifier,' a multiplier akin to the usual amplification factor of vibration theory, which expresses the ratio of the vibration amplitude to the deflection that would be caused by a static load equal to the hammer blow. This factor is first developed for the synchronous condition for all spans and then corrected for the interrelations of span length and locomotive frequency. It would appear that spans around 100 ft. are subject to the largest dynamical magnification. The curve for this important factor should ultimately take an important place in bridge design rules.

The report briefly discusses other causes of impact, such as effects of irregularities of track, rail joints, and the 'lurching' of locomotives; and enters at large into the tabulation of loads and allowances for impact. Appendixes on impact formulæ, instruments, balancing of locomotives, etc., are given. The whole report constitutes an impressive compilation of the details and conclusions of a courageous and exhaustive full scale research that reflects great credit on the Committee and its staff.

Obituary.

THE issue of the *Physikalische Zeitschrift* for Jan. 1 contains a photograph and an obituary notice of Prof. A. H. Bucherer of Bonn, who died in May 1927, written by his former colleague, Dr. R. Tomaschek. He was born in Cologne on July 9, 1863, the eldest of six children of H. Bucherer, a chemical manufacturer, and his wife, a musical and highly educated English lady. He was educated at the Cologne High School, where he displayed a gift for languages. After serving his year in the army and spending a year at the Hanover technical school, he went in 1885 to the Johns Hopkins University, Baltimore, where he studied under Prof. Ira Remson, and for a time held a lectureship, then in 1893 to Cornell University, and in 1895 returned to Germany to complete his studies under Prof. Braun at Strasbourg, and took his doctor's degree in 1896. After a further three years at Leipzig under Ostwald, and at other universities, he became a lecturer on physical chemistry at Bonn in 1899. Later he became honorary professor, a post he resigned in 1923. From his youth he showed himself of independent thought, little disposed to conciliate those from whom he differed, and this attitude did not smooth his way in life. He is best known for his "deformable electron" and for his experimental determination of the influence of the speed of an electron on its apparent mass. He was not satisfied with Einstein's relativity theories, and was engaged towards the end of his life in an endeavour to deduce all the results of that theory and remove some of the difficulties it has raised, by a logical development of classical mechanics.

BY the recent death of Dr. Franz Oppenheim, announced in the *Chemiker-Zeitung*, Germany has lost one of its leading personalities in chemical industry. For nearly fifty years Dr. Oppenheim was associated with the Aktiengesellschaft für Anilinfabrikation in Berlin, of which concern he was president at the time of its inclusion in the I.G. Farbenindustrie Aktiengesellschaft in 1925. His ripe experience led to his appointment on the board of management of the latter amalgamation. He held several public offices connected with the German chemical industry; for example, he was treasurer of the Emil Fischer Society for the promotion of

chemical research, of the Adolph von Baeyer Society for the promotion of chemical literature, and of the Justus von Liebig Society for the promotion of chemical teaching. Quite recently he had been elected to the committee of the Chemisch-Technische Reichsanstalt in Berlin. He died at Cairo at the age of seventy-seven years.

THE death on Feb. 28, at the age of seventy-three years, of Dr. J. Wells, formerly Warden of Wadham College and Vice-Chancellor of the University of Oxford, is felt as a serious loss in many departments of University activity. Though not himself a student of science, he was never unmindful of the scientific traditions of the College over which he presided. It is undoubtedly the case that but for his wise and fair-minded dealing with the matter during his vice-chancellorship, the Lewis Evans collection of scientific instruments might have been lost, not only to Oxford, but to England as well. It should always be remembered that not only this invaluable asset for the history of science, but also many other advances in the scientific equipment of the University of Oxford, owe their efficiency, if not their existence, to the good offices of Dr. Wells.

News and Views.

THE fiftieth birthday of Prof. A. Einstein occurred on Mar. 14, and brought congratulations from all parts of the world. The German Chancellor hailed him as "Germany's great savant," and the Berlin municipality gave him the life tenancy of a pleasantly situated mansion. The University of Paris conferred an honorary degree. The Zionists are to plant an "Einstein Wood" near Jerusalem. Never before has the name of a scientific worker meant so much to the average man. Yet the creator of relativity and of the unitary field theory remains a quiet and retiring personality who dislikes publicity and society. His appearance suggests a musician, and indeed his love of music is one of his leading characteristics. Last year he gave a violin recital for a charity. He finds much pleasure in Russian literature, and appreciates modern ideas in architecture. He is an ardent sympathiser with efforts for world peace. Recently his health has not been good, but he says, "Illness has its advantage: one learns to think. I have only just begun to think."

EMPLOYERS and trade unionists associated under the auspices of the Conference on Industrial Reorganisation and Industrial Relations have recently issued an interim joint report on unemployment. In this report the problem of unemployment is investigated and suggestions made for its diminution. It is pointed out that, since 1920, there have seldom been fewer than a million workers unemployed in Great Britain, while at times the number has exceeded two millions. The heavy industries in particular have been severely hit by the depression, and the activity of certain prosperous industries, such as artificial silk and the motor industry, has not really compensated for this depression in the great basic industries. The report stresses three factors, monetary policy, world economic conditions, and the temporary displacement of labour due to the rapid adoption of labour-saving methods, as being the main causes of the present acute unemployment.

CORRESPONDING to this analysis of the causes of unemployment in Great Britain, the main remedies (that is, apart from immediate or merely palliative measures) suggested in the recent interim report are: *first*, an inquiry into monetary policy with whatever action may be found necessary; *second*, the reorganisation of industry, including rational organisation into larger units and the substitution of modern plant and technique; and *third*, measures to mitigate the evils resulting from rapid displacement of labour. Finally, the novel and interesting suggestion is put forward that a Labour Reserve Fund should be set up either by firms or by particular industries, which fund would be available for the purpose of assisting displaced labour. Progressive firms, it is pointed out, build up special reserve funds (apart from normal depreciation) to enable plant to be replaced before it is worn out, so that the most modern equipment can be introduced. It is even more necessary that such progress should not involve hardship to the human element.

INDUSTRIALISM in England moves on apace and the town continues to swallow up the countryside. This is a healthy economic sign even though it leads to unhealthy social conditions. The old order of towns and villages is giving place to new groups of towns or 'conurbations' and regional associations. Mr. F. Longstreth Thompson in his address on 'Recent Developments in Town Planning,' read at the Surveyors' Institution on Mar. 4, enumerates no fewer than 67 joint committees covering a total area of almost 12,000,000 acres and having a population of approximately 30,000,000—out of a total population for England and Wales of only 38,000,000. In view of the near approach of the next census, this raises a question of great importance. Hitherto the statistical information has been given separately for the towns, the urban and the rural districts. This assumes an economic isolation which no longer exists, and serious consideration should be given to furnishing returns on the basis of these new divisions which have developed by and from the recognition of mutual dependence and interests. For the sake of continuity it may be essential to maintain the earlier census divisions, but supplementary summaries may at least be possible.

RETURNING to Mr. Thompson's paper, he points out two useful outgrowths from the original Town Planning Act. For the moment, town-planning schemes are confined to land which is in course of development or appears likely to be used for building purposes. For boroughs and urban districts with a population

of more than 20,000, such schemes are obligatory, though the date of their completion has been twice postponed. The fact that other communities have organised themselves voluntarily for the preparation of a scheme shows that regional and town planning is now accepted as part of local administration. The latest developments have been in the direction of controlling areas already built upon. The Minister of Health now has powers to act with the view of preserving the existing character and protecting the existing features of any locality of special architectural, historic, or artistic interest. Advantage has already been taken of this permission to prepare schemes for Oxford, Winchester, Exeter, and Canterbury. Mr. Thompson notes also that official consideration is being given to the question of extending town-planning powers in respect of all built-on areas and that it may be anticipated that the scope of the Act will be enlarged in this sense in the not distant future.

AT the time of writing no detailed account has appeared of the circumstances attending the commencement of the disastrous floods that began on Mar. 13 in Alabama, U.S.A., owing doubtless to the speedy interruption of communications between the devastated area and the outside world. In the *Weekly Weather and Crop Bulletin* of the U.S.A. Department of Agriculture, it is stated that in January a large part of the States northwards and northwestwards from the Ohio and Missouri valleys had extreme cold, with heavy snowfall, which in some places exceeded anything known before in January. The rainfall over Alabama for that month was, however, not remarkable. In February there was an equally pronounced area of cold, rather farther south than that of January; the distribution of excessive precipitation was different and covered a smaller proportion of the country, Alabama lying, however, well within the most notable wet region, which included the Atlantic coastal States and extended south-westwards to the Lower Mississippi River. Within this wet zone the fall was sometimes more than twice the normal for the month. The same publication contains a note of excessively heavy rains over parts of Alabama early in the present month, and of the rivers Tombigbee and Coosa being in flood before the end of the first week.

MORE recent meteorological information is available on the charts for the northern hemisphere published by the Meteorological Office, London. Between Mar. 10 and 12, a large anticyclone moved eastwards from a position south of the Great Lakes. A long chain of depressions which extended from Alaska southwards to the western part of the Gulf of Mexico, if not still farther, began to replace the anticyclone and brought wet weather with southerly winds and rising temperatures to the Gulf States. Cyclonic weather appears to have continued at least up to Mar. 16, that is to say, for three days beyond the date when the floods are reported to have begun. The southerly winds evidently extended from regions well within the tropics, and must have been heavily charged with moisture. It is reasonable to suppose that the work of the tropical rainstorms may have been aided by rapid melting of the snow on high ground farther north, and that the overcharged rivers burst their banks or 'levees,' as happened in the Mississippi floods of 1926–27. Such disasters, and the more frequent devastations on a smaller scale due to travelling 'tornadoes,' are inevitable in a country where the gradient of temperature with latitude in early spring is so steep. It is the presence of the tempering waters of the North Atlantic in high latitudes that saves the British Isles from like visitations.

SEVERAL of the Livery Companies of the City of London have made very substantial provision for the development of science and technical education; and it is estimated that the amount actually expended by them on these objects exceeds two million pounds. Some of the companies have established scholarships or fellowships, in addition to making grants to institutions. Thus, the Grocers' Company has three scholarships of £300 a year each, for inquiry into causation of prevalent disease or as to means of prevention of premature death; the Salters' Company has founded its Institute of Industrial Chemistry, which offers fellowships of £250 to £300 a year to chemists of graduate standing to enable them to undergo a special further training for careers in chemical industry; the Drapers' Company has devoted £20,000 to scholarships for the textile industries; and similar endowments have been made by the Leathersellers' Company and the Fishmongers' Company. About six years ago the Armourers' and Brasiers' Company founded its research fellowship in metallurgy, which is awarded by a committee consisting of three persons appointed by the Company and four appointed by the Royal Society, and is of the value of £500 a year. Miss C. F. Elam has done very successful research in metallurgy while holding this fellowship for the past five years, and she still has another six months in which to continue her work. Announcement is now made that a new fellow will shortly be appointed. Full particulars of the fellowship can be obtained on application to the Secretaries of the Royal Society, Burlington House, London, W.1.

WIDESPREAD interest has been aroused by the announcement made by Mr. Leonard C. Woolley in the *Times* of Mar. 16 that he has discovered at Ur evidence for the historicity of the Flood of Genesis and Mesopotamian legend. In excavating the deposits belonging to the early occupation, to which reference has been made in previous communications, he found relics of human activity on the low-lying parts of the island which had been submerged under a huge bank of water-laid clay of some eight feet in thickness. On top of this was a fresh occupation which carried on some of the old traditions but departed entirely from others. There is thus a break in continuity caused by this disaster which he suggests can be none other than the flood of Sumerian history and legend.

COMMENTS by Sir E. A. Wallis Budge and others appear in the *Times* of Mar. 18, and they generally

accept Mr. Woolley's suggestion. The most interesting comment is that made by Prof. S. Langdon of Oxford, who has revealed some hitherto unpublished evidence from the expedition at Kish which conclusively points to the historical nature of the Bible story. At Kish, where excavations have been carried down to virgin soil, are two precipitations of clay containing potsherds and stranded fish lying perfectly horizontal in a way which could only be the result of a flood. This flood took place between 3400 B.C. and 3200 B.C. Another deposit of a similar character on the water level is dated at about 4000 B.C. Prof. Langdon is inclined to regard the flood of Genesis as the one between 3400 B.C. and 3200 B.C., which he connects with the Sumerian legend of Ziudzudra, the last of the antediluvian kings in the traditional royal lists, who built a boat to escape the waters. This legend was incorporated in Babylonian story and thence reached the Hebrews. In view of the extreme interest of this theory, it is scarcely necessary to stress the importance of securing continuity of excavation at both Ur and Kish. We hope that public interest may be stimulated by this latest discovery to provide the necessary funds.

IT is now more than six years since the inauguration of broadcasting produced a world-wide demand for a loud speaker. A paper by R. P. G. Denman on the development of these instruments was read to the Royal Society of Arts on Mar. 13. The early forms of loud speakers were incapable of radiating sound the frequency of which was below about middle C (256). This was not at first recognised, as the ear has a marvellous power of reconstructing a mutilated complex tone. A pure tone is essentially a single vibration which follows the sine law. In a complex tone we have one or more overtones in addition. The B.B.C. recently carried out experiments to determine the minimum value of the amplitude of the second harmonic which must be superposed on the first harmonic so that it becomes noticeable in an ordinary loud speaker.

IT was found in the B.B.C. experiments that when the frequency of the fundamental was 900, the amplitude of the second harmonic has to be at least 3 per cent. of the amplitude of the fundamental before it becomes audible. At higher frequencies a much greater percentage is necessary. When the frequency, for example, is 5000, the percentage of the amplitude of the second harmonic required for audibility is 49. The introduction of cone loud speakers and the annulment of resonance effects by frequency filters were notable steps in advance. The efficiency of transformation of all ordinary loud speakers is very low. Some of the loud speakers, however, used in the commercial operation of 'Movietone' and 'Vitaphone' talking-film systems have efficiencies of 30 per cent. A new Western Electric loud speaker is claimed to have a fifty per cent efficiency. It seems probable that great improvements will be made in the near future in the instruments used in theatres, and that the small domestic loud speaker will either remain as it is or become similar to a small auditorium instrument.

AT a meeting of the Section of Neurology of the Royal Society of Medicine, held on Mar. 14, a kinematograph demonstration was given of a film, showing some of the experiments on conditioned reflexes done in Prof. Pavlov's laboratory at Leningrad. Although the work and conclusions were familiar to most of the audience, yet it was obvious that the film proved interesting, giving, as it did, a reality to experiments hitherto known only through verbal descriptions in text-books. The film is not intended for the general public, but as a means of illustrating lectures for students; as such it certainly seems to have many advantages. There is, however, a possibility of danger, for it would be very easy to select a series of experiments because they happen to illustrate a thesis and to omit the negative instances; the arresting nature of the presentations renders this more serious than in any other form of exposition. There can be no question as to the scientific value of Prof. Pavlov's experiments, but the deduction therefrom that man is nothing but a bundle of conditioned reflexes is fallacious. The Society is to be congratulated on the novel and provocative form of meeting.

THE controversy about the future development of the Bodleian Library has been closed by the acceptance of a decree in Congregation authorising the University Chest to receive subscriptions for the carrying out of a definite scheme of extension. The scheme is of the nature of a compromise, and is probably not thoroughly satisfactory to any of the interested parties. It involves the transformation of part of the north side of Broad Street, one of the characteristic features of Oxford, and also the removal of some of the Bodleian stores to a site three miles distant from the city. A recent decision of the Curators to exclude certain kinds of literature, considered to be of merely ephemeral value, gives rise to some difference of opinion, many people holding that publications of this kind may become, with the lapse of years, of great interest and importance as illustrating manners and modes of life of the present day.

THE Zoological Society of London celebrates this year the centenary of the granting of its Royal Charter in 1829, three years after the formation of the Society itself, and an announcement has just been made of the manner in which the occasion is to be commemorated. The large number of fellows, of whom there are now more than 8000, has made necessary the arranging of more than one function. A centenary celebration meeting will be held in the Great Hall, University College, Gower Street, on April 29, when centenary speeches will be delivered and official and foreign guests will be present. In the evening of the same day the foreign and official guests will be entertained to dinner by past and present members of council and other officials of the Society. The greatest gathering of all will be a centenary celebration garden party, to be held at the Society's Gardens on the evening of June 20, and to this every fellow will receive an invitation for himself or herself and one guest. In an earlier note we referred to the historical account of the development of the Society to be written by Dr. P.

Chalmers Mitchell, and we understand that this interesting volume is well advanced.

As recently announced by the Prime Minister of the Commonwealth of Australia, the Commonwealth Government is promoting an expedition, under the leadership of Sir Douglas Mawson, for scientific and survey work in the Antarctic lands lying south of Australia. The British Government is making a financial contribution sufficient to enable the R.R.S. *Discovery* to be placed at the disposal of the Expedition. It is anticipated that the investigations will occupy two seasons, from the summer of 1929 to the summer of 1931. Every effort will be made to maintain the closest co-operation between the Australian work and that already in progress under the *Discovery* Committee, and in order to assist in securing complete uniformity of method a member of the *Discovery* staff will be seconded for service with the Australian Expedition. In view of the loan of the *Discovery* to the Australian Expedition, the Secretary of State for the Colonies has sanctioned the construction of a ship which, with the *William Scoresby*, will enable the work of the *Discovery* Committee to be continued. The new vessel will be a steamship with a superior radius of action, and will be able to undertake long ocean traverses for which the *Discovery* is not well suited. She will carry echo-sounding gear and also a specially designed winch, carrying 5000 fathoms of wire rope, for working large nets at any depth. For smaller nets and hydrological observations three auxiliary machines will be provided. Large biological and chemical laboratories on the upper deck, a photographic room and a survey office, workshop storerooms and other accommodation necessary for the intended service are being provided. In addition to a full complement of executive officers, she will carry a scientific staff of six and a survey officer, the total of officers and crew being about fifty. The vessel is being constructed at Port-Glasgow by Messrs. Ferguson Bros. (Port-Glasgow), Ltd.

ON Tuesday, Mar. 12, Dr. H. Przibram, professor of experimental zoology in the University of Vienna, delivered, at the request of Prof. E. W. MacBride, a lecture on the "Transmission of Acquired Modifications from Parent to Offspring" in the Imperial College of Science. Dr. Przibram commenced by referring to the four postulates in Weismann's theory of natural selection, and stated that every one of the four has proved to be untrue. He also referred to theories of Mendelian inheritance, depending upon 'genes,' which would require modification in the event of the discovery that acquired modification could be transmitted to offspring. Dr. Przibram pointed out that although no one sufficiently skilled to be able to repeat the work of his pupil, Kammerer, on rearing Amphibia for several generations had yet appeared, Kammerer's results, so far as the effects of the environment on one generation are concerned, had received abundant confirmation in recent years, the latest of these being the discovery in the Jardin des Plantes in Paris of a strain of *Alytes* which bred in or near the water, in which the males had vestigial 'nuptial pads' on their hands.

DR. PRZIBRAM described a long list of experiments made in recent years which had given evidence of the transmission of acquired characters. Many of these have been performed in his own laboratories under his supervision, and incidentally he remarked that the fact that some people had tried to repeat them and failed was no disproof of their validity, for in experiments of this kind where conditions are complicated, the failure to get one condition out of the whole number right was sufficient to upset the experiment. Perhaps the most interesting part of the lecture was that in which Dr. Przibram outlined his attempt to analyse how environmental effects are transmitted to offspring; thus rats brought up in high temperatures have longer tails than those bred at low temperatures, but the heat of the air does not act directly on the growth of the tail, but indirectly, by stimulating metabolism and increasing body temperature. One is involuntarily reminded of that far-seeing dictum of Lamarck's: "But what ever it does, the environment never directly affects the growth of an animal, but indirectly by altering its needs necessitating fresh efforts on the part of the animal to satisfy them, causes it to use some parts more than others and so stimulates their growth."

IN the course of an address on "Road Transport," read before the Junior Institution of Engineers on Mar. 8, Mr. S. H. Hole stated that the first practical mechanically propelled road vehicle was the steam tractor built by Cugnot in 1769, which carried four persons and attained a speed of 2¼ miles per hour; an improved type was designed to carry 4½ tons at the speed mentioned, and cost £800. In 1798, Trevithick and Vivian patented inventions relating to high pressure steam in connexion with locomotion, and in 1803 had a road vehicle in operation in the streets of London. Between 1827 and 1830, steam coaches were in operation between Gloucester and Cheltenham which had an average speed of 12 miles per hour with a maximum of 20, and they were operated successfully in London until Parliament enforced tolls in the proportion of 12 to 1 as compared with the four-horse coach, and they thus fell into disuse. A still further check to the progress of mechanical transport was the Act passed in 1865, limiting the speed of mechanically propelled vehicles in the country to 4 miles and in towns to 2 miles per hour, with a flagman in front. The years 1906 and 1907 saw important changes in motor-car design, when magnetos replaced coil and battery ignition and the worm drive to the live back axle, coupled with a differential gear, was built by Lanchester. The more rapid development in mechanical transport, both for goods and transport, during the past twenty years, has been due largely to research on the properties of special steels; this has enabled great reductions in weight to be made without sacrifice of reliability. The progress in machine tools and in the scientific balancing of engines, especially for aeroplane purposes, have all aided the evolution of the modern car. Further lines of progress will be in the number and positioning of cylinders, higher speeds of engines, combined with decreased weight and greater flexibility.

THE dramatic element in aerial flight has always appealed to the popular press and would have succeeded in maintaining a live interest in that subject whether the technical men were active in it or not, but the scientific interest has been steadily pursued, and the time is rapidly approaching when special journals will require to be produced to cater particularly for this development. Germany has already a number of journals of this type. In Great Britain we have been very prone in the past to maintain our scientific journals in omnibus type, and only workers in such specialised fields realise the difficulties involved in digging out and collecting the papers they are concerned with from these various miscellaneous journals; our scientific press is certainly not scientifically organised. On the aeronautical side, the reports of the Aeronautical Research Committee have in this respect pursued a very effective policy, but they suffer from two disadvantages. They are in the first place almost entirely confined in their publications to the work which is being undertaken in Government research establishments: in the second place, they are issued to the public almost a year after the work has been executed. Scientific workers, therefore, not professionally in immediate contact with these places, but striving to work in these fields, must continually lag behind in respect to any developments that have occurred. No doubt there are difficulties in the way of earlier issue to the public. A new journal, styled *Aircraft Engineering*, under the able editorship of Lieut.-Col. W. Lockwood Marsh, has now made its appearance—an old title for a new paper. In format it is not unlike *Engineering* itself, but it is a monthly journal and restricts its attention to those matters of direct interest in the design and construction of aircraft and in research work on aerodynamics. It is intended to be a scientific and technical journal for aeronautical engineers and research workers. The first issue in March contains, among other important articles, a résumé of the research and technical progress in 1928, special discussions on stream lining of air-cooled engines, on a new theory of tail flutter, and on the efficiency of the auto-gyro. If the standard of succeeding issues can be maintained, this journal should play a very important part in the concentration of aeronautical publication.

ACCORDING to the annual report of the U.S. Bureau of Standards for the year ending June 1928 (Washington, D.C.: Government Printing Office, 5 cents) the work of the Bureau has been divided into two groups, the first dealing with scientific research and testing, the maintenance of standards and their improvement, the second with the supervision of commercial standards with special reference to the needs of industry. The regular staff now numbers 860, and the salaries 572 thousand dollars per annum. The fee values of the tests carried out by the Bureau were: for the public, 67 thousand dollars; for the Government and States, 351 thousand dollars; and for the Bureau, exclusive of research and standardisation tests, 46 thousand dollars. Upkeep of the buildings, plant and grounds has cost 83 thousand dollars and additions 88 thousand dollars. The work done is summarised under various headings, the total cost of each group is stated, and ten or a dozen lines are devoted to a description of each research of the group.

IN order to test structural and miscellaneous materials, the Bureau of Standards maintains three branch laboratories, one at Northampton, Pa., one at Denver, Col., and one at San Francisco. These branch laboratories are fully occupied, and there is need for increase of personnel and equipment to cope with the ever-growing increase in the work. In view of the hazardous tests sometimes carried out at the Bureau, a demand is made for a first-aid station under the care of a competent physician. Elaborate apparatus has been constructed in order to obtain a more accurate value of the constant of gravitation, as a knowledge of this constant is necessary in many tests. The tests made with metal furniture prove that the fire risk is considerably diminished by its use. Metal shelving in particular prevents a fire from spreading. The large variation in the index of refraction of lead glass with the annealing temperature has been investigated. Good practical work has been done in developing radiobeacons for aeroplanes. A demonstration between two air ports was given of a new type of beacon which produces visual signals on an instrument on the aeroplane board. Aeroplanes fitted with these instruments can fly perfectly safely in fog or darkness between these ports although no landmarks are visible.

THE Council of the Royal Society of Edinburgh has awarded the Gunning Victoria Jubilee Prize for the period 1924–28 to Prof. Edmund Taylor Whittaker, in recognition of his distinguished contributions to mathematical science, and of his promotion of mathematical research in Scotland; and the Makdougall-Brisbane Prize for the period 1924–28 to Dr. W. Ogilvy Kermack, for his contributions to chemistry, published in the Society's *Proceedings* and elsewhere.

THE Council of the Iron and Steel Institute has this year decided to present its Carnegie Gold Medal to Dr. Arthur Bramley, head of the Metallurgical Department of the Loughborough College. The Medal, which was founded by the late Mr. Andrew Carnegie, is awarded to the research worker who, in the opinion of the Council, has produced the most meritorious piece of research work in each year under the scheme of the Andrew Carnegie Research Scholarships of the Institute.

AT the invitation of the Société Française des Électriciens, the summer meeting of the Institution of Electrical Engineers will be held in France on June 11–22. The Paris-Orléans and Midi Railways are providing railway transport free of charge for a trip to the Pyrenees, and the Chemin de Fer du Nord will transport the party between Calais (or Boulogne) and Paris at half-fare. Numerous visits to works and places of interest are being arranged.

A PUBLIC meeting on Developments of British Chemical Manufactures has been arranged by the British Science Guild and will be held in the Mansion House, E.C.2, on Wednesday, April 24, at 4.30 P.M., when the Rt. Hon. Lord Melchett, president of the

Guild, will take the chair. The programme will include the following addresses: (1) "Fertilisers from the Air," by Sir Frederick Keeble; (2) "Rayon (Artificial Silk)," by A. B. Shearer; and (3) "Synthetic Drugs," by F. H. Carr. Tickets for the meeting may be obtained on application to the British Science Guild, 6 John Street, Adelphi, W.C.2.

A SEVERE earthquake occurred in the North Atlantic on Feb. 22 at 3.41 P.M. The position of the epicentre is given by the seismologists of the U.S. Coast and Geodetic Survey as approximately in lat. 10° N., long. 42° W., or about a thousand miles from the mouth of the river Amazon (*Daily Science News Bulletin*, Science Service, Washington, D.C.). This region is one of the belts of seismic activity in the Atlantic Ocean and was the scene of a severe earthquake in October 1925, recorded by instruments all over the world. As it also lies along the course of vessels between New York and Pernambuco, the shock must have been felt on any passing ships as if the vessels were grating on the ground below.

A NEW part (No. 813) of Sotheran's invaluable "Catalogue of Science and Technology" has reached us. Its designation is Part IX.: XIII. Engineering, Section 1, and gives the titles of and much bibliographic information respecting periodical publications, early works to the end of the eighteenth century, and general works, including lives of engineers. The list can be had upon application to the publishers, 140 Strand W.C.2.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—Temporary assistants and temporary sub-assistants in the Herbarium of the Royal Botanic Gardens, Kew—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (April 8). A sub-inspector of quarries in the Midland and Southern Division of the Mines Inspectorate—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, Millbank, S.W.1. (April 20). A secretary of the Institute of Physics and editor of the *Journal of Scientific Instruments*—The President, Institute of Physics, 1 Lowther Gardens, S.W.7 (April 21). A director of extra-mural studies in the University of Birmingham—The Registrar, The University, Birmingham (April 27). A clinical pathologist at the Crichton Royal Mental Hospital—The Physician Superintendent, Crichton Royal Mental Hospital, Dumfries. A clinical bacteriologist at the Cheshire Joint Sanatorium, Market Drayton—The Medical Superintendent, Cheshire Joint Sanatorium, Market Drayton. A male junior assistant under the Directorate of Ballistics Research, Research Department, Woolwich—The Chief Superintendent, Research Department, Woolwich.

Our Astronomical Column.

A PROBABLE NEW TROJAN PLANET.—The Trojans are a group of minor planets the period of revolution of which is the same as that of Jupiter, and which maintain an approximately constant position relatively to Jupiter; four of them, Achilles, Hector, Nestor, Agamemnon, are 60° in front of Jupiter, while Patroclus and Priamus are 60° behind it. *Beobachtungs-Zirkular* No. 7 states that Nestor was photographed by Dr. Reinmuth at Königstuhl on Feb. 9; on the same plate, 46′ east of Nestor and 36′ north of it, another planet was found with the same motion as Nestor in Right Ascension (−0·5 m. daily). This is much slower than the average retrogradation of the asteroids when near opposition, and makes it probable that the new body belongs to the Trojan group. Its provisional designation is 1929 CM. It is slightly brighter than Nestor, their magnitudes being 14·2 and 14·8 respectively. 31 new planets were discovered in the first half of February.

THE SPECTRA OF COMETS.—The theory of Schwarzschild and Kron on the nature of comets' tails is extended by H. Zanstra in the *Monthly Notices* of the Royal Astronomical Society, vol. 89, p. 178, to explain the line and band spectra of the heads. It is suggested that the observed lines are resonance lines producible under low excitation, or in some special instances are caused by fluorescence; in other words, sunlight is absorbed by the gases of the comet's head and then re-emitted in the same (or sometimes longer) wave-length. The intensity of the spectrum to be expected from this theory is computed and compared so far as possible with actual observations. The result seems to show that the theory is quite sufficient to account for the observed luminosity in the case of such comets as are considered, though some of the very bright comets with only one known apparition may provide a severer test. One example of such comets (Comet Wells, 1882) is discussed in some detail. The *D*-lines of sodium were observed to be very nebulous, which is in agreement with the requirements of the theory, while the iron lines noticed in this comet are capable of explanation by fluorescence.

THE UNIVERSITY OBSERVATORY, OXFORD.—The report of this Observatory for 1928 has been issued. It records the completion of the measurement of the plates taken at the Vatican Observatory for the Astrographic Catalogue, and sent to Oxford for measurement; the Pope has presented medals to the director and his assistants in recognition of their share in this work. The zeal of the director, Prof. H. H. Turner, for the completion of the whole Catalogue is well known. He has undertaken to complete the southern portion (+32° and +33°) of the zone originally allotted to Potsdam. The northern portion is being undertaken at Hyderabad, and it is hoped that the middle may be filled in by an observatory in the United States.

Allusion is made in the report to Dr. Fotheringham's work on the Venus tablets of Ammizaduga, in conjunction with Prof. Langdon, and to his studies on the relation between Babylonian and Greek astronomy, with special reference to Naburianos and Cidenas.

The new buildings in the Observatory have been completed. The seismographs have been moved there from the Clarendon Laboratory. The upper rooms afford a much-needed extension to the Library. Five papers and reports on seismology by the Director have been published since the last annual report. The cœlostat belonging to the Observatory has been lent for the expedition to Siam to observe the total solar eclipse of May 9.

Research Items.

NEOLITHIC FAYUM POTTERY.—In *Ancient Egypt*, 1928, pt. 3, Miss G. Caton-Thompson has released in advance an account of the neolithic pottery of the Fayum, pending adequate publication of the material collected in the three seasons' investigations, of 1924–1925, 1925–26, and 1927–28. The bulk of the material is from a larger midden settlement, Kom W, of more than 600 ft. by 400 ft. and about 5 ft. deep. It belongs almost entirely to the earlier Neolithic or Fayum A period. Other and better-preserved vessels came from straw-lined granaries. Some were found singly in other parts of the desert. All the pottery is handmade in coarse clay with straw as a *degraissant*. Unequal and insufficient firing has produced a grey mottling on red pots, the core in nearly all cases being black and soft. Owing to the combination of organic matter from the midden and the salt of the desert, the texture has suffered and few pots retain their original surface. Many of the pots were rough-faced and devoid of slip and burnish. Some may originally have had a slip. A polished ferruginous wash and a burnished black finish were frequently used. One class (class 5) is associated with a thin ferruginous slip, polished and of a purple-red colour similar to the old Nile Valley pre-dynastic wares. Black polish is rare. A few sherds were hand smoothed. The forms are grouped into five classes: (1) Small bowls and cups; (2) cooking bowls or pots—these two classes being of the type common to all primitive ceramic development; (3) pedestal cups, an important class suggesting the prototype of rare and early Nile Valley pre-dynastic vases—this form occurs in the Middle Neolithic stratum at Knossos; (4) cups, with legged bases—poorly represented; (5) rectangular dishes with 'peaked' rims—a type which appears to have no parallel in the pre-dynastic period.

MILK YIELD OF DAIRY COWS.—A statistical analysis of the data of the Scottish Milk Records Association by Dr. J. F. Tocher has been issued by the Biometric Laboratory, University College, London (*Biometrika*, vol. 20, B, pt. 2, p. 105; 1928). There is a distinct improvement in the milk yields of recent years compared with those of twenty years ago, from an average of 16½ gallons to one of 18½ gallons per week. The yield per week is shown to vary with age of cow. Young cows give an average of less than 16 gallons, whereas cows of 9-11 years give more than 20 gallons. There has also been an average increase in total butter fat, amounting to 7 per cent. The monograph is profusely illustrated with diagrams and photographs, and contains a number of tables, some of which should be of value to the practical dairy farmer. For example, there are tables showing the yield of milk for each stage of lactation period, and one showing the average amount of butter fat obtained for cows of a given age and for a given length of lactation period. A farmer could thus compare the actual yield of a cow with the average, and so determine whether she is up to standard.

CONTROL OF POWDER-POST BEETLES.—Beetles of the genus *Lyctus* are commonly termed 'powder-post beetles' from the fact that their larvæ bore into timber and, as a result, give rise to the production of a fine powdery dust or 'frass.' Particular attention has been paid to these insects at the Forest Products Laboratory at Princes Risborough, and the result of recent inquiries are embodied in *Bulletin* No. 2 (1928), Forest Products Research, by Dr. R. C. Fisher. Evidence has been collected which indicates that the increase and spread of these insects in Great Britain since the War have been due to the importation of infested American ash and oak. Among the most notable facts stressed in this *Bulletin* is the egg-laying habits of these beetles. In the species studied the eggs are always inserted within the vessels or pores of the wood, whether they be transversely or horizontally exposed, and are never laid on the surface. It is therefore impossible to see a *Lyctus* egg except by microscopical examination of the wood. A definite correlation has been found between *Lyctus* attack and the size of the vessels in different kinds of wood. So far as is known, the insects never attack conifers, probably owing to the absence of vessels or pores in which their eggs could be placed. Not all hard woods are attacked, and those with large vessels are the most liable to suffer: such close-grained timbers as beech and birch have not been observed to be attacked, and it is very probable that the size of their vessels is too small to allow of the insertion of a *Lyctus* egg. In so far as control measures are concerned, the Laboratory has concentrated its attention upon the practicability of heat sterilisation of infested timbers before practical utilisation. Humidity is an important factor to be taken into account, and there is evidence that prolonged treatment with humidity between 60 per cent and 70 per cent, provided the temperature does not fall below 120° F., would probably suffice for the purpose. The *Bulletin* may be obtained, price 3*s*. net, from H.M. Stationery Office or through any bookseller.

THORACIC APPENDAGES OF *ANOPHELES* LARVÆ.—The existence of peculiar paired dorso-lateral organs on the anterior region of the thorax of *Anopheles* larvæ was described by Nuttall and Shipley in 1901, and confirmed by Imms six years later. On account of their transparency these structures are not easily seen, and this probably explains why they have been almost entirely overlooked by subsequent investigators. Mr. M. O. T. Iyengar, in the *Indian Journal of Medical Research*, vol. 16, No. 2, 1928, has studied these organs in 29 species of *Anopheles* besides examining many Culicine larvæ, but in the latter creatures the thoracic appendages were entirely wanting. Each appendage is capable of contraction and extension, and is moved by a special muscle. Morphologically the organ consists of a basal pedicle and two apical lobes, each of which is provided with a flat cuticular expansion. It is believed that the thoracic appendages, by maintaining close contact with the surface film, act as anchoring organs which maintain the larva in a constant position, and enable it to withstand the forward 'creep' while working its mouth-brushes and thus setting up a current in the water. In the case of a Culicine larva, the movements of the mouth-brushes causes the animal to move in a forward direction all the time it is feeding.

NEW BIVALVES FROM SOUTH AMERICA.—In a paper entitled "New Freshwater and Marine Bivalve Shells from Brazil and Uruguay" (No. 2762, *Proceedings of the United States National Museum*, vol. 74, art. 17), Mr. William B. Marshall, assistant curator, Division of Mollusks, United States National Museum, describes a new pearly freshwater mussel from Brazil, four new freshwater mussels and three marine bivalves from Uruguay. *Diplodon Jacksoni* n. sp. is a handsome shell collected by Mr. Ralph W. Jackson of Cambridge, Md., from Arcas, Province of Mines, Geraes, Brazil. Its beak sculpture is usually well preserved and the whole shell measures 49 mm. by 28 mm. (type specimen). It is closely related to *Diplodon santamariæ*. The mussels from Uruguay are a Diplodon, two Anodonites and a Mycetopoda.

A Corbula and two Nuculas from Uruguay are also described. One of the Nuculas, *Nucula Felipponei*, called after the donor, was taken from the stomach of a fish known as a corbina, *Micropogon undulatus*. Photographic plates are given of all these new species.

THE CULT OF THE PRIMULA.—The first hundred pages of the *Journal of the Royal Horticultural Society*, vol. 54, part 1, 1929, are taken up with the report of the proceedings of the fourth Primula Conference, held under the auspices of the Society on Thursday, May 24, 1928, during the Chelsea Show. The greater part of the space is occupied by the important paper by Prof. W. Wright Smith of Edinburgh and Mr. G. Forrest upon "The Sections of the Genus *Primula*." This paper has previously been published in the *Notes from the Royal Botanic Garden*, Edinburgh, No. 76, March 1928. Accompanying this paper in its present, somewhat altered, form are a large number of beautiful photographic illustrations of various species of *Primula*. Similar photographs accompany many of the other papers, which include some interesting notes on the Primulas of the Far East, especially a valuable discussion of their natural habitats in the East, by Dr. W. Handel-Mazzetti, of the Natural History Museum, Vienna. There are also valuable notes on cultural experience with difficult and rare species, whilst the workers at the John Innes Horticultural Institute are responsible for some interesting communications upon genetic experiments with *Primula*. The late Dr. Bateson commenced experiments upon the genetics of *P. sinensis* so far back as 1903; these were continued by Mr. Gregory and had yielded many valuable results before they were cut short by his untimely death in 1918. The three papers in the *Journal* upon *P. sinensis*, *P. Kewensis*, and *P. Juliæ* and its hybrids with the oxlip and primrose, are brief and clear summaries of the present state of our knowledge of the genetics of these species.

JOLY'S THEORY OF THERMAL CYCLES.—In a recent number of *Gerlands Beiträge z. Geophysik* (vol. 20, p. 288; 1928), Prof. J. Joly replies to criticism by Dr. F. Lotze. He points out that the theory of thermal cycles is more in keeping with the complexity of the earth's surface history than one of uniform loss of heat. The suggestion of Dr. J. W. Evans that radioactive energy may be in large part expended on chemical changes within the rocks dies hard. Joly again directs attention to the fact that this suggestion is in flat contradiction with all investigations bearing on the subject. He further claims, in opposition to Lotze, that volcanic heat liberated at the surface is negligible in quantity, and that it cannot be supposed to proceed in its entirety from the deep-lying substratum which is responsible for the cycles. Perhaps the most interesting feature of this short paper is the tacit abandonment by Joly of the 'short' estimates of geological time, of which in recent years he has been by far the most ardent advocate. On p. 289 he asks, "To what other source than the theory of thermal cycles can we refer the repetitional character of earth-history covering much more than a thousand million years?" Later, he states that "the surface history of the earth must have already run some thousand millions of years when the Appalachian Revolution took place." The momentum of the older view favouring a hundred-million-year earth may now be said to have spent itself, leaving a clear field for the development of a geological time scale based on radioactive disintegration.

DOMESTIC GRATES AND COKE.—In a lecture delivered on Jan. 16 and printed in the *Journal of the Royal Society of Arts* for Feb. 15, Prof. C. R. Darling put before the Society what he considers a practical solution of the domestic smoke problem. He has used, for two years, a grate for burning gas coke, in which the difficulty of ignition has been met by the incorporation of a gas burner. This grate, introduced by the South Metropolitan Gas Company, seems satisfactory and economical, so that, taken in conjunction with other appliances and smokeless fuels available, Prof. Darling considers that there is no technical obstacle to a large immediate reduction of domestic smoke. This would follow the replacement of raw coal by gas coke and anthracite where possible, and so far as available. Meanwhile the development of low temperature carbonisation processes will result in additional supplies of smokeless fuels to supplement the coke by the time demand for coke overtakes supply. Technically, Prof. Darling's claims are well founded. The room-heating efficiency of gas coke consumed in an open grate is greater than that of coal and at least as great as that of low temperature cokes. The grate, however, must be accommodating to the peculiarities of coke, but the monetary saving following the use of coke will easily pay the cost of adaptation. Unfortunately, in the matter of home-heating, custom, prejudice, and æsthetic considerations often determine the choice, not technical efficiency. Moreover, until the ash content is brought much nearer to what is customary in house coal, it will be hard to secure the general adoption of coke in the open domestic fire.

EFFECT OF ANTI-KNOCK MATERIALS ON FLAME SPEED.—The *Proceedings of the Imperial Academy of Science*, Tokyo, vol. 4, No. 9, contains a paper by Y. Nagai on the speed of the initial uniform movement of the flame in hydrocarbon–air mixtures. The effect of the addition of up to 25 per cent of diethyl selenide, tetramethyl tin, and tetramethyl lead to such mixtures was investigated in a long glass tube. The flame speed, which was measured photographically, decreased with the concentration of the anti-knock agent up to a certain point. This effect is explained by a consideration of the differences between the theoretical propagation temperatures of the hydrocarbon (1450°) and diethyl selenide (1750°) and the tetramethyl compounds (both 1680°). It is suggested that the theoretical flame propagation temperature of the hydrocarbon is raised by addition of the anti-knock compound until it reaches the corresponding temperature for that compound. The maximum anti-knock effect is then obtained.

AMATEUR KINEMATOGRAPHY.—Dr. C. E. K. Mees has contributed an article to the January issue of the *Journal of the Franklin Institute* which includes an account of the Eastman Kodak Company's new Kodacolor process, which has been specially designed for the production of coloured films by amateurs. In this, a colour filter with three separate areas—red, green, and blue—is used over the surface of the camera lens, and the film surface, instead of being flat, is embossed with small cylindrical lenses of the film material by forming it through steel rollers. These lenses intercept the light directed on to the sensitive emulsion, which is at the back of the film, and so impress upon the latter three distinct sets of images, one for each of the primary colours of the filter. The film is developed by a reversal process, and projected through an optical system which is essentially the same as that used for its production, the triple filter appropriate to the colour sensitivity of the emulsion being again placed over the lens. A drawback of this method appears to be that there is considerable absorption of light by the colour filter used in projection,

with the result that only small pictures can be thrown on to the screen, but Dr. Mees states that although the Kodacolor process has been on the market for only a short time, the results that are being obtained show quite definitely that it is successful, and that with reasonable care there is no more difficulty now in obtaining motion pictures in colour than in the making of still photographs.

COSMIC RAYS.—The papers on cosmic rays that have appeared in Continental journals during the last three years have not hitherto led to any new results which have been generally accepted, and have not attracted much attention. Most of them have, however, included detailed reports of the observations which have been made, and have thus furnished a valuable collection of data for a statistical investigation, which has now been performed by A. Corlin, of Lund Astronomical Observatory, and published in the form of a *Communication* (No. 115) from this observatory in the *Zeitschrift für Physik* (vol. 50, p. 808). His analysis has brought to light a consistent variation in the intensity of the softer components of the radiation during the sidereal day. A maximum occurs at about 15h., a minimum at about 11 h., and a second, but less definite maximum, at about 7 h. The finer details of the intensity–time curves of different investigators also show a certain degree of similarity. If soft rays are screened off from the ionisation chamber, temporal fluctuations are not present. The obvious inference is that the more penetrating cosmic rays are produced indifferently throughout space, but that at least a part of the softer radiation has a more localised origin. In a second *Communication* (No. 116), which has been published in the *Arkiv för Matematik, Astronomi och Fysik* (vol. 21, No. 1), it is suggested that the softer rays are really initially hard, but that they are produced inside material celestial bodies, and are softened by scattering on the way out. Further investigations are evidently needed to settle the important points that have been raised in these two papers, and, as is pointed out, it would be extremely valuable if it could be arranged that simultaneous records of the ionisation produced by the cosmic rays were made at different latitudes.

THE PREVENTION OF IONISATION IN PAPER DIELECTRICS.—Messrs. S. G. Brown and P. A. Sporing read a paper on the prevention of ionisation in paper dielectrics to the Institution of Electrical Engineers on Mar. 14. It is known that the performance of paper-dielectric condensers, which are much used in Great Britain in connexion with 600 volt alternating current systems, has not been satisfactory. After a period of service of about a year, an appreciable number of breakdowns occur, and this takes place even when the condensers are subjected to very severe tests before installation. Very similar results have also been observed in connexion with cables insulated by impregnated paper. There is now a very large amount of evidence which supports the view that the breakdown is due to the presence of air bubbles in the dielectric. It is found that when the voltage applied to the cable or condenser is increased, then at a certain voltage, called the critical or ionisation voltage, the power taken by the cable suddenly begins to increase rapidly. The assumption is usually made that if the dielectric be worked below the critical voltages then ionisation of the enclosed air cannot take place. The authors show both by experiment and theory that this is not the case. They explain some of the phenomena observed by recalling the experimental results obtained by Lord Rayleigh and others on the electrical properties of thin layers of air. It is known that however close together two electrodes are in air at atmospheric pressure, then ionisation does not ensue unless the voltage exceeds a number which is approximately 330. They utilise this theorem in the design of condensers. Instead of increasing the thickness of the dielectric, they build it up of a large number of thin sections in series in such a way that the voltage across any one section does not exceed that required for ionisation. The same effect can be produced by placing isolated conducting layers (interleaves) in the dielectric. Great advantages are stated to accrue from this method of construction.

HYDRAZINE HYDRATE SOLUTIONS.—The concentration of hydrazine hydrate solutions, which usually contain less than 30 per cent of available hydrazine, has hitherto been a matter of considerable difficulty, but a simple method of concentration is described by Hurd and Bennett in the *Journal of the American Chemical Society* for January. The hydrazine hydrate is mixed with a quantity of xylene and heated until the xylene has distilled away. The amount of xylene used determines the concentration of the residual hydrazine hydrate solution, and solutions containing up to 95 per cent hydrazine hydrate can be prepared in good yield at one distillation. The aqueous portion of the distillate contains a small quantity of hydrazine which may be recovered. Toluene may be used in place of xylene, but is less efficient; benzene is quite unsatisfactory. Attempts were made to prepare hydrazine by treating its salts with sodamide, calcium carbide, and aluminium carbide. With the two latter substances the desired reaction did not proceed, while sodamide reacted explosively unless diluted. The use of hydrocarbons as reaction media caused the reaction to proceed less violently, but only negligible yields of anhydrous hydrazine were obtained.

ARTIFICIAL ANALOGUE OF RUBBER.—The investigation of the problem of the chemistry of rubber by Staudinger and his school has been complicated in the past, on the natural side by the very great susceptibility of caoutchouc to oxidation, and on the synthetic side by the fact that the synthetic caoutchouc produced by condensation of the hydrocarbon isoprene may have a very different structure from the natural material, owing to the possibility of molecules uniting together into complex three-dimensional systems. A new approach to the subject is described by Prof. Staudinger in the January *Berichte* (vol. 62, pp. 241-263). Instead of isoprene, the aromatic compound styrene is condensed. This, being a benzene derivative, cannot furnish a true caoutchouc, but the condensed product which it gives, *polystyrene*, may be regarded as a 'model' of the natural substance, and can be accurately investigated, since its constituent groups can link together only in one single chain. An interesting discovery is that if the condensation is carried out at high temperatures, for example, 240° C., the product is relatively simple, being composed of some thirty units, whereas if the styrene is condensed slowly at ordinary temperatures it yields a very complex, colloidal substance, composed of some hundred thousand units, and resembling natural caoutchouc. All intermediate degrees of complexity are obtainable by varying the temperature and the time of condensation, and at any temperature the product obtained is a complex mixture of numerous members of a series, comparable with the series of natural paraffins; the most highly condensed products, and these only, resemble caoutchouc in viscosity, and in elastic and swelling properties. Prof. Staudinger concludes that natural caoutchouc is built up on a similar plan to polystyrene, and that it contains long chains of some thousand molecules of the unit 'polyprene,' $[C_5H_8]_8$.

Gravity Expedition of the U.S. Navy.

By Dr. F. A. VENING MEINESZ.

IN the course of 1928 an invitation from the Carnegie Institution of Washington was received and accepted to go to the U.S.A. with the apparatus for maritime gravity survey of the Netherlands Geodetic Commission. The U.S. Navy, having received a communication on this subject from the International Union of Geodesy and Geophysics, wished to organise an expedition for determining gravity in the Gulf of Mexico and the Caribbean Sea. The Secretary of the Navy, the Hon. Curtis D. Wilbur, designated the Naval Observatory for making the arrangements.

The expedition took place in the autumn of 1928. It consisted of the U.S. Submarine *S-21*, on board of which the observations were made, and two surface ships, the U.S. *Eagles 35* and *58*. The expedition was under the command of Lieutenant T. L. Nash, Captain of the U.S. *Eagle 35*, while Lieutenant J. L. Fisher had command of the U.S.S. *S-21*; officers of the submarine were Lieuts. F. S. Hall, F. D. Hamblin, and A. R. Sodergren. The scientific staff on board the *S-21* consisted of Dr. Fred. E. Wright, of the Geophysical Laboratory of the Carnegie Institution, Mr. Elmer B. Collins, principal scientist of the Hydrographic Office of the U.S. Navy, and myself.

The expedition started from Washington on Oct. 2 and completed the following schedule :

Leave.	Arrive.	Number of Observations.
Oct. 1. Washington	Oct. 2. Hampton Roads	0
Oct. 4. Hampton Roads	Oct. 8. Key West	3
Oct. 10. Key West	Oct. 14. Galveston	7
Oct. 19. Galveston	Oct. 23. West Key via Mississippi Delta	7
Oct. 29. Key West	Nov. 2. Guantanamo (Cuba) via Bartlett Deep	8
Nov. 5. Guantanamo	Nov. 9. St. Thomas via Nares Deep	9
Nov. 15. St. Thomas	Nov. 19. Guantanamo via Caribbean Sea	6
Nov. 21. Guantanamo	Nov. 27. Washington	5

In addition, observations were made in all the harbours, of which Hampton Roads, Guantanamo, San Juan (during trip from Guantanamo to St. Thomas), and St. Thomas, were gravity stations, which have not been occupied before. The total number of new stations amounted therefore to 49.

The pendulum apparatus was mounted in the central control room of the ship ; this was a favourable spot for making the observations, as it is near the metacentre of the ship, so that the rolling and the pitching cause only small translations of the apparatus. The apparatus is hung in gimbals, which makes it possible to work it even if the rolling or pitching is very great ; a few observations have been made with a roll of 7° to both sides of the vertical, and with a slight modification of the gimbals it is hoped that in the future observations may be made with still larger angular movements. In this way it was often possible to work at periscope depth. During the return, however, from Guantanamo to Washington, the Atlantic was so rough near Cape Hatteras that the two observations which had been planned above the top and above the bottom of the continental slope could not be made, as the ship's movement at 100 feet depth exceeded the limit of 7°.

The apparatus used has been constructed at the workshop of the Meteorological Institute at De Bilt (Holland) by the chief mechanic L. M. van Rest ; begun in 1925, it received its final shape in the spring of 1928 by the rearrangement of the photographic recording apparatus. It consists of a pendulum apparatus and a recording apparatus, combined in one unit hung in gimbals.

The pendulum apparatus contains three half-second pendulums swinging in the same plane ; in order to avoid magnetic influences, brass pendulums are used, although of course their temperature constants are great. An insulating cover reduces the changes of temperature inside the apparatus. As, however, the central control room of the U.S.S. *S-21* showed less variation of temperature than the control rooms of the submarines with which I made previous voyages, the temperature inside the apparatus was likewise more stable ; it seldom showed greater fluctuations than a few hundredths of a degree.

The pendulums are not recorded separately but combined in two pairs. For each pair the difference of the angles of elongation is recorded, and this angle may be considered as the angle of elongation of a fictitious pendulum of the same period as the original pendulums. It can be shown—and this is the fundamental principle of this method for determining gravity at sea—that the movement of this fictitious pendulum is free from the principal disturbing effect of the ship's movements : the effect of the horizontal accelerations. The records of the two pairs which the apparatus provides are therefore nearly regular ; there remain only small disturbances by the vertical accelerations of the apparatus and by the tilt of the swinging-plane. The first is practically eliminated by taking the mean pendulum period over a sufficiently long period of observation ; for this purpose half an hour is more than enough. The second makes it necessary to apply a certain correction to the result, which can easily be computed if the tilt is known. The apparatus is therefore provided with an auxiliary pendulum, which can move in a plane perpendicular to the swinging-plane and is damped in order to prevent its proper oscillations. The position of this pendulum with regard to the apparatus is recorded. This correction amounts only to a few units in the seventh decimal place of the second if the tilt is small, for example, not more than 10′ ; the gimbal suspension easily keeps it below this limit.

Besides the records which have been mentioned, two others are made ; one of the temperature inside the apparatus and another of the middle pendulum alone. This last record is necessary for computing the reduction of the pendulum periods to infinitely small amplitudes ; it is irregular because the movement of each pendulum is strongly disturbed, but as it is only used for the computation of a small reduction, this gives no special difficulties for the computations.

The records are provided with two series of time-marks by means of two shutters, which are actuated by electrical circuits opened and shut by two chronometers. Each shutter passes during a fraction of a second before the light-source which is used for recording purposes.

The rate of these chronometers is found by taking wireless time-signals ; during the recent voyage the signals of Annapolis were used. Reception was effected by means of an auxiliary chronometer, provided by the Naval Observatory at Washington, the rate of which had been strongly deranged, so that every 65 seconds a full second coincidence could be observed with the signals, of which the rhythm is the same as of mean time. These coincidences were observed by ear through the well-known method of putting the contact of this chronometer in series with the telephone of the wireless. The appearances and the disappearances of the signals in the telephone have both been used.

The rates of the chronometers have been satisfactory, so that the uncertainty resulting from the fact

that the rate during the observation may deviate from the mean rate deduced from the time-signals will probably not amount to more than 2 or 3 millidynes in the result for the gravity.

The programme of the expedition was chosen with an eye to the numerous geophysical and geological problems in that part of the earth's crust. We may mention the question if isostasy prevails in the Gulf of Mexico in general and near or above the Mississippi delta; further, the problem of the Bartlett Deep south of East Cuba and the Nares Deep north of Porto Rico; the question of isostasy in the Caribbean Sea and in the Atlantic between Cape Hatteras and the West Indies, and, lastly, the gravity field above the continental slope for that part of the coast of North America.

Thanks to the whole-hearted co-operation of Captain Fisher, who ordered all the dives necessary for the measurements, this programme was fully accomplished. This involved a great deal of diving, often several times a day—once even five times in seventeen hours—which meant an additional strain for everybody. The helpful assistance of the captain, officers, and crew during the whole voyage in all circumstances may here be thankfully acknowledged.

Besides the pendulum observations a great number of soundings were taken. The submarine was provided with the sonic depth-finder of the U.S. Navy, which has given excellent results; not only during submergence, but also at the surface soundings were possible, so that the whole route could be covered. Over the ocean deeps the soundings were taken at short intervals, so that a detailed profile could be obtained.

The results of the gravity observations were provisionally computed during the voyage, and at the same time the isostatic reductions of the stations were made at the bureau of the U.S. Coast and Geodetic Survey, so that the complete provisional results were available a few days after the return of the expedition. The final computations are now being made at the Naval Observatory at Washington. Pending these, a definite interpretation is not advisable, but a few remarks concerning the provisional results may be given. It is not probable that the final results will change these conclusions.[1]

The Gulf of Mexico has shown a curious positive anomaly of about 60 millidynes over nearly its whole extent; only north of Yucatan it is somewhat less, but the anomaly is still positive. Towards Key West and Galveston this anomaly disappears. Returning from Galveston to Key West a special series of observations was made over the Mississippi delta in two profiles perpendicular to the contour lines of the sea bottom, in order to investigate the isostatic equilibrium of the earth's crust in that neighbourhood. It might be thought likely that deviations of equilibrium would occur because of the great load of material deposited by the river in the Gulf, but the results have not given any evidence in this direction. The slight positive anomaly which has been found seems rather to be in accordance with the general trend of anomalies in the Gulf, so that there is no reason to bring them in connexion with the delta and to assume a lag in the re-establishment of equilibrium.

A second result of importance has been found over the Nares Deep, north of Porto Rico. It is in harmony with the few values observed in that part during my former cruise with the Dutch submarine *K XIII* from Holland via Panama to Java. It shows great departures from isostatic equilibrium, which probably may be ascribed to stresses working in the earth's crust in connexion with the formation of the deep. Over the deep is a great deficiency of gravity; before reduction, it was more than 300 millidynes, and after isostatic reduction about 190 millidynes. North and south of the deep the anomaly after isostatic reduction is small; north of the deep it is slightly positive ($\pm$25 millidynes), and south of it on the north coast of Porto Rico slightly negative ($-$10 m.d.). The gravity in Porto Rico is yet unknown, but the U.S. Coast and Geodetic Survey is planning an expedition for supplying a series of land values in connexion with the results of the expedition, and a few stations on the island will be occupied so that in a short time the continuation of the gravity field through Porto Rico will be known. The importance of this land gravity expedition is obvious; it will complete the data which have been found. South of the island, positive anomalies of about 40 m.d. have been found, as has also been the case throughout the whole part of the Caribbean Sea which has been crossed. Summing up these results, we see that apparently the great deficiency of gravity above the deep is not accompanied by considerable positive anomalies in the neighbourhood, unless the values on Porto Rico should reveal any such anomalies.

Another result worth mentioning in connexion with the deep is that two stations north of the island of Haiti, both situated to the west of the Nares Deep, likewise show great negative anomalies ($\pm$ $-$120 m.d.), and even farther to the west, in two stations north of East Cuba, the anomaly is still negative ($\pm$ $-$40 m.d.). This seems to indicate that the stresses in the earth's crust which are causing the Nares Deep are not limited to the region of the deep itself, but continue much farther to the west. The topography itself does not reveal this.

The values of gravity found above the eastern part of the Bartlett Deep, south of East Cuba, show smaller anomalies after isostatic reduction than the Nares Deep; the greatest negative anomaly above the deep is $-$61 m.d., while most of the anomalies found to the north or the south of the deep are less than $+$25 m.d. This gives the impression that the stresses in this part of the crust are smaller than those near Porto Rico.

Lastly, we will mention the results found in the Atlantic Ocean on the way back from Guantanamo to Washington. The three stations above deep water, which are all situated near the bottom of the continental slope, show small positive anomalies of about $+$10 m.d., which contrast with the value of $-$26 m.d. in Crooked Island Passage at the top of the slope and with the values found along the part of the Atlantic Coast to the south-west of Cape Hatteras by the U.S. Coast and Geodetic Survey, which are likewise negative; their mean value is $-$24 m.d. We find here an analogous result, although somewhat less pronounced, to that found in 1926 by the *K XIII* on the west coast of Central and North America between Panama and San Francisco. In the latter case the values above the top of the slope were about normal and those above the foot positive, with a mean value of about 65 m.d.; the difference between the values above the top and the foot of the slope has the same sign, but is larger on the west coast than on the east coast.

Without wishing to enter into a premature interpretation of these results, we may mention two points. First, it seems difficult to explain these isostatic anomalies by a different location of the compensation masses from that assumed for the isostatic reduction, so that we appear to be forced to accept a deviation of equilibrium on these coasts. Secondly, an explanation of these disturbances of equilibrium on the west

[1] All the anomalies mentioned in this paper have been derived from gravity values, which are isostatically reduced according to the method of the U.S. Coast and Geodetic Survey.

coast by a westward drift of the American continent and a corresponding pressure on the ocean floor, seems not in harmony with the results which have now been found on the east coast; in this case the reverse might be expected — a negative anomaly above the foot of the continental slope behind the moving continent.

Before and after the expedition, base observations were made with the apparatus both in the gravity base station, Washington, of the U.S. Coast and Geodetic Survey, and in the Netherlands gravity base station, De Bilt. These observations provide, therefore, a new check on the comparison of Washington with the international base station Potsdam. The final computations and the application of the final corrections of the time-signals have to be awaited before any conclusions will be possible.

The expedition has doubtless meant an important step for geodetic and geophysical science: because of the immediate results of which a short sketch has been given in this article, but still more because of future possibilities should the U.S. Navy continue this research. Results of great importance and extent might then be expected. The expedition has been made possible by the co-operation of the U.S. Navy with the Carnegie Institution and the Dutch Geodetic Commission. Sincere thanks may be expressed to the Secretary of the U.S. Navy, the Hon. Curtis D. Wilbur; to Admiral Hughes, Chief of Naval Operations; to Admiral Leigh, Chief of the Bureau of Navigation; also to Captain Freeman, Superintendent of the Naval Observatory, for his indefatigable work in preparing the expedition.

Personally, I wish to acknowledge the kind reception accorded me everywhere, in Washington, in naval as well as in scientific circles, on board the U.S.S. *S-21* and the other ships, and ashore in the different ports which have been touched, where the naval authorities or, in St. Thomas, the Governor of the Virgin Islands, gave me a most cordial welcome.

Zoological Exploration of Mongolia.

IN the summer, 1928, the Russian Academy of Sciences sent a zoological expedition to Mongolia, under the direction of A. Y. Tougarinov, who gives a short preliminary account of it in *Priroda*, No. 12, 1928. The problem of the expedition was the study of the Mongolian fauna to the east of Urga, a region which so far had not been zoologically investigated. The expedition took the route south-east of Urga. Plains, with occasional chains of comparatively low mountains, or individual peaks, distinguished by extreme poverty and uniformity of fauna, stretch east of Urga practically to Hingan.

The expedition was astonished by the great numbers of *Microtus brandti*, whose colonies stretch for tens of kilometres. There are no large mammals, with the exception of rare antelopes; at times colonies of tarbagans were met. The characteristic birds are *Haliœetus leucoryphus*, *Buteo hemilasius*, and the desert larks. Such poor landscape stretches up to Hingan, and only after 50 kilometres is a change observed. Owing to the humid conditions, the semi-desert is gradually transformed into a steppe, the herbaceous carpet is thicker, gramineous plants and other densely leaved steppe grasses are predominant. A grassy steppe takes the place of the xerophytic flora. The representatives of desert, such as the sandgrouse, disappear, and dwellers of steppe and forest begin to appear, which shelter in the elm forests of the valley of Chalhin-gol. Representatives of Manchurian fauna such as *Xanthopygia tricolor*, *Pica sericea*, *Circus melanoleucus* are met with. The expedition observed a great flight of birds across Chalhin-gol, the species being characteristic of taiga and the tundra of eastern Siberia. It may be assumed that here around Mongolia and along Hingan lies the migratory route of east Siberian birds, the origin of which is known to have been in the south-east of Asia.

Summing up the character of the explored region, it may be said that besides the Mongolian and Manchurian provinces mentioned, the rest of eastern Mongolia may be considered as one district, the chief characteristic of which is the predominance of central Asiatic fauna. Series of species characteristic and usual to regions south of Urga are absent (for example, *Podoces hendersoni*, *Accentor fulvescens*, *Emberiza godlewskii*). Their absence cannot always be explained by the lack of suitable habitats. The Turanian elements and the forms of the southern Palæarctic are also absent. All this leads to the conclusion that recently the country has been exposed to conditions which have impoverished the fauna and hindered the spreading of forms from east and south. The extreme desert state and the xerothermic climate were probably the required conditions.

University and Educational Intelligence.

CAMBRIDGE.—Dr. N. E. Goldsworthy, of Clare College, has been elected to the John Lucas Walker studentship for three years. This studentship was founded for the furtherance of original research in pathology and is of the value of £300 a year for three years.

Smith's prizes have been awarded to H. D. Ursell, of Clare College, and J. M. Whittaker, of Trinity College. Rayleigh prizes have been awarded to J. Hargreaves, of Clare College, J. G. Semple, of St. John's College, and S. Verblunsky, of Magdalene College.

EDINBURGH.—At the meeting of the Senatus held on Mar. 14, it was announced that His Royal Highness Prince George has consented to visit the University on May 15 to open the new Department of Zoology.

At the same meeting the Senatus resolved to offer the honorary degree of doctor of laws to the following among others: Prof. E. S. Goodrich, Linacre professor of zoology and comparative anatomy, University of Oxford; Prof. A. V. Hill, Foulerton research professor of the Royal Society; Prof. C. E. Inglis, professor of mechanics and applied mechanics, University of Cambridge; Dr. A. P. Laurie, formerly principal of Heriot-Watt College; Sir James Walker, emeritus-professor of chemistry of the University of Edinburgh; and the Right Hon. Baron Woolavington of Lavington.

MANCHESTER.—Sir Ronald Ross, Director-in-Chief of the Ross Institute and Hospital for Tropical Diseases, the discoverer of the life-history of malaria parasites in mosquitoes, is among those on whom it is proposed to confer the honorary degree of D.Sc. on May 15.

ST. ANDREWS.—H.R.H. The Duchess of York has signified her willingness to be present at the opening on June 28 of the Graduation Hall gifted to the University of St. Andrews by James Younger, of Mount Melville, St. Andrews, and Mrs. Younger. After performing the opening ceremony, Her Royal Highness will receive the honorary degree of doctor of laws.

PROF. C. E. WEATHERBURN, of Canterbury College, Christchurch, New Zealand, has been appointed to the chair of mathematics in the University of Western Australia.

APPLICATIONS from medical women are invited for the William Gibson research scholarship, value £292 per annum, and tenable for two years. The applications should reach the Secretary, Royal Society of Medicine, 1 Wimpole Street, W.1, by June 1 at latest.

THE sixth vacation course in terrestrial and aerial photogrammetry will be held at the Technical-Physical Institute of the University of Jena on April 8–20. Practical work will be arranged in connexion with the lectures, the necessary apparatus being provided by Messrs. Carl Zeiss. Particulars can be obtained from A. Kramer, Schützenstr. 72, Jena.

AN election to Beit fellowships for scientific research will take place in July next. The latest date for the receipt of applications is April 16. Forms of application and all information respecting the fellowships are obtainable by letter from the Rector, Imperial College of Science and Technology, South Kensington, S.W.7.

THE Board of Education is again prepared to receive applications for full-time studentships from teachers of not less than five years' standing, desiring financial assistance in order to attend approved full-time courses of advanced study at universities or other institutions at home or abroad. The amount of grant will not exceed £100 for an academic year. The Board is also prepared to consider proposals involving travel or the practical study of industrial conditions connected with the teaching of technical subjects. Applications for the year 1929–30 should be made as soon as possible. Further information can be obtained from the Board of Education, Whitehall, London, S.W.1.

A SCIENTIFIC survey of secondary education in England and the United States has been initiated by the Division of Secondary Education of the University of Pennsylvania with the co-operation of committees in both countries. The English committee, of which Dr. Cyril Norwood (Harrow) is chairman and Mr. C. W. Bailey (Holt School, Liverpool), secretary, met on Mar. 9, and in the light of information given by Prof. E. D. Grizzell, of Pennsylvania, who is spending the year in England and has already accomplished much preliminary work, approved a scheme based on the selection of some fifty representative schools. Many of the problems confronting secondary education to-day are common to both countries, and this joint inquiry should prove helpful. The rapid growth since the War in the numbers of schools and pupils has been accompanied by the creation of new types of school and modifications of the old to meet changed conditions, and there has been an enormous amount of research and experimentation in this field, of which the joint survey will doubtless take cognisance. Of special interest at the present time are the numerous important researches recently conducted under the auspices of the Iowa Research Conference on Commercial Education, the survey of secondary commercial education in Minnesota and other studies, described in the report for 1927–28 of the United States Commissioner of Education, designed to contribute to improvement of instruction in commercial departments of secondary, normal, and collegiate schools.

Calendar of Patent Records.

March 24, 1802.—To Richard Trevithick, one of the greatest of British engineers and inventors, we owe the introduction of the high-pressure steam-engine, a patent for which was granted to him, in conjunction with Andrew Vivian, on Mar. 24, 1802. The specification describes also a steam-carriage to which at that time Trevithick attached considerable importance though he abandoned it after a few years of not very successful experiment. The first locomotive to run on a railway was, however, the outcome of these experiments. This was constructed by Trevithick, and ran at the Pen-y-darren Iron Works near Merthyr Tydfil for a few months in 1804.

March 25, 1840.—The commercial success of electro silver-plating was founded on the patent granted to George Richard Elkington and Henry Elkington, of Birmingham, on Mar. 25, 1840. The idea of using the double cyanide of silver and potassium was due to John Wright, a Birmingham surgeon, who had been working independently in the same field, and, arriving in London to secure patent rights for his process, met George Elkington, then engaged on the preparation of his patent specification. The two agreed to work together, and on the satisfactory demonstration of Wright's process, this was incorporated into the Elkingtons' specification.

March 27, 1886.—The first commercial process to utilise successfully the action of diastase on starch in breadmaking was employed in the making of 'Bermaline' bread, under a patent which was granted to John Montgomerie of Lanark on Mar. 27, 1886.

March 28, 1764.—A step was taken towards the machine production of lace by the patent granted to Thomas Morris and others on Mar. 28, 1764, for a new machine "which is to be fixed to a stocking-frame for making oilett holes or network in silk, thread, cotton, or worsted, as mitts, gloves, hoods, aprons, handkerchiefs, and other goods manufactured on stocking-frames." The idea of the new machine seems first to have occurred to a stocking-maker of Mansfield named Butterworth, who, with the object of having a machine made, confided it to John Betts, a smith. Betts, however, obtaining financial support from Thomas and John Morris, hosiers, of Nottingham, took the invention to London, where the patent was granted in the joint names of the Morrises and Betts. The patent was afterwards assigned to John Morris, and the invention was successfully applied in Nottingham, the knitting industry of which reaped considerable benefit from its introduction.

March 28, 1787.—During the last few years of the eighteenth century, many experiments were made in England, America, and France in the application of the steam-engine to navigation. Amongst these, and the first to receive a practical trial in the United States, was the invention of John Fitch, who was granted a patent by special Act of Assembly for the State of Pennsylvania on Mar. 28, 1787. A steamboat, according to Fitch's specification, moved by twelve oars or paddles working perpendicularly after the manner of the paddle of a canoe, six paddles entering the water as the remaining six are raised, was built in Philadelphia, and ran on the River Delaware in 1788 carrying more than thirty persons a distance of 20 miles in 3 hours 10 minutes.

March 28, 1907.—The control pillar or 'joy-stick' in almost universal use in aeroplanes was the invention of Robert Esnault-Pelterie, who was granted a French patent on Mar. 28, 1907, in which an aeroplane with warping wings and elevators controlled by one lever was for the first time described. A corresponding English patent was applied for in January 1908.

Societies and Academies.

LONDON.

Institute of Metals, Mar. 13.—**P. Saldau**: Special properties of eutectics and eutectoid alloys in binary metallic systems. As regards hardness and electrical resistance, the eutectic occupies an abnormal position on the property-composition curve, even in drastically annealed alloys. For coalescence to occur, an excess of one of the phases is necessary.—**F. Hargreaves** and **R. J. Hills**: Work-softening and a theory of intercrystalline cohesion. For work-softening there must be more than one phase present and, roughly, *both* constituents must undergo spontaneous annealing after working at air temperature. A theory of intercrystalline cohesion is outlined. Briefly, it postulates the existence of a transition zone between two orientations. Work-hardening and work-softening are identical phenomena concerning the early stages of the latter. The pronounced softening caused by heavy working is attributed to interphase boundary action and the retention of the individual phases in a quasi-viscous condition.—**P. J. Durrant**: The constitution of the cadmium-rich alloys of the system cadmium-gold. The constitution of the alloys of cadmium and gold from 0 to 48 atoms per cent of gold has been reinvestigated by thermal and micrographic analysis. Saldau's equilibrium diagram, published in 1915, has been modified. A new area of solid solution has been detected (phase III) which lies in the field described by Saldau as containing $\beta+\gamma$. This solid solution undergoes two polymorphic changes—one at about 500° C., and the other at about 375° C., the latter being analogous to the change in the β-phase of brass at 460° C. No evidence was obtained for the existence of the compound $AuCd_3$ at the liquidus, but the form of the equilibrium diagram suggests the existence of two compounds, Au_2Cd_5 and Au_2Cd_3, both of which are much dissociated at high temperatures.—**Marie L. V. Gayler** and **G. D. Preston**: The age-hardening of some aluminium alloys. Five typical aluminium alloys containing copper, magnesium silicide, or both, have been examined. Changes in density and lattice parameter which take place during ageing suggest that precipitation from solid solution takes place. X-ray analysis shows also that the crystals themselves are in a disturbed state, which is gradually relieved by further ageing at high temperatures. The increase in electrical resistance on ageing corresponds to this distortion of the space lattice of the solid solution, caused by the presence of minute particles due to the decomposition of the solid solution.—**Clement Blazey**: Brittleness in arsenical copper (2). Under certain conditions, about 0·004 per cent of bismuth can produce a susceptibility to brittleness. The conditions are: plain melting under charcoal of arsenical copper of the quality used, followed by poling and the addition of bismuth before casting. The addition of phosphorus after bismuth destroys the susceptibility or it may be removed by remelting.—**W. Hume-Rothery** and **E. O. Rounsefell**: The system magnesium-zinc. The equilibrium diagram of the system magnesium-zinc has been investigated in the range 0 to 70 atomic per cent magnesium. Particular attention has been paid to the structure of the solid alloys and the limits of solid solution in the various phases. The compound $MgZn_5$, discovered by Chadwick, and $MgZn_2$, discovered by Grube, have been confirmed. A new compound, MgZn, has been shown to exist, and this also is of fixed composition. It may be distinguished from $MgZn_2$ by means of Benedicks' reagent. The compound is formed at 354° C. by a peritectic reaction between $MgZn_2$ and liquid. On the practical side, the present work shows that in elektron metal, and similar alloys, any zinc present in excess of that contained in solid solution in magnesium will exist in the form of the new compound MgZn, and not, as previously supposed, as $MgZn_2$.

Geological Society, Feb. 20.—**C. A. Matley**: The basal complex of Jamaica, with special reference to the Kingston district. With petrological notes by **F. Higham**. There is a basal complex of great thickness, unconformably underlying Upper Cretaceous and Eocene rocks. The 'granite and syenite' of the Survey—chiefly a granodiorite—is an important plutonic member of the complex, and contributes abundant pebbles to overlying Upper Cretaceous and Eocene conglomerates. Another plutonic member of the complex is a peridotite of Harzburg type, now converted to serpentine. The other members of the complex, many of which are found in a metamorphic condition, were originally sediments and volcanic lavas and tuffs. The metamorphism appears to be late Palæozoic (Hercynian) or even older. No trace of fossils has been found in the complex. Comparison is made with similar rocks in Cuba, Hispaniola (Haiti and Santo Domingo), Porto Rico, and the Virgin Islands. With the exception of Porto Rico, Jamaica now falls into line, as regards the presence of a pre-Cretaceous basement, with the other islands of the Greater Antilles, although there is still want of agreement as to the ages of the rocks of that basement.

Physical Society, Mar. 8.—**Ezer Griffiths** and **J. H. Awbery**: The dependence of the mobility of ions in air on the relative humidity. The apparatus employed was a modification of Zeleny's original method; the end of a wind channel being closed by a disc of gauze fitted with a guard ring through which a steady stream of air of definite humidity was pumped. The motion of the negative ions due to the action of the air stream was balanced by a counter potential gradient, and the mobility deduced from the critical potential required to produce a balance.

LEEDS.

Philosophical and Literary Society, Feb. 19.—**W. P. Milne**: Three theorems on the cubic surface.—**A. O. Allen**: A simplified derivation of v. Seidel's aberration formulæ.—**W. H. George**: X-ray examination of insulin, edestin, and hæmoglobins. Only the powder method could be applied.—**G. W. Brindley**: Distribution of charge on the carbon atom. The F curve calculated for the carbon atom model does not agree quantitatively with the experimental curve. The disagreement is most noticeable for large values of $\sin\theta$ for which the theoretical curve is known with most certainty.—**H. M. Dawson** and **G. Claxton**: The miscibility of phenol with aqueous solutions of electrolytes. If S and C represent the molar concentrations of the phenol and the electrolyte in the aqueous phase, then for a wide range of C values the experimental results are accurately reproduced by the formula $S=S_0C^{-kc}$, where S_0 is the value of S for $c=0$, and k is a constant which varies with the nature of the electrolyte. The results suggest that the miscibility is not appreciably affected by the interionic forces which are associated with the presence of the salt.—**C. K. Ingold** and **H. Burton**: The existence and stability of free radicals. The basis of the theory is the principle of electronic exclusion, which is also regarded as the radical cause of tautomerism.—**W. H. Pearsall**: Form variation in *Ceratium Hirundinella* O.F.M. Statistics as to its variation in size and form in Rostherne Mere support the view that the

population is composed of a single race of this species. The form variation shows three phases, and an explanation of the changes in size is advanced, based on the differential rates of protoplasmic growth and cell wall formation.—R. G. S. Hudson: On the lower carboniferous corals: *Orionastræa* and its distribution in the north of England. The northern forms, with the exception of those from the D_2 zone, belong to other groups than that of *Orionastræa phillipsi* or *O. placenta* and have therefore been described as new species and a structural sequence established.

PARIS.

Academy of Sciences, Feb. 11.—G. Charpy and L. Jacque: The reduction of the sulphates of the alkaline earths in metallurgical operations. From the experiments described it is concluded that although it may be true that in certain metallurgical operations barium sulphate does not introduce so much sulphur into the casting as calcium sulphate, this is not due to a difference in the chemical properties of the two sulphates but to certain physical peculiarities, more especially the fusibility of the slag.—A. Khintchine: The law of large numbers.—S. Serghiesco: The number of roots common to several simultaneous equations.—Charron: A curious gyroscopic phenomenon.—E. Huguenard and A. Magnan: An apparatus for the comparison of aerodynamical velocities round an aeroplane.—Dussaud: Apparatus for the blind.—A. Auric: The ring of asteroids. An examination of the distribution of the asteroids with respect to their distance from the sun leads to the conclusion that the asteroids do not constitute one homogeneous family, but a mixture of two families differing in their origin and their constitution. The study of the distribution of the eccentricities and the inclinations of the orbits leads to the same conclusion.—Thadée Banachiewicz: The ellipticity of the terrestrial equator.—Z. Horàk: The wave equation of Schrödinger.—Vasilesco Karpen: The equations of state and thermodynamics. Reply to some criticisms by M. Verschaffelt.—B. Decaux: The measurement of very high radiotelegraphic frequencies by means of piezo-electric quartz oscillators.—A. Travers and Nouvel: The solubility of $Mg(OH)_2$ at high temperatures. Special attention was given to the preparation of a pure magnesium hydroxide, and in the experiments at high temperatures glass vessels were replaced by copper flasks. The solubility becomes inappreciable at 178° C.—Lespieau: A heterocyclic diacetylene derivative. The interaction of the dimagnesium compound of acetylene on symmetrical dichlormethyl ether gives rise to a substance the properties of which are consistent with the formation of a ring compound with eight carbon atoms and two oxygen atoms in the ring.—L. Blanchard: Some derivatives of cyclobutanol.—Henri Moureu: The tautomerism of the α-diketones. The two tautomeric forms of phenylbenzylglyoxal and of phenylanisylglyoxal.—L. Meunier and R. Guyot: The absorbent properties of cellulose fibres after treatment with formol in acid solution.—J. Savornin: The artesian hydrogeology, hydraulics, and thermodynamics of the eastern Sahara.—Ch. Killian: The development and biology of *Ambrosinia Bassii*.—P. J. Shiwago: The chromosome complex of the chicken and turkey.—Jules Lefèvre: Bioenergetics and its new laboratory.—C. Levaditi and P. Lépine: Experimental herpetic encephalitis of the ape.

PRAGUE.

Czech (Bohemian) Academy of Arts and Sciences (2nd class, Natural Sciences and Medicine), Jan. 11.—F. E. Vološin: A new ice pyrheliometer.—F. Čechura: Magnetic declination in Bohemia in 1925·5. The following communications of members of the 2nd class of the Academy were presented to be incorporated in a jubilee volume in commemoration of the tenth anniversary of the foundation of the Czechoslovak Republic.—1. B. Brauner: Some physiologico-optical experiments.—2. B. Bydžovský: Symmetric involutions of the fifth order.—3. E. Čech: Asymptotic correspondences between two surfaces.—4. K. Domin: The hybrids and the garden forms of the genus *Pityrogramma*.—5. J. Hanuš, A. Jílek, and J. Lukas: Para-brom-benzol-aceton, its iso-nitroso-compound and dioxime.—6. J. Hanuš and J. Vořišek: The action of hydrazine hydrate on some unsaturated acids of the series $C_nH_{2n-2}O_2$, $C_nH_{2n-4}O_2$, $C_nH_{2n-6}O_2$.—7. F. Hasa: The quality of butt and molten electrical weldings.—8. J. Heyrovský and S. Berezicky: The deposition of radium and other alkaline earth metals at the dropping mercury cathode.—9. I. Honl-Ungarn: Properties of bacteriophages.—10. R. Kettner and F. Slavík: A new profile in Algonkian and Cambrian of Tejřovice.—11. J. Křepelka: A study of perselenic acid.—12. V. Láska: Hyetometry in mountainous countries.—13. B. Němec: Immunity in plants.—14. M. Pelišek: Space rolling of a hyperbola on a congruent hyperbola.—15. J. Pelnář: The cancer of *Micterus* and our clinical experience.—16. K. Petr: The composition of binary quadratic forms.—17. V. Posejpal: Resonance spectra and the Raman effect.—18. C. Purkyně: The Carboniferous and Permian formations in western outskirts of Krkonoše (Giant's Mountains).—19. V. Rosický: Two articles on the study of crystal properties.—20. K. Rychlík: The extension of the idea of congruence.—21. J. Štěrba-Böhm and S. Škramovský: Complex oxalates of scandium.—22. V. Trkal: The equation of the wave-propagation in the wave-mechanics and Hamilton's principle.—23. J. Vilhelm: Verdant and proliferous flowers of some plants.—24. E. Votoček-V. Prelog: The 3, 12-di-hydroxy-palmitic acid, a non-sugar component of rhamno-convolvulic acid.—25. K. Weigner: Physical education respecting constitution and sex.—26. J. Wenig: The structure of secondary envelopes of chords in *Ammocetes*.—27. J. Wenig: A peculiar phenomenon in the abnormal growths of incisor teeth of Rodentia.—28. F. Záviška: The translation of circular cylinders through a viscous liquid.

Feb. 8.—J. Paroulek: The action of liver and ligamentic tissues on the exogenic uric acid.—J. Scheiner: The lipoid nephrose.—V. Jedlička: The pathogenesis and etiology of pernicious anæmia.—S. Prát and Z. Kobza: The chemical composition of some Algæ.—J. Babička: The Bohemian Travertins.—B. Brauner: Analysis of water from the pond 'Babylon.'

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, Vol. 14, No. 12, Dec. 15).—Raymond Pearl, Charles P. Winsor, and Florence Barclay White: The form of the growth curve of the canteloup (*Cucumis melo*) under field conditions. The growth of seedlings of this plant in the field, as in the laboratory, without exogenous food and light, can be represented by a generalised logistic curve. The experiments suggest that, to a first approximation, the rate of growth is identical whether the environment is constant or highly varied, that is, it is determined by the organism itself. Food from the soil, etc., is only a means of prolonging its life.—E. T. Bell: Invariant sequences.—A. Adrian Albert: (1) Normal division algebras satisfying mild assumptions.—(2) The group of the rank equation of any normal division algebra.—Morgan Ward: Postulates for an abstract arithmetic.—Einar Hille and J. D.

Tamarkin: (1) On the characteristic values of linear integral equations.—(2) On the summability of Fourier series.—**G. A. Miller**: Groups involving a cyclic, a dicyclic, or a dihedral group as an invariant subgroup of prime index.—**Ancel B. Keys**: The weight-length relation in fishes. It is shown statistically that this relation is given by {weight = constant × (length)^n}, where n is between 3 and 4. The form of a fish changes during growth, and the paper gives a method of calculating the magnitude of the change.—**Gordon D. Snell**: A cross-over between the genes for short-ear and density in the house mouse. The detection of one cross-over shows that the genes for short-ear and density, although borne in a common chromosome, are not at identical loci.—**Mildred S. Moses and Chas. W. Metz**: Evidence that the female is responsible for the sex ratio in *Sciara* (Diptera). Breeding shows that certain females are female-producers and others male-producers, regardless of males with which they mate, fertilisation being by the first male used in mating.—**Chas. W. Metz and Mildred S. Moses**: Observations on sex-ratio determination in *Sciara* (Diptera). Sex-ratio is probably determined by a simple Mendelian inheritance of a single pair of factors for which female-producing females are heterozygous and male-producing females and males are homozygous and recessive.—**John Warren Williams**: The relation between polarisation and association. A development of Debye's theory that association in liquids depends on the interaction of the dipoles.—**L. W. Elder, Jr., and W. H. Wright**: pH measurement with glass electrode and vacuum tube potentiometer. A quadrant electrometer is generally used with the glass electrode for electrometric work with substances affected by platinum. A vacuum tube potentiometer gives consistent results and the only precaution necessary is that it must be set up in a dry atmosphere.—**Carl Barus**: Chemical reaction in the interferometer U-gauge.—**P. W. Bridgman**: Resistance and thermo-electric phenomena in metal crystals. By an improved method of making single metal crystals, it has been possible to cast from the same melt a number of single crystal rods of a wide range of orientation. The general results indicate that the Kelvin-Voigt symmetry law for thermal e.m.f. is an approximation. The detailed paper is to appear in *Proc. Am. Acad. Sci.*—**Ronald W. Gurney**: Angular distribution of intensity of resonance radiation. It has been assumed that the emission of resonance radiation will be distributed at random in direction; this assumption seems to be unwarranted. If the plane of polarisation of plane polarised light is rotated rapidly, consideration of the movement of the atomic oscillators shows that though the intensity along the beam is unaltered, in other directions it is modified. This must be taken into account in intensity measurements of resonance radiation.—**Stanley Smith**: Some multiplets of singly ionised thallium.—**J. D. Hanawalt**: The influence of the presence of hydrogen on the L III X-ray absorption edge of palladium. Whether the hydrogen is occluded electrolytically or in a hydrogen furnace, there is X-ray evidence of the presence of the chemical compound of formula Pd_2H, with a face-centred cubic lattice in which alternate grating points are PdH molecules, the remaining points being occupied by Pd atoms.—**Harlow Shapley**: Studies of the galactic centre. (3) The absolute magnitudes of long period variables.—**B. P. Gerasimovič**: The absolute magnitudes of long period variable stars. A period-luminosity relation is obtained: for a period of 100-250 days, mean absolute visual magnitude is $-2{\cdot}3$, for a period of 250-340 days it is $-1{\cdot}1$, and for a period greater than 340 days it is $+0{\cdot}3$.

Official Publications Received.

BRITISH.

Memoirs of the Asiatic Society of Bengal. Vol. 11, No. 1: Diaries of Two Tours in the Unadministered Area east of the Naga Hills. By J. H. Hutton. Pp. 72+16 plates. (Calcutta.) 11.13 rupees.

The Indian Forest Records. Silviculture Series, Vol. 13, Part 3: Commercial Volume Tables for *Sal* (*Shorea robusta*) in the Wet Mixed Forests of the *Bengal Duars*. By Parma Nand Suri. Pp. ii+25+2 plates. 6 annas; 8*d*. Silviculture Series, Vol. 13, Part 4; Volume Tables for *Sundri* (*Heritiera Fomes*, *Buch.*, Syn. *Heritiera minor*, Roxb.) in the Sundarbans, Bengal. By Parma Nand Suri. Pp. ii+49+2 plates. 10 annas; 1*s*. (Calcutta: Government of India Central Publication Branch.)

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series. Vol. 9, Memoir No. 2: Revision of the Jurassic Cephalopod Fauna of Kachh (Cutch), Part 3. By Dr. L. F. Spath. Pp. 161-278+plates 20-47. (Calcutta: Government of India Central Publication Branch.) 15.4 rupees; 24*s*. 6*d*.

Empire Cotton Growing Corporation. Reports received from Experiment Stations, 1927-28. Pp. xii+278+12 plates. (London.)

Geological Survey Department, Tanganyika Territory. Short Paper No. 1: Outlines of Geology of the Regions adjoining the South-Eastern Shores of Lake Victoria. By F. B. Wade. Pp. iv+24+1 map. Short Paper No. 2: Lupa Gold Field. By Dr. D. R. Grantham. Pp. ii+6+2 maps. Short Paper No. 3: Kigugwe Copper Deposit near Brandt's. By G. M. Stockley. Pp. ii+8+1 map. Annual Report, 1927. Pp. 60+2 maps. 5*s*. (Dar es Salaam: Government Printer.)

Department of Agriculture, Tanganyika Territory. Pamphlet No. 3: Tea Cultivation. By M. F. Bell. Pp. 12+1 plate. Tea Planting Prospects in the South-Western Highlands of Tanganyika. By M. F. Bell. Pp. ii+32. (Dar es Salaam: Government Printer.)

Institute of Physics. The Presidential Address on Physics in Astronomy, given before the Institute on May 15, 1928. Pp. 15. 1*s*. net. The Physicist in the Glass Industry, given before the Institute of Physics on May 25, 1927. By Prof. W. E. S. Turner. (Physics in Industry: Lecture No. 12.) Pp. 22+6 plates. 1*s*. net. Physics in the Food Industry, given before the Institute of Physics on November 14, 1927. By Sir William Hardy. (Physics in Industry: Lecture No. 13.) Pp. 21+2 plates. 1*s*. net. The Physics of Photography, given before the Institute of Physics and the International Congress of Photography on July 12, 1928. By Dr. C. E. Kenneth Mees. (Physics in Industry: Lecture No. 14.) Pp. 20+1 plate. 1*s*. net. (London.)

Proceedings of the Royal Society of Edinburgh, Session 1928-1929. Vol. 49, Part 1, No. 1: The Theory of Bigradients from 1861 to 1919. By Sir Thomas Muir. Pp. 15. 1*s*. 3*d*. Vol. 49, Part 1, No. 2: Mathematical Consequences of certain Theories of Mental Ability. By John Mackie. Pp. 16-37. 2*s*. Vol. 49, Part 1, No. 3: On a Quadrature Formula for Trigonometric Integrals. By Prof. L. N. G. Filon. Pp. 38-47. 1*s*. Vol. 49, Part 1, No. 4: The Fulcher Bands of Hydrogen. By Dr. Ian Sandeman. Pp. 48-64. 1*s*. 6*d*. (Edinburgh: Robert Grant and Son: London: Williams and Norgate, Ltd.)

Pharmaceutical Society of Great Britain: Pharmacological Laboratories. Third Annual Report, 1928. Pp. 19. (London.)

Proceedings of the Cambridge Philosophical Society. Vol. 25, Part 1, January. Pp. 120. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Students from other Countries in the Universities and University Colleges of Great Britain and Ireland, Session 1928-29. Pp. 33. (London: Universities Bureau of the British Empire.) 1*s*.

Leeds Public Libraries. What to Read on Zoology. By Prof. J. Arthur Thomson. Pp. 39. 3*d*. What to Read on Biology. By Prof. William John Dakin. Pp. 32. 3*d*. (Leeds.)

The South African Journal of Science. Vol. 25: Being the Report of the Twenty-sixth Annual Meeting of the South African Association for the Advancement of Science, Kimberley, 1928, 29 June to 5 July. Pp. xliv+526. (Johannesburg.) 30*s*. net.

The Imperial College of Tropical Agriculture. Prospectus for 1929-30, also Principal's Report for 1927-28 and Register. Pp. 38+2 plates. (St. Augustine, Trinidad; and London.)

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1171 (Ae. 335): The Theoretical Relations for an Aerofoil with a Multiply Hinged Flap System. By W. G. A. Perring. (T. 2632.) Pp. 14+3 plates. 9*d*. net. No. 1174 (Ae. 338): Wind Tunnel Tests with High Tip Speed Airscrews; Some Experiments upon an Airscrew of Conventional Blade Section, Aerofoil R. and M. 322, No. 3, at High Speeds. By Dr. G. P. Douglas and W. G. A. Perring. (T. 2652.) Pp. 8+4 plates. 9*d*. net. No. 1176 (Ae. 340): The Boundary Layer of the Front Portion of a Cylinder. By Dr. A. Thom. (T. 2553 and A.) Pp. 20+7 plates. 1*s*. net. No. 1180 (Ae. 344): The Inclusion of Partial Glides in Routine Performance. By A. E. Woodward Nutt. (T. 2626.) Pp. 3+2 plates. 4*d*. net. No. 1182 (Ae. 346): Rolling Experiments on an Aerofoil of R.A.F. 32 Section. By H. B. Irving and A. S. Batson. (T. 2649.) Pp. 8+3 plates. 6*d*. net. (London: H.M. Stationery Office

FOREIGN.

Meddelanden från Statens Meteorologisk-Hydrografiska Anstalt. Band 4, No. 7; De svenska vattendragens arealförhallanden. 6: Ångermanälven och indalsälven m.fl. (Vattendragen mellan umeälvs och ljungans områden.) Av Gustaf Wersén. Pp. 24. 2.50 kr. Band 4, No. 10: Tåkern en hydrografisk Undersökning. Av Ragnar Melin. Pp. 72+6 planscher. 5.00 kr. Band 5, No. 1: Väderlekens samband med Hälsotillståndet. Av Axel Wallén. Pp. 71. 3.00 kr. Band 5, No. 2: Eine neue Methode zur Bestimmung des Wassergehaltes der Wolken, Von Hilding Köhler. Pp. 11. 1.00 kr. (Stockholm.)

Abisko Naturvetenskapliga Station. Observations météorologiques à Abisko en 1926. Rédigées par Bruno Wolf. Pp. iv+66. Observations météorologiques à Abisko en 1927. Rédigées par Bruno Wolf. Pp. vi+66. (Uppsala: Almquist and Wiksells Boktryckeri A.-B.)

University of California Publications in American Archaeology and Ethnology. Vol. 23, No. 10: Dental Pathology of Aboriginal California. By R. W. Leigh. Pp. 399-440+plates 60-67. (Berkeley, Calif.: University of California Press; London: Cambridge University Press.) 50 cents.

Wisconsin Geological and Natural History Survey. Bulletin No. 69, Economic Series No. 23: Molding Sands of Wisconsin. By David W. Trainer, Jr. Pp. 103. (Madison, Wis.)

The University of Chicago: Publications of the Yerkes Observatory. Vol. 4, Part 7: Astrometric and Photometric Statistics of certain of Hagen's Fields photographed with the 24-inch Reflector. By Harriet McWilliams Parsons. Pp. v+32+plates 8-9. (Chicago: University of Chicago Press; London: Cambridge University Press.) 7s. 6d. net.

Scientific Papers of the Institute of Physical and Chemical Research. No. 172: The Slip-Bands produced when Crystals of Aluminium are Stretched. Part 2: Extension at High Temperatures. By Keiji Yamaguchi and Sakuichi Togino. Pp. 277-292. (Tokyo: Iwanami Shoten.) 35 sen.

Carnegie Institution of Washington. Annual Report of the Director of the Department of Terrestrial Magnetism. (Reprinted from Year Book No. 27, for the year 1927-28.) Pp. 203-267. (Washington, D.C.)

The Science Reports of the Tôhoku Imperial University, Sendai, Japan. Second Series (Geology), Vol. 12, No. 1. Pp. 152+23 plates. (Tôkyô and Sendai: Maruzen Co., Ltd.)

Proceedings of the United States National Museum. Vol. 74, Art. 18: Bathnopterus, a new Fossil Gasteropod Genus from the Silurian of Alaska. By Edwin Kirk. (No. 2763.) Pp. 4+1 plate. (Washington, D.C.: Government Printing Office.)

Proceedings of the California Academy of Sciences. Vol. 18, No. 1: A new Species of Corambe from the Pacific Coast of North America. By Frank M. Macfarland and Charles H. O'Donoghue. Pp. 27+3 plates. Vol. 18, No. 2: A new Bird Family (Geospizidae) from the Galapagos Islands. By Harry S. Swarth. Pp. 29-43. Vol. 18, No. 3: A Contribution to our Knowledge of the Nesting Habits of the Golden Eagle. By Joseph R. Slevin. Pp. 45-71+plates 4-7. (San Francisco, Calif.)

Journal of the Faculty of Science, Imperial University of Tokyo. Section 1: Mathematics, Astronomy, Physics, Chemistry. Vol. 1, Part 11. Pp. 417-437. 0.60 yen. Section 2: Geology, Mineralogy, Geography, Seismology. Vol. 2, Part 7. Pp. 331-362+plates 66-69. 1.00 yen. Section 4: Zoology. Vol. 2, Part 1. Pp. 49+8 plates. 1.70 yen. (Tokyo: Maruzen Co., Ltd.)

Proceedings of the American Academy of Arts and Sciences. Vol. 63, No. 5: A new Equation of State for Fluids. By James A. Beattie and Oscar C. Bridgeman. Pp. 229-308. 1.45 dollars. Vol. 63, No. 6: The Electrical Resistance of Alloys under Pressure. By C. W. Ufford. Pp. 309-328. 60 cents. Vol. 63, No. 7: The Effect of Pressure on the Resistance of Three Series of Alloys. By P. W. Bridgman. Pp. 329-345. 45 cents. Vol. 63, No. 8: The Compressibility and Pressure Coefficient of Resistance of Zirconium and Hafnium. By P. W. Bridgman. Pp. 347-350. 35 cents. (Boston, Mass.)

Rendiconti del Seminarjo Matematico e Fisico di Milano. Vol. 2 (1928—VI). Pp. xii+200. (Milano.)

Journal of the Faculty of Agriculture, Hokkaido Imperial University, Sapporo, Japan. Vol. 24, Part 2: Influence of Ultra-violet Ray upon the Milking Cow. By Kenzo Iguchi and Kentaro Mitamura. Pp. 39-60. (Tokyo: Maruzen Co., Ltd.)

Department of the Interior: Bureau of Education. Bulletin, 1928, No. 15: Educational Achievements of One-Teacher and of larger Rural Schools. By Timon Covert. Pp. v+23. (Washington, D.C.: Government Printing Office.) 5 cents.

Proceedings of the United States National Museum. Vol. 74, Art. 22: Two new Frogs from Jamaica. By Emmett Reid Dunn. (No. 2767.) Pp. 2. (Washington, D.C.: Government Printing Office.)

Calendario del Santuario e delle Opere di Beneficenza Cristiana di Pompei, 1929. Pp. 256+32. (Pompei.)

CATALOGUES.

Entomologia (Neue Werke). No. 74. Pp. 56. (Berlin: W. Junk.)

A Rough List of Recent Purchases of Valuable Books on Zoology, Botany, the Physical and Mathematical Sciences, Sport, etc. (New Series, No. 22.) Second Portion. Pp. 61-108. (London: Wheldon and Wesley, Ltd.)

Engineering and Industrial Instruments. (List E5.) Pp. 460. (London: Negretti and Zambra.)

Books and Measures for the Timber, Plywood, Pulp, Paper, Cabinet and Furniture and Woodwork Trades. Pp. 16. (London: Stobart and Son.)

Diary of Societies.

FRIDAY, MARCH 22.

INSTITUTION OF NAVAL ARCHITECTS (Annual Meeting) (at Royal Society of Arts), at 11.—Eng. Rear-Admiral W. Scott-Hill: Powdered Coal for Ships.—A. Spyer: Modern Developments of the Water Tube Boiler for Marine Purposes.—Eng. Rear-Admiral A. E. Hyne: Suggested Modifications to Marine Water Tube Boilers.—At 3.—J. Rennie Barnett: Motor Life-Boats of the Royal National Life-Boat Institution.

TEXTILE INSTITUTE (Lancashire Section) (at Manchester), at 1.15.—J. W. Cooling: Air Conditioning Apparatus, including Humidifying and De-Humidifying.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates' and Students' Section) (Newcastle-upon-Tyne), at 2.30.—J. T. Whetton: The Optics of Surveying Instruments and Tacheometric Surveying.—Paper open for further discussion:—The Lubrication of Colliery Coal Tubs, by L. H. Forster.

ROYAL SOCIETY FOR THE PROTECTION OF BIRDS (Annual Meeting) (at Middlesex Guildhall, Westminster), at 3.—Col. Sir George Courthope, Bart.: The Economic Value of Wild Birds.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section) (Clinical Meeting at Royal Free Hospital), at 4.30.

PHYSICAL SOCIETY (Annual General Meeting) (at Imperial College of Science), at 5.—Dr. W. H. Eccles: Presidential Address.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration on the Nerve Supply and Movements of the Colon.

INSTITUTION OF CIVIL ENGINEERS (Birmingham and District Association) (at Chamber of Commerce, Birmingham), at 6.—A. Page: The Development of the Generation and Distribution of Electricity in the British Isles.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—Annual General Meeting.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—T. Robson: Experiments on Buffer Springs.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. Lambert: Warm Tones on Chloro-Bromide Papers.

WEST OF SCOTLAND IRON AND STEEL INSTITUTE (Annual General Meeting) (at Royal Technical College, Glasgow), at 7.—F. G. Martin: Elastic Limit Steel.

BLACKBURN TEXTILE SOCIETY (at Blackburn Technical College), at 7.30.—A. J. Hall: The Dyeing and Finishing of Cotton Piece Goods containing Artificial Silk.

LEICESTER TEXTILE SOCIETY (at Victoria Hall, Leicester), at 7.30.—S. Kershaw: Faults in Yarns.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—D. A. Collin: Ventilation.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Sir Ernest Rutherford: Penetrating Radiations.

SATURDAY, MARCH 23.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Molecular Motions in Rarefied Gases (IV.).

MONDAY, MARCH 25.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.30.—Wing-Comdr. T. R. Cave-Browne-Cave: Aircraft Engineering in its Relation to Mechanical Engineering (Annual Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Hon. Sir Charles A. Parsons and J. Rosen: Direct Generation of Alternating Currents at High Voltages.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—J. Wright and C. W. Marshall: The Construction of the Grid Transmission System in Great Britain.

SOCIETY OF CHEMICAL INDUSTRY (Glasgow Section) (at Royal Technical College, Glasgow), at 7.30.—J. R. Campbell: The Activity of Various Catalysts in Promoting the Oxidation of Methane by Means of Oxygen.—W. J. Skilling and E. D. Ballantine: A Simple Method for the Determination of Phosphorus in Coal Ash.

HUNTERIAN SOCIETY OF LONDON, at 7.30.—Drs. H. Dally, E. Obermer, and T. Grey: Discussion on Blood Pressure in Health and Disease.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—C. H. Howkins: The Dental Aspects of Radium Treatment.—J. B. Parfitt: A Compound Composite Odontoma.

ROYAL GEOGRAPHICAL SOCIETY (at Polytechnic, Regent Street), at 8.30.—Sir Douglas Mawson: Recent Work on the Fjords of New Zealand.

MEDICAL SOCIETY OF LONDON, at 8.30.—E. Holland, Dr. B. T. Parsons-Smith, and Dr. B. Hart: Medical Indications for the Induction of Abortion and Premature Labour.

TODMORDEN TEXTILE SOCIETY (at Todmorden).—Mr. Bentley: Cardroom Processes.

TUESDAY, MARCH 26.

ROYAL SOCIETY OF ARTS (Dominions and Colonies Meeting), at 4.30.—H. Warington-Smyth: The Base Metal and Mineral Resources of South Africa.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. R. A. Young: A Medical Review of the Surgery of the Chest (Lumleian Lectures) (III.).

ROYAL AERONAUTICAL SOCIETY (at 7 Albemarle Street), at 5.30.—Annual General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—B. L. Goodlet: The Testing of Porcelain Insulators.

ROYAL PHOTOGRAPHIC SOCIETY (Scientific and Technical Group) (Annual General Meeting), at 7.—Dr. F. C. Toy: "How it Works" in Photography.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—C. Lucas: The Nature of the Colour of Pottery, with Special Reference to that of Ancient Egypt.

MANCHESTER ATHENÆUM TEXTILE SOCIETY (at Manchester).—T. Hunt and Dr. E. R. Cooper: Life and Conditions in a Modern Spinning Mill.

WEDNESDAY, MARCH 27.

ROYAL SOCIETY OF MEDICINE (Comparative Medicine and Neurology Sections), at 5.—Special Discussion on Encephalo-myelitis of Man and Animals. I. A. Galloway (Comparative Medicine); Dr. J. G. Greenfield (Neurology). Other speakers: Dr. W. Russell Brain, Dr. T. Hare, L. P. Pugh, and others.

NEWCOMEN SOCIETY FOR THE STUDY OF THE HISTORY OF ENGINEERING AND TECHNOLOGY (at 17 Fleet Street), at 5.30.—W. A. Benton: John Wyatt, and the Weighing of Heavy Loads.

INSTITUTION OF CIVIL ENGINEERS (Students' Meeting), at 6.30.—D. H. Little: Roads.

ROYAL PHILOSOPHICAL SOCIETY OF GLASGOW (at 207 Bath Street, Glasgow), at 8.—Dr. F. Fergus: Vision and Industrial Efficiency.

INSTITUTE OF THE RUBBER INDUSTRY (at Glasgow).—Dr. Daynes: Methods and Appliances used in the Control of some Manufacturing Processes in the Rubber Industry.

PUBLIC LECTURE.

SATURDAY, MARCH 23.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—M. A. Phillips: Mammals of Britain.