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Land Drainage.

THE heavy rainfall and snowstorms of last month, culminating in the overflow of the Thames in London on Jan. 7, with grievous loss of life, has brought vividly before the nation the subject of the control and disposal of surplus water. In Great Britain, the problems, although serious, are not of the same magnitude as elsewhere. The disastrous Mississippi floods of last summer, and the extensive damage done around Bagdad when the Tigris broke its banks about two years ago, are illustrations of a menace the full force of which is happily spared us. In these cases the fundamental cause is the gradual raising of the river bed in its lower reaches by the suspended material brought down from the uplands and deposited when the speed of the current is reduced.

In the absence of measures of control, the river will frequently change its course, and may build up an extensive delta in the estuary. The difficulty is met by dredging, which is rarely able to meet the case completely, especially in extensive river systems, and reliance is placed mainly on embankments or levees for confining the river to its course. The embankments must be raised from time to time to keep pace with the silting up of the river bed, and eventually the normal water level may be several feet above the level of the surrounding land. In such conditions a break in the defences is disastrous, and the longer the catastrophe is in coming, the greater it is. The effect is felt most in the lower reaches of the river, but the causes extend over the full region of the catchment area. Every little stream, every small trickle of surface water, is contributing its small quota of suspended material to the main stream, and the engineer is in reality struggling against Nature's ceaseless modification of the topography of the land over the whole of the drainage area discharging into the river. The battle can never be won; an armed truce is all that can be hoped for, and man's energies are or should be directed towards postponing the evil day.

The necessity for co-ordination in such efforts is self-evident: it is worse than useless for the protection of one part of the area to be carried on as an isolated problem, independent of the conditions in adjacent areas; and yet in Great Britain this piecemeal method is still the rule rather than the exception. For a long time past, the problem of land drainage has been growing steadily more acute, and the enforced neglect during the years of the War brought matters to a head. Attempts were

made in the Land Drainage Acts of 1918 and 1926 to secure improvements in co-ordination and grouping of the multitudinous drainage authorities, each of which is more or less a law unto itself. These acts were not satisfactory, quite apart from the question of lack of funds, and a Royal Commission was appointed in March 1927, with the Right Hon. Lord Bledisloe as chairman, to inquire into the present law and its administration, and to suggest any improvements that would lead to an efficient arterial drainage system without placing undue burdens on any particular section of the community. The Commission was ordered to report as soon as possible, and it has obeyed this instruction with commendable zeal: the Report [1] was issued last month.

The main recommendation is that a catchment area shall be regarded as one unit, and be under the control of its own elected central authority, that shall be responsible for the main channel of the river, the upkeep of which shall be a rating charge on the whole catchment area. The numerous drainage boards existing within any catchment area are to be reorganised and grouped as internal drainage authorities, which will levy their local rates for internal drainage, and be supervised by the catchment authority in order to secure co-ordination of effort. The Thames is regarded as a special case, and it is recommended that beyond constituting the Conservancy a drainage authority for the whole of the catchment draining into its present area of jurisdiction, no change should be made; the Port of London Authority would therefore continue to exercise control from below Teddington weir to the Crowstone. This suggestion may need modification in view of the recent floods in London.

The recommendations of the Commission are simple, and indeed obvious, but they are none the less sweeping in their effect. They reduce to a logical scheme the confusion that now exists. There are more than 360 drainage authorities of various types in England and Wales, many of them of great age. The earliest appears to be the Commission of Sewers for Romney Marsh, appointed in the reign of Henry III., and it covers the period when the land was settled in more or less isolated and self-supporting communities. Much of the low-lying part of the country, now occupied, was then wastes of marsh or fens that provided, until reclaimed in their turn, a ready and convenient accommodation for the drainage water from the settled areas. The fens of East Anglia provide the best example of this process. Reclamation on an extensive scale was begun in the seventeenth century in spite of the determined opposition of the fenmen, whose attitude can be judged from the following verse of a doggerel poem of the period:

"The feather'd fools have wings to fly to other nations,
But we have no such things to help our transportations;
We must give place (oh, grievous case!) to hornéd beasts and cattle,
Except that we can all agree to drive them out by battle."

It is not surprising that these difficulties, together with the lack of engineering resources, and the absence of much of the interdependence that now marks British agricultural life, should have resulted in the construction of many independent reclaimed areas, the drainage authorities of which would say, with Chesterton, "I don't care where the water goes, if it doesn't get into"—my land. This very natural attitude was reinforced and protected by the powers granted by law and custom to each area. The recommendations of the Commission, if adopted, will enable the catchment authorities appropriately to modify the constitutions of these areas. Further, the upland districts, the drainage water of which increases the difficulties of dealing with the lowland areas, will be under their jurisdiction.

It is asserted that the drainage of upland agricultural districts by pipe and mole drains has shortened the time taken for this surplus water to reach the main stream. As a result, flood water that formerly slowly percolated by undefined channels is now discharged much more rapidly, and has forced the lowlander to increase his embankment protections and to enlarge the outfall facilities of the main stream.

The claim is undoubtedly correct; large areas were drained in the middle of last century, and except where drains were laid too deep to be of service, the condition of the land was improved. Renewed attention is now being paid to field drainage, and we hope it will be examined not only as a simple technical question of removing surplus water, but also as one of the related aspects of soil physics demanding fuller investigations in the light of recent advances in the theory and practice of this subject.

It is indeed questionable whether drainage alone is the best method of dealing with occasional surplus water. In spite of our adequate and well-distributed rainfall, foreign agriculturists visiting Great

[1] "Report of the Royal Commission on Land Drainage in England and Wales." (Cmd. 2993.) Pp. 60. (London: H.M. Stationery Office, 1927.) 1*s.* 3*d.* net.

Britain are surprised at the susceptibility of our crops even to mild droughts; the suggestion is frequently made that our normal cultivation operations do not conserve sufficient soil moisture. The principles underlying these operations are certainly worthy of further study; they reached their present form about 1750, and were based on cheap labour and on horse power. Greatly increased labour costs have altered the situation completely, but the cultivation methods have not undergone any essential modifications to meet the new conditions, in spite of the facilities for mechanical power now available. A full examination of the effects of deeper cultivations, subsoiling, and rotary tillage on the amounts and rate of flow of percolation water, and studies of the influence of mulching on evaporation, should give valuable information on the ability of the soil to hold a greater reserve moisture supply. These problems are essentially physical, and they imply parallel studies of the physical and physico-chemical properties of the finest soil particles, the colloidal nature of which makes the soil differ in many respects from a simple porous material.

There is another aspect of the subject. This fine material is now known to exercise a controlling influence on both the inherent fertility of the soil and its ability to fall into that favourable physical condition known as good tilth. Unfortunately, this material is the most susceptible to removal by erosion and drainage to lower levels, where it silts up and intensifies outfall difficulties. In areas where it can be accumulated, it gives rise, as would be expected, to a very fertile soil. The narrow belt bordering the Nile, the warp-lands of the Humber estuary, and to some extent the polders of Holland, are well-known examples where natural forces or man's intervention have succeeded in saving some of this valuable material for agriculture.

Finally, we may point out that the above problems of drainage, tilth, and fertility are combined with peculiar force in all irrigation areas, and it is encouraging to note that those members of the recent Imperial Agricultural Research Conference most familiar with the practical problems of overseas agriculture were foremost in urging the vital necessity of fundamental research on the soil. The establishment of a Bureau of Soil Science, as suggested at the Conference, would be a distinct aid to such research by collating the results and showing the bearing which soil survey work has on problems of drainage and of irrigation in all parts of the Empire.

The Dolomites of South Tyrol.

Das Grödener-, Fassa- und Enneberggebiet in den Südtiroler Dolomiten: Geologische Beschreibung mit besonderer Berücksichtigung der Überschiebungserscheinungen. Von Dr. Maria M. Ogilvie Gordon. 1 und 2 Teil: *Stratigraphie-Tektonik.* (Abhandlungen der Geologischen Bundesanstalt, Band 24, Heft 1.) Pp. xxiii + 376 + 26 Tafeln. 90*s*. 3 Teil: *Paläontologie.* Mit einem Atlas von 13 Tafeln. (Abhandlungen der Geologischen Bundesanstalt, Band 24, Heft 2.) Pp. 89. 30*s*. (Wien: Geologische Bundesanstalt, 1927.)

THE work under review is one exceptional for its comprehensiveness, and one that marks the conclusion of an enormous amount of labour, both physical and mental, on the part of the author, Dr. Maria Ogilvie Gordon. Begun in youth, under the ægis of two great students, Ferdinand von Richthofen and August Rothpletz, both long since dead, it was completed after she had borne with fortitude the bitter blow that fate had dealt her as a wife, and after she had devoted her energies to her country's cause during the War. By reason of the length of the period over which the work was spread, and the magnitude of the events that encompassed us all during the years of interruption, her earliest work must appear now as objective to her as to the reviewer. It must almost seem not to be her own work, but that of some stranger of a past generation. Yet underlying all her work, from those early days of 1893 up to the present time, one motive may be traced—the endeavour to unravel the tectonic structure of the Dolomites, enormously complicated in reality, albeit described as simple by some; and, on the basis of this work, to solve certain other problems, one of the most important of which is the question, first raised by von Richthofen, and since repeatedly denied or affirmed, as to the coral-reef origin of the gigantic masses of limestone and dolomite. It must, moreover, be mentioned with approbation that the author, in spite of the keenness and originality of her own perception, has adhered to the principle laid down by von Richthofen so to present her observations that they remain available for other interpretations. This remark is especially applicable to the work now under review.

The volume comprises an almost overpowering wealth of detailed observations concerning the stratigraphy, the tectonics, and the palæontology of the area studied. Nobody will ever think of starting work upon this area without availing

himself of this colossal archive of observations, while he who also knows the actual mountaineering difficulties that face the worker in the Dolomites cannot but express his wonder at the energy, the courage, and the spirit of the author.

The first section of the work, consisting of 169 large quarto pages, is devoted to stratigraphy. It begins with a comparatively short description of the Permian (Bellerophon limestone and quartz-porphyry). The several stages of the Trias are, on the other hand, most exhaustively portrayed. The old division of the Werfen beds into a lower series (Seis beds) and an upper series (Campil beds) is retained, but the conglomerate of Richthofen is referred to the Lower Muschelkalk, so that, in this respect, the classification differs from that of Wittenburg. Numerous detailed profiles are given, both for the strata of this series and for those of higher horizons.

In the Upper Anisian stage the occurrence of *Diplopora annulatissima* Pia at numerous localities is described. The Lower Buchenstein beds of Mojsisovics are here included. The Buchenstein beds *sensu stricto* (*Protrachyceras reitzi* and *P. longobardicum* zones) and the Wengen beds (*P. archelaus* zone) are grouped together as the Ladinian stage. The eruptive rocks of this age receive very exhaustive treatment. The author concludes from her observations that, during the period of deposition of the Upper Buchenstein beds, differential movements of the earth's crust occurred along the northern margin of an anticlinal flexure or elevated zone with a W.N.W.-E.S.E. trend, while erosion and re-deposition of the limestone and dolomite sediments occurred. Lavas and tuffs were erupted from the fissures that were developed in the sunken northern section. This process did not occur continuously, but at intervals. Hence along the border zone between the two facies the volcanic rocks sometimes predominated, and sometimes the limestones and dolomites. This is the true reason for the extremely complicated differences in facies met with in the area.

During the period of the Wengen beds, the eruptive activity decreased only slightly, eruption taking place along the same structural lines as during the Buchenstein period. Both for this and for palæontological reasons, the author unites the Wengen with the Buchenstein beds, and separates from them the so-called Pachycardia tuffs.

The St. Cassian and Raibl beds are grouped together as Carnian, since the author has been able to show, in the so-called Upper St. Cassian beds, the close connexion between the horizons above and below, thereby demonstrating the absence of any gap in the history of the marine faunas. In the Raibl beds also a very sudden change in facies is demonstrated. Each subdivision of that series of strata can be shown to pass laterally from a calcareous or sandy facies into dolomite.

Next follows a section bringing together all the available information bearing on the coral-reef theory. The author is in favour of the view, developed by the present reviewer, that the chief builders of the great calcareous masses were not corals but calcareous algæ. She proves conclusively that the reef-like appearance of many of the present-day dolomite mountains is due primarily to later tectonic movements, even if it has depended also on facies differences.

The tectonics are dealt with in a most thorough manner. This section of the work is made all the clearer by the inclusion of a map on the scale of 1 : 100,000, showing the tectonic lines, two large charts of profiles, a geological map of the Enneberg district on the scale of 1 : 25,000, a geological map of the Schlern district (1 : 25,000), including, to the north, the Gröden Valley, and to the south-east the upper portion of the Fassa Valley as far as the western slopes of the Marmolata, and a small map of the Rodella district (1 : 12,500), with two special profiles.

In the space of a short review it is impossible to deal in full with the author's interesting and detailed observations. The most important result is the demonstration of the existence of two series of tectonic movements ; these occurred at different periods and acted in different directions. The older had a general W.N.W. trend, the younger an N.N.E. trend. The result was a sort of interference, and a tendency to produce a turning movement of mountain masses. For this turning movement the author uses the term ' torsion.' Many might deny the propriety of this use of the term. To the reviewer the actual term used seems to matter less than the facts observed ; and there appears to him to be no doubt that the statements of Dr. Gordon in this connexion are trustworthy and deserving of the greatest respect, even if one differs in their interpretation.

Overthrusting also was connected with this phase of earth movements, and on this subject the present work contains a mass of important observations. It is true that this overthrusting was not on the same scale as that of the large Alpine nappes. Nevertheless, it is not to be underestimated, as Cacciamali's studies in the Alps of Lombardy have also taught us.

The author has rendered especial service by the clear manner in which she has described the tectonic rifts to which the considerable volcanic activity of Triassic times was due.

In the palæontological volume, a large number of known fossil species as well as a few new forms are figured on thirteen plates and carefully described in the text. The new species are *Allorisma depressa*, *Avicula stachii*, *Gymnocodium nodosum*, *Pecten nicolensis*, *Myophoria elliptica*, *Leda minuta*, *Thecosmilia norica*, *Elysastræa parvula*, and *Milleporidium fassani*. The chief importance of this section lies in the fact that the horizons of the fossils are accurately determined, while new localities and horizons are recorded for various algæ and hydrozoa, and investigations are made into the structure of these organisms. The author has found in the Bellerophon limestone at various localities the algæ *Mizzia velebitana* and *M. yabei*, hitherto known only from the Upper Carboniferous of Dalmatia and Japan, as well as *Vermiporella velebitana*.

The whole work is sumptuously got up and excellently illustrated. It is a credit to the Vienna Bundesanstalt. Together with the earlier works of the author it forms a monument in the field of Alpine geology upon which both special and general geologists, professional or not, may look with pride and satisfaction.

WILHELM SALOMON-CALVI.[1]

Biology before Darwin.

(1) *De Linné à Jussieu : Méthodes de la classification et idée de série en botanique et en zoologie* (1740–1790). Par Dr. Henri Daudin. (Études d'histoire des sciences naturelles, 1.) Pp. v + 264. (Paris : Félix Alcan, n.d.) 20 francs.

(2) *Cuvier et Lamarck : Les classes zoologiques et l'idée de série animale* (1790–1830). Par Dr. Henri Daudin. (Études d'histoire des sciences naturelles, 2.) 2 vols. Vol. 1. Pp. xvii + 460. Vol. 2. Pp. 338. (Paris : Félix Alcan, 1926.) 60 francs.

WE are not familiar with the name of Dr. Henri Daudin, of Bordeaux, as a working biologist, but however that may be, he has, in the above treatise, produced a history of modern biology which it would be inexcusable to overlook. His original intention was to discuss the historical aspects of the works of Darwin and the evolutionary school, but he has instead traced the development of systematic biology during the immediate pre-evolutionary period, and has hence preferred to devote his attention to causes rather than to effects.

Dr. Daudin divides his work into two sections, the first of which deals with the years 1740–1790, which he regards as introductory to his main or critical period extending from the latter date to 1830. There is something to be said for this division. The years in the neighbourhood of 1790 were certainly critical. They stand at the onset of that sudden burst of research activity which culminated in the 'thirties and thence rapidly declined. Thus Dr. Daudin's final date is also a significant one. On the other hand, to stop at 1830 results in including the early and less productive years of a large number of distinguished workers, ranging back from Stannius and Michael Sars to Dufour. It would have been more logical and instructive to have extended the limit to 1840, or at least to 1835, so as to include the first years of the decline.

Before 1790, research was neither intensive nor coherent. The old school, including O. F. Müller, Spallanzani, the Hunters, Meckel, Camper, Bonnet, Daubenton, Ellis, Lyonet, Buffon, and Linnæus, representing all the earlier phases of descriptive and speculative biology, was slowly preparing the way for the emergence of Cuvier, whose work covers the whole of the very important period from 1790 to 1830, of which it may be said to constitute the foundation. It is not easy to explain fully the sudden display of activity at the beginning of Cuvierian times. The publications of Buffon, and to a lesser extent those of Bonnet and Spallanzani, had aroused a definite and widespread interest in the investigation of animals, and must have exerted some influence on the extent and trend of contemporary inquiry. Dr. Daudin's earlier date of 1740 may be justified as a more or less natural boundary between the methods and traditions of the seventeenth century and those of the pre-Cuvierian school.

The works under review embrace a prolific period, the adequate investigation of which involves the examination of piles of literature. This has naturally occupied the leisure of the author for many years, and the result is a serious contribution to the subject based on original authorities. There are, however, several omissions within the limits Dr. Daudin has laid down for himself, and some of them are of first-rate importance. Indeed the author almost confines himself to the work of the French school, which is fully and carefully debated,

[1] Translated by L. R. Cox.

but no history of the period can be said to be in any sense complete which omits discussion of the publications of Roesel, Meckel, Hunter, Spallanzani, the second Monro, Bojanus, and Straus—to mention only a few of the more important names. A further criticism of the author's bibliographical methods is that wrong editions are frequently quoted, and translations are used instead of the originals. Contemporary translations are helpful as evidence of how an author was interpreted in his own time; but they are often misleading, and it is never safe to assume that the translation accurately conveys the meaning of the original text. We have, on the contrary, at times encountered wide differences between the two. It is necessary, however, to make allowances for a writer in the provinces, far removed from the National Library—probably almost the only French library which could provide him with all the literature he needed.

The history of animal classification before Darwin receives special and admirable treatment in these volumes. Dr. Daudin attaches considerable importance, and rightly so, to this aspect of the subject, because the constant striving after an acceptable classification must sooner or later lead to a natural classification, or in other words to the recognition of evolution. The only guarantee of the reality of a group is that its members should constitute a harmonious whole, with which members of other groups are out of tune. The intuition which introduced the word 'family' into pre-evolutionary classification carries with it a prophetic recognition of the doctrine of common descent.

The fact that the biological catalogues of the seventeenth century were already crystallising into natural groups before the time of Darwin can only be regarded as the unconscious growth of the idea of descent, and many pre-Darwinian naturalists must certainly be credited with this 'intellectual perception.' In the domain of morphology the recognition that, for example, the abomasum of the compound stomach is the only part homologous with the stomach of other mammals is a comparable result. Thus, as Daudin points out, the truth was in Lamarck even before he became a conscious transformist. The steady and unobtrusive work on classification and comparative anatomy did more to precipitate the coming of evolution than all the crazy rhetoric of the so-called philosophers of the Geoffroy school—"plus hardis que solidement informés."

We may be permitted to regret that historians of science are not occasionally tempted to apply the knowledge which they so laboriously acquire. Who better than the historian could tackle the epidemics of callow speculation which afflict us from time to time, and check the exuberance and tyranny of the latest fashion in research. We are called upon to accept, on pain of excommunication, creeds and dogmas which we regard with vigorous misgivings. The modern speculator excuses his vice on the ground that it is better to have a bad theory than no theory at all. History not only gives little support to this ingenuous claim, but even cries out aloud against it. An unsound hypothesis, should it gain general acceptance, hangs like a millstone round the necks of contemporary workers. It is easy to show that a doctrine like the preformation theory in embryology, or the vertebral theory of the skull, not only retards the advance of science, but also may cruelly oppress a sound observer who has the genius to see through its absurdities and the courage to expose them.

Progress in science is the result of faithful observation combined with the generalisations of those rare individuals who are born to this difficult task. The historian can smile at the modern worker who holds the speculations of Oken and Geoffroy in contempt, but lacks the imagination to suspect that a future generation may be mildly amused at his own magnificent system. On matters such as this the historian should have much wholesome and weighty advice to offer. Why does he not produce it?

The Validity of Modern Physics.

The Logic of Modern Physics. By Prof. P. W. Bridgman. Pp. xiv + 228. (New York: The Macmillan Co., 1927.) 10*s.* 6*d.* net.

THE author of the latest discussion of the foundations of physics, Prof. P. W. Bridgman, of Harvard University, is a highly distinguished experimenter in a branch of physics with a peculiarly difficult technique, most of which he has developed himself, while his experimental work has repeatedly been greatly aided by his capacity for doing his own incidental theory. His main attitude in the present work may be called a qualified phenomenalism; that is, apart from the material objects of ordinary observation, he is prepared to admit other concepts, but anxious to keep their number down to a minimum. His

test of the validity of a concept is that the old facts co-ordinated must outnumber the new assumptions made. The fundamental analysis in terms of sensations is not attempted, but the view is consistently maintained that a physical magnitude is defined by the operations that measure it and not by any prior considerations. The opening discussion of the meaning of length, in application to atomic and electronic distances on one hand, and stellar distances on the other, where the ordinary methods based on measuring scales are useless for opposite reasons, brings out extremely well the nature of the logical problems involved. On this point of view it is simply meaningless to assert or deny a physical proposition without some means of verifying it experimentally; thus the statement that space on a small scale is Euclidean is meaningless.

The rejection of unobservable entities until he is forced to accept them leads Bridgman to accept action at a distance, and to reject the ether, while with the latter goes the physical reality of the electric field. But the point assumes a knowledge of what we mean by physical reality in this connexion. Bridgman seems to know what it means, and not to believe in it. So far as I can tell, the situation is that measurement of the forces on electric charges and magnetic poles gives the values of the electric and magnetic forces experimentally wherever we like to find them, and that these vectors satisfy Maxwell's differential equations. If the possibility of measurement is enough to determine physical reality, the electric field is as real as distance.

The notion of action at a distance, on the other hand, seems to mean that the field is determinate when we know the neighbouring charges and magnets, and is independent of the intervening medium. But actually it depends on the dielectric constant and permeability of this medium, which is therefore highly relevant. The reviewer's own point of view is that the differential form of the laws is more general and, except in the simplest cases, more fundamental in knowledge than the integrated form, and involves direct reference to intervening places. Consequently, while having no use for the ether, I should accept the field and reject action at a distance when they are defined so as to convey any meaning to me.

In a later part of the book Bridgman discusses problems of time and relativity. From his phenomenalist point of view he is led to reject the notion of light at any places except those where it is emitted or absorbed, because all means of testing its presence at intermediate places involve either diverting or destroying it. Thus light as a thing travelling with a finite velocity disappears. With it goes Einstein's definition of simultaneity; the velocity of light is made infinite by "setting a distant clock on zero at the instant it receives a light signal flashed from our clock at its zero." In this way we arrange for the light to spend no time on the way in going; but if we fix a mirror at the distant clock the light spends twice the accepted time on the way back, and the trouble about observing the returning beam is as acute as ever.

This seems to be a case where pure phenomenalism is impracticable. The phenomenalism of Mach and Karl Pearson was a reaction against the realist and mechanist attitude of the older physics, expressed especially in such concepts as absolute position and the elastic solid ether. Accepted physical laws had to be re-examined to find out how far they were demanded by the data; mere consistency with the data was no longer enough. The results were seen in improved understanding of essentials and attention to formal properties instead of models, and cleared the way for such positive advances as the theory of relativity and the modern quantum theory. But a critical attitude towards fundamentals does not mean that we must deny the existence of anything we cannot perceive directly. It is true that light cannot be perceived in transit; but if we therefore deny its existence we immediately get into worse difficulties.

The author gives a discussion of the value of mathematical methods, appreciating both the utility and the danger of their ability to carry us far beyond the original data. Later he gives an extended account of the validity of the postulate that physical laws are formally simple. He has thus given all the preliminaries to an analysis of the validity of physical laws in terms of probability, but he does not attempt such an analysis or mention what progress has been made by other writers.

Prof. Bridgman's points are always well made and his style is attractive. His acute, though at times too far-reaching criticism is the best example known to the reviewer of both the benefits and the drawbacks of the phenomenalist attitude, and his work can be strongly recommended to the attention of those interested in the foundations of science.

HAROLD JEFFREYS.

Our Bookshelf.

Meteorological Office: Air Ministry. British Rainfall, 1926: the Sixty-sixth Annual Volume of the British Rainfall Organisation. Report on the Distribution of Rain in Space and Time over the British Isles during the Year 1926 as recorded by about 5000 Observers in Great Britain and Ireland. (M.O. 295.) Issued by the Authority of the Meteorological Committee. Pp. xv + 293. (London: H.M. Stationery Office, 1927.) 15*s*. net.

THE sixty-sixth volume of "British Rainfall," which deals with the year 1926, follows the lines of earlier volumes and is mainly statistical. There are tables and diagrams giving the total rainfall in each month, and for the whole year. The monthly totals are for nearly four hundred stations evenly distributed over the British Isles, while the annual totals are for nearly five thousand stations. The monthly evaporation from a free water surface, and the amount of rain percolating through depths of twenty, forty, and sixty inches of soil, in relation to the rainfall of each month, appear for a dozen stations. Covering as they do a variety of soils, these figures provide information of considerable horticultural interest. The annual rainfall statistics, on the other hand, continue to constitute indispensable information for engineering firms dealing with water-supply. An interesting analysis of heavy falls of rain in short periods is given (pp. 44-54). It includes figures for 1926 as well as for previous years. Falls of an inch in ten minutes have apparently occurred on several occasions, though not in 1926, and there is one instance of a quarter of an inch descending in a minute and a half.

To the general student of meteorology, mere statistics, especially when they refer to one meteorological element only, are of limited interest, and for this reason analyses of individual occasions of exceptional rain, illustrated by synoptic charts, such as are given for the severe and widespread thunderstorms of July 17–18, and for the heavy cyclonic rains of Nov. 4–5, are welcome additions.

It is interesting to note that for the British Isles as a whole, 1926 was rather a wet year, and was the fifth in succession to have a total equal to or greater than the average—the longest run of wet years experienced since 1875–83. The year 1927, it may be observed, will be an addition to this run. In distribution the rainfall of 1926 was very erratic, including the wettest January since 1877, the wettest November since 1870, and the driest December since 1870, when comparable statistics first became available.

How we Behave: an Introduction to Psychology. By Prof. A. E. Heath. Pp. vi + 90. (London: Longmans, Green and Co., Ltd., 1927.) Cloth, 2*s*.; paper, 1*s*.

AMIDST the mass of psychological works that emanate from the printing presses at the present time, this little book deserves more than a passing notice. It is one of an admirable series designed, in the words of the prospectus, "to meet a widespread demand from working-class students for inexpensive introductory books on subjects studied in elementary classes," and published under the auspices of the Workers' Educational Association. The present work fully keeps up the high standard set by others in the series. It is, indeed, remarkable with what success Prof. Heath has tackled the task, that one would have been inclined to pronounce impossible, of giving an adequate introduction to psychology within the limits of ninety small pages. It is of course intended as an introduction and not a complete survey of the subject, and it is a merit of the work that it constantly suggests further questions in a way which cannot fail to stimulate the student to carry on his inquiries. The general scope of the work is sufficiently indicated by the chapter headings: "The Nature and Aim of Psychology," "The Subject Matter of Psychology," "The Development of Animal Behaviour," "The Development of Human Behaviour, (1) Towards a more Unified Response of the Self as a Whole, (2) Towards Completer Adjustment to the Full Realities of the Environment."

Prof. Heath studies the working of the mind from a dynamic point of view, and emphasises the element of conation or 'striving' in mental life. If he ever expands what he has to say here into a fuller work, one would welcome more detailed discussion of the relation of this 'striving' to consciousness, a point on which, while interesting and suggestive, he does not seem perfectly explicit. The only general criticism, if it is a criticism, that one could suggest, is that the student who begins on this work might get the impression that psychology is always a delightfully interesting and amusing study, a dream from which he would be likely to have a rude awakening when he went on to the works of some other authors. G. C. FIELD.

Fūrie Kyūsū oyobi Sekibun Ron, being a Japanese translation of H. S. Carslaw's "Introduction to the Theory of Fourier's Series and Integrals." Translated by G. Takemae. Pp. xii + 482. (Tōkyō: Uchida Rōkakuho, 1927.) 8 yen.

DURING the last fifteen years or so, several important books on physics and mathematics have been translated into Japanese. To the list of these is now added the book under notice. It is translated with accuracy into a clear and simple Japanese. In the preface the translator describes the difficulties which he had to cope with in bringing the book to the stage of publication, occasioned by the great earthquake of 1922 and his long illness in following years. Both the translator and the publishers must indeed be congratulated on their admirable work in translating and publishing in such a clear and well-printed form this excellent book by Prof. Carslaw.

The translation will no doubt prove useful to Japanese students of physico-mathematical and technological science. One fears, however, that the translator may not receive due reward for his labours. All Japanese university science students

are able to read English well enough to understand the explanations of a technical book, and it is unnecessary for them to resort to translations. Especially is it so with a book on mathematics. Moreover, the reading of foreign books in the languages of the originals is to be encouraged, as later on it will be necessary for many of them to read original papers in foreign languages as well as in Japanese.

Nevertheless, the present translation will be very welcome to students who cannot go through a systematic course of study, either of their special subject or of the language in which that special subject is written. Furthermore, in the present translation are included various important alterations and corrections due to Prof. Carslaw, thus rendering the translation more up-to-date than the original work. S. YOSHITAKE.

The Magneto Manual. By H. R. Langman. (Lockwood's Manuals.) Pp. x + 221. (London: Crosby Lockwood and Son, 1927.) 7*s.* 6*d.* net.

IN practically every motor-car the ignition of the explosive mixture is effected by means of an electric spark produced by a small generating device called a magneto. During recent years considerable advances have been made in the design of these generators, and they are now thoroughly trustworthy. It is advisable, however, that every driver of a car should have some knowledge of the timing and setting of magnetos and of their necessary adjustments. He will find much that is useful to him in this book. Luckily, the permanent magnets of magnetos now normally retain their magnetic properties for many years. This is due mainly to the great advances that have been made in the manufacture of magnetic steels and to improved methods of magnetising them.

Heat and vibration, however, have a demagnetising effect even on the best magnets. It sometimes happens, therefore, that the magnet becomes weak and the functioning of the device becomes uncertain. The pull of the magnet can be easily tested by placing a soft iron keeper across the poles and by means of a spring balance measuring the pull required to displace it. A good-sized magnet when new can easily support a weight of at least sixteen pounds. The author gives some useful and convenient methods of testing and remagnetising the particular type of magnetos used in Ford cars, many of which are running in Great Britain. A list of questions is given at the end of the book, and this will enable the student to test his knowledge.

Land Tenure and Agricultural Production in the Tropics (being a Discussion on the Influence of the Land Policy on Development in Tropical Countries). By Dr. H. Martin Leake. Pp. ix + 139. (Cambridge: W. Heffer and Sons, Ltd., 1927.) 7*s.* 6*d.* net.

DR. LEAKE has had practical experience of tropical agriculture as Director of Agriculture in India and as Principal of the Imperial College of Tropical Agriculture in Trinidad. In discussing these vital problems, therefore, he has a first-hand knowledge of the facts in certain areas. It must not be thought, however, that he takes a restricted view of the subject, and while he recognises the importance of local knowledge of conditions, and has been at pains to make himself acquainted with these conditions, he argues on lines which aim at elucidating general principles modifiable in their application to specific cases.

How far Dr. Leake has been successful may perhaps best be judged from his very valuable and suggestive appendix on land tenure in tropical Africa, which is reprinted from the *Empire Cotton Growing Review.* He there suggests a triple partnership which would seem to merit a trial, though the position which is assigned to the chief is perhaps open to question. It is also doubtful how far it would be generally applicable even in East Africa, where it would seem best adapted to conditions among certain tribes only. With Dr. Leake's plea for increased agricultural education, his readers will find themselves in hearty agreement.

Psychology and the Soldier. By F. C. Bartlett. Pp. viii + 224. (Cambridge: At the University Press, 1927.) 7*s.* 6*d.* net.

IT is a difficult matter to discuss the practical application of psychology in a manner that appeals to the novice without offending the expert, but in this book Mr. Bartlett has succeeded admirably. Although he addresses himself primarily to the student of military affairs, his discussion is also of interest to the general reader. Problems of mental and physical fitness, tests for general ability and for special aptitudes, the effects of practice, the study of fatigue, and allied topics, are discussed simply and with appropriate illustrative detail. The sections dealing with leadership, discipline, and morale, and with the mental disorders of warfare, are, however, more attractive because more expressive of the author himself. Such a combination of sound psychology and simple exposition deserves a larger audience than the students to whom it was originally addressed.

An Introduction to Psychology. By Prof. John J. B. Morgan and Prof. A. R. Gilliland. Pp. xi + 319. (New York: The Macmillan Co., 1927.) 7*s.* net.

THE suggestion that courses in elementary psychology to high school pupils will be of value is decidedly novel, but, when we consider the character of American high schools, not so ill-advised as might at first sight appear. In this text-book the authors have aimed at giving concrete expression to the idea. The work has been efficiently done and the book will doubtless meet the needs of those who require a formal text for class purposes. Interest in the 'parlour tricks' of experimental psychology is of course easily secured, and the authors have not overlooked this. The usual topics, such as the nervous system, habit, sensations, attention, learning, memory, etc., are included, but the treatment is very simple and is concerned chiefly with facts. Questions and references are given at the end of each chapter.

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.*]

Pleochroic Haloes and the Age of the Earth.[1]

IN several communications, including one in NATURE (vol. 109, p. 480, 1922), Joly has directed attention to discrepancies between the position of the innermost ring of pleochroic haloes due to uranium and the accepted ionisation curve of the α-particles of uranium. Since the range of the α-particles which produce the haloes by ionisation processes is related to the velocity of decay of the disintegrating substance by Geiger and Nuttall's law, Joly concludes that uranium may have disintegrated more rapidly at one time than it does to-day, or that in early geological times a more rapidly disintegrating uranium isotope may have existed, the ionisation curve of which is no longer accessible to observation, owing to the fact that the isotope has decayed completely in the later geological epochs.

Objections to these conclusions have been raised, particularly by O. Hahn in his book "Was lehrt uns die Radioaktivität über die Geschichte der Erde?" (Berlin, 1926, pp. 55-56). Hahn assumes that the position of the innermost uranium ring is by no means anomalous, but that it indicates the true current range of the α-particles. From this it follows, of course, that the Geiger-Nuttall relation no longer holds valid for extremely long half-value periods.

Since no similar discrepancies are observed in the case of thorium haloes, Hahn's explanation raises difficulties, which can, however, be avoided if we assume the following causes to be operative in the production of the anomalies.

The range of an α-particle depends not only on the velocity of disintegration of the radioactive substance, but also on the physical constants of the medium into which the α-particle penetrates. Changes in the cohesion properties of the medium can call forth deviations in the range, without the intervention of accompanying changes in the rate of disintegration. Müggé's observations show that radioactive disintegration can produce isotropy in minerals, loosening of the crystal lattice, and alterations in cohesion (*Nachrichten der Gesellschaft der Wissenschaften*, Göttingen, 1922, Math.-Phys. Klasse, p. 110). Such processes must also take place within pleochroic haloes, particularly in the central portion, where for geometrical reasons the action of the α-particles is concentrated. In the region of the innermost uranium ring the effect must be particularly strong, for in this zone the α-ray absorption shows a maximum value, as is indicated by the integral ionisation curve of uranium, which possesses a steep peak in this position.

We must, therefore, conclude that the coloration of the mineral is accompanied by an alteration in its cohesion properties, with a corresponding increase in the range of the α-particles. This increase will be revealed especially in the *innermost* uranium ring; it will probably remain outside the limits of measurement for the remaining rings. On the basis of this assumption, the history of a uranium halo will be somewhat as follows:

The innermost ring first develops at the normal distance from the nuclear inclusion. With advancing development, and corresponding to the increased range, the outer periphery of the halo advances in a radial direction, whereby the part of the ring directed towards the centre is no longer darkened to the same extent as previously and soon is lost in the general brown coloration of the inner parts of the halo. The outer radius of the innermost halo thus increases in the course of time, exactly as in Joly's observations. The changes in cohesion which it is necessary to assume to explain these alterations of the radii are but very small.

That an analogous phenomenon has not hitherto been found with thorium haloes is, in my opinion, due to the fact that the integral ionisation curve of thorium is not so steep as that for uranium, but is much more evenly distributed. In particular, no marked maximum of absorption of the α-rays coincides with the innermost rings, as in the case of uranium. Changes in the cohesion properties of the mineral containing the halo are thus smaller, and above all more uniform, for thorium haloes than for uranium haloes. Corresponding anomalies in the radii of the haloes are therefore much more difficult to detect. In the elucidation of this question, however, it is very desirable that accurate observations in this matter should be carried out, and that in this connexion attention should be directed to a possible dependence of the position of the innermost halo on the physical and chemical nature or condition of the containing medium.

The explanation I have given of the anomalies in the uranium haloes invalidates Joly's assumption of the existence of uranium isotopes with abnormally high disintegration rates in early geological time, and hence the conclusions as to the calculation of geological ages which Joly has drawn from this work appear unjustified.

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[1] Translated by Dr. R. W. Lawson.

The Nature and Function of Golgi Bodies.

"Youth is, we all know, somewhat reckless in assertion, and when we are juvenile and curly, we take a pride in sarcasm and invective."—BENJAMIN DISRAELI.

THE opening sentence of Prof. Gatenby's letter (NATURE, Jan. 7, pp. 11 and 12) raised in me hope that at last we should be given some kind of indication of the function of the Golgi bodies, by one who has apparently devoted himself to them entirely. On reading through his letter I find that he makes no suggestion as to function, and that the only definite destiny attributed to them is that they form the acrosome of the sperm. As, however, we are also told that the Golgi bodies are "as universal as the nucleus itself" in animal cells, this cannot be their only destiny; and as this assertion claims no more than that the Golgi bodies give rise to a specific structure in a particular group of highly specialised cells, which in a certain sense can scarcely be regarded as part of the body of the animal or plant, we are still left in ignorance as to what Prof. Gatenby believes is the function and destiny generally, of what he calls "this intra-cellular organella."

I suppose that the most modest of men would not, in ordinary circumstances, be displeased if he were told that he had had part in a scientific discovery. Prof. Gatenby's style is such that when he writes, "It was really Moore and Walker who discovered the 'Golgi apparatus' in animal spermatogenesis!" I am not sure whether he gives this as his own or someone else's opinion. In either event the opinion is mistaken, and the mistake does not please me. The particular vesicles described in the paper of which I was part author ("The Meiotic Process in Mammalia." Univ. Press, Liverpool, 1906) were described by Benda in 1896, by Baumgartner in 1902 and 1904, by others

later, and again by me in 1925 (*Proc. Roy. Soc.*, B, vol. 98). Their behaviour under the action of staining and fixing reagents is entirely different from that attributed to Golgi bodies by Prof. Gatenby. In fact, when the methods he recommends for the demonstration of Golgi bodies are used, only a distorted image of the later stages can be traced, even by one familiar with these structures in properly preserved material.

It is curious and suggestive that these vesicles, which can be traced through three cell generations, which are described as going to form the cap of the sperm, and are best demonstrated by those methods of fixation regarded as least likely to distort the structure of the cell long before Golgi bodies became fashionable, should be those which are now claimed as the Golgi bodies which can be seen in the living cell. The true Golgi body, according to Prof. Gatenby, is not demonstrable in fixed material if acetic acid is used, and the material requires subsequent treatment for a week or two in osmic acid, or the use of some other drastic method such as those, the use of which is deplored by many histologists, necessary in the case of some preparations of nervous tissues ; deplored because, though they are requisite for the particular purpose in view, they distort the structures to be examined. I see no reason, therefore, for calling a structure which is best demonstrated by the use of a fixative containing a considerable percentage of acetic acid and by rigidly avoiding the methods recommended by Prof. Gatenby, a Golgi body ; particularly as its history and destiny were more clearly shown by other investigators many years before he published his first paper upon the subject.

With regard to the rest of what Prof. Gatenby calls Golgi bodies, I am sorry that he did not give any reasons for his condemnation of my paper (*Proc. Roy. Soc.*, **101**; 1927). His assertion that I have been asleep for thirty years I can scarcely regard as bearing upon the validity of my observations. Nor do I see that their truth is affected by my failure to quote papers by a botanist on "mitochondria *which even divided*."

The observations referred to were briefly as follows. If mixtures containing proteid, peptone, albumose lipins, and other substances found in cells, are treated with a fixative that does not contain acetic acid, structures indistinguishable from the 'Golgi bodies' may be demonstrated if the preparation is dealt with according to Prof. Gatenby's osmic acid method. Moreover, if minute globules of fat are introduced into the solutions, some of the 'Golgi bodies' take up 'a juxta-nuclear position' just as do some of the 'Golgi bodies' in the cell. They do not appear if the lipins are omitted from the mixture. If acetic acid is used in the fixative, the 'Golgi bodies' do not appear either in my mixtures or in the cells. Now all cells, animal and vegetable, contain lipins, chiefly lecithin and kephalin, therefore it would be very surprising if these bodies did not appear in the cells just as they do in the mixtures.

How are Prof. Gatenby's assertions supported ? Evidently from his letter there is much disagreement even among the adherents of the Golgi body. But he quotes "the leading English workers" as believing certain things about them. Who are the leading English workers ? Prof. Gatenby's style of writing again makes me doubtful as to his exact meaning, but I rather gather from his letter that he means himself, Dr. Ludford, Dr. Brambell, and Miss Shana King. Surely there are some others ! But later on in his courteous criticism when he says, "If Prof. Bose expects other cytologists to accept the view . . . , he is much mistaken," he appears to consider himself justified in speaking for cytologists in general, so perhaps these really are our leaders.

There is one request I would venture to make of Prof. Gatenby, and that is that he would cease to use the word 'inclusions' in describing all structures contained in the cell or even in the cytoplasm. I hope he means something different from what the word may be interpreted as meaning when he uses it thus. The invention of a new word, or trying to give a new meaning to an old word, is always regrettable, though the former proceeding is sometimes unavoidable.

"He strikes no coin, 'tis true, but coins new phrases,
And vends them forth as knaves vend gilded counters,
Which wise men scorn, and fools accept in payment."
(Old Play, quoted by Sir Walter Scott,
chap. xv. "The Monastery.")

CHARLES WALKER.

The University, Liverpool,
Jan. 10.

A Dark Space in High-frequency Discharges.

KIRCHNER (*Ann. d. Phys.*, **77**, 287 ; 1925), Gill and Donalson (*Phil. Mag.*, **2**, 129 ; 1925), and Wood and Loomis (NATURE, Oct. 8, 1927) have shown that a glow discharge can be produced in vacuum tubes at very low pressures, provided the exciting current has a frequency of the order of 4×10^7.

Some experiments were carried out by me in which a 17 cm. spherical bulb, fitted with both internal and external electrodes, was excited at low pressures by a short-wave oscillation generator having a frequency of $3{\cdot}8 \times 10^7$. Discharges of about equal brightness were obtained with either pair of electrodes.

When the internal electrodes (made of sheet aluminium 3 cm. × 3 cm.) were used, a well-defined dark space appeared surrounding each electrode. This dark space had the appearance of the well-known Crookes's dark space but differed decidedly in thickness. When the pressure was such that a 25,000-volt transformer produced a 12 cm. Crookes's dark space, this new dark space had a thickness of only 2 cm. The thickness of this new dark space proved to be more or less inversely proportional to the pressure, for on decreasing the pressure, the thickness increased to about 3·5 cm. At the minimum pressure used, the transformer produced no trace of a discharge in the tube. The dark space could also be seen when the tube was excited by means of the external electrodes.

According to Kirchner, the high-frequency discharge results from a to-and-fro motion of electrons in the rapidly alternating field, the distance between electrodes necessarily being greater than the amplitude of the to-and-fro motion of the electrons. On this hypothesis a dark region near the electrodes is to be expected, for if the mean position of the electron is less than half its amplitude of oscillation from an electrode, the electron will be removed from the field by the electrode. To account for the sharp boundary of the dark space, one must recall that the strength of the electric field in these high-frequency discharges is not large, so that only in the vicinity of its mean position will the electron have sufficient energy to excite radiation. It is probable that the change with pressure is due to an increase in potential, for lowering the pressure decreases the number of available electrons, and if we consider the to-and-fro motion of the electrons as a kind of displacement current, decreasing the number of electrons will change the potential across the tube. SINCLAIR SMITH.

Mount Wilson Observatory,
Dec. 20, 1927.

Temperature and Salinity Observations in the Gulf of Aden.

My letter on the observations of the outflow from the Red Sea, made by H.M. Surveying Ship *Ormonde* during the spring of 1927 (NATURE, Oct. 8, 1927, p. 512), and the account of the oceanographical work of the Italian Surveying Ship *Ammiraglio Magnaghi* in the same area during the spring of 1924 ("Camp. idrografica nel Mar Rosso della *R.N. Ammiraglio Magnaghi*, 1923, 1924." *Ricerche di oceanografia fisica*. Parts I. and IV.), were published independently and almost simultaneously. Prof. Vercelli has now sent me the drawing reproduced here (Fig. 1) with an

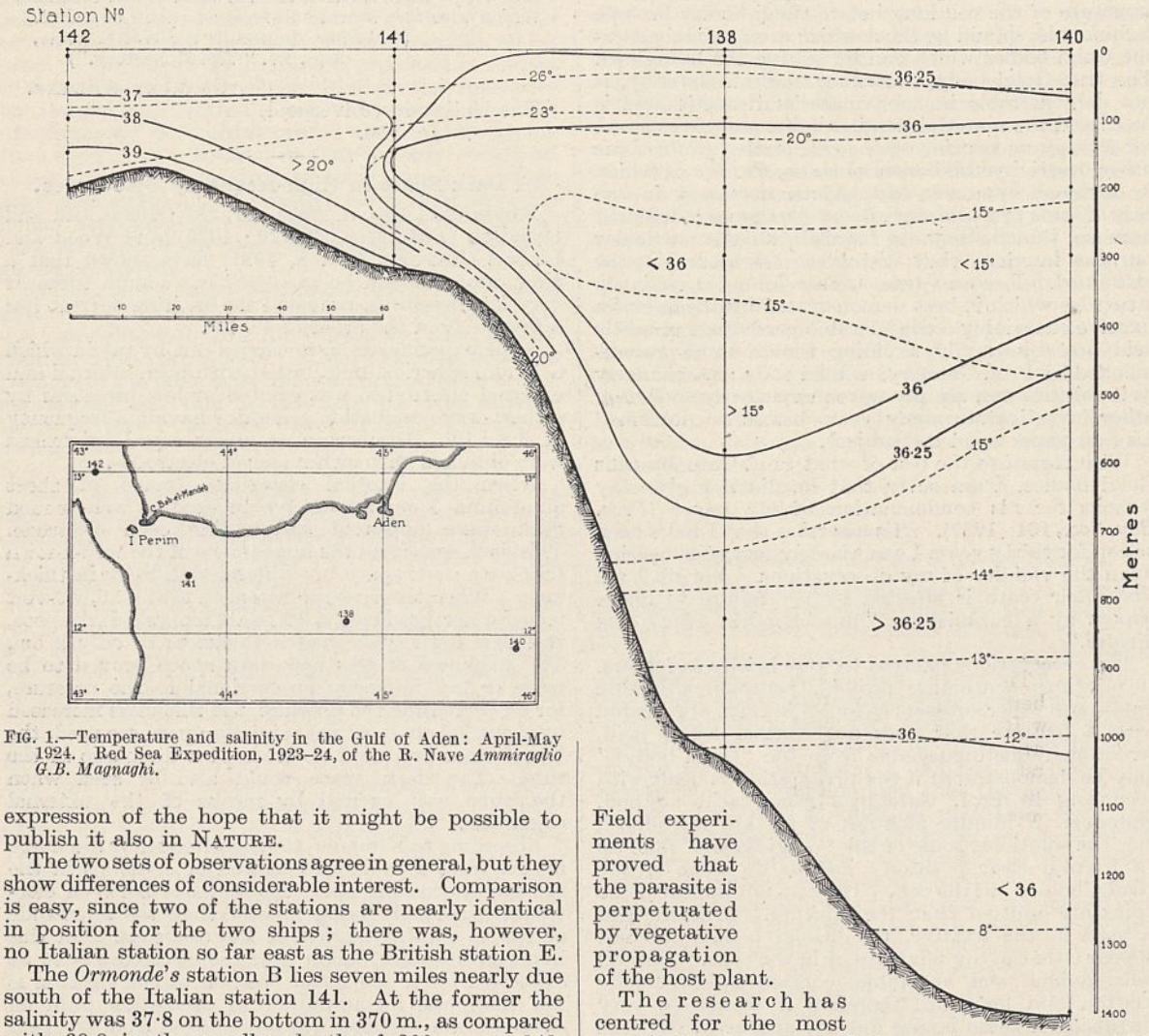

FIG. 1.—Temperature and salinity in the Gulf of Aden: April-May 1924. Red Sea Expedition, 1923–24, of the R. Nave *Ammiraglio G.B. Magnaghi*.

expression of the hope that it might be possible to publish it also in NATURE.

The two sets of observations agree in general, but they show differences of considerable interest. Comparison is easy, since two of the stations are nearly identical in position for the two ships; there was, however, no Italian station so far east as the British station E.

The *Ormonde's* station B lies seven miles nearly due south of the Italian station 141. At the former the salinity was 37·8 on the bottom in 370 m., as compared with 38·8 in the smaller depth of 300 m. at 141. Again, at D the *Ormonde's* maximum salinity was 37·54, at 1000 m., against 36·44 at 830 m. at the Italian station 138, which lies two miles farther northward and ten miles to the westward. The *Ormonde* sounded 1300 m. here, with water of a decidedly oceanic character, 35·76 salinity, at 1200 m.; the *Ammiraglio Magnaghi* found only 1015 m., so it is possible that the distance between the two stations was more than ten miles.

The differences support Prof. Vercelli's contention that the tidal currents in the western part of the Gulf of Aden extend to great depths.

DONALD J. MATTHEWS.

5 Holly Bush Lane, Harpenden, Herts, Dec. 19.

Disease of Grasses caused by *Epichloe typhina*.

THE Ascomycete fungus, *Epichloe typhina*, has been recorded on eight species of Gramineæ in the neighbourhood of Aberystwyth during the past seven years. Although not a parasite of general economic importance in the district, the fungus has been decidedly destructive at the Station, entailing the loss of some valuable breeding plants. An investigation relative to the biology of the fungus started in 1922 has given some interesting results.

Epichloe typhina is found to possess a slender intercellular mycelium, which permeates the stems and leaves of infected plants at all periods of the year. Field experiments have proved that the parasite is perpetuated by vegetative propagation of the host plant.

The research has centred for the most part in the disease on *Festuca rubra*, a species which first aroused the interest of the writer by showing the conidial stage on exserted panicles. In most grasses the fungus fills the spaces between successive leaves of the fertile shoot and holds the panicle a prisoner.

Seed collected from diseased specimens of *Festuca rubra* has produced consistently a high percentage of infected plants. Visible symptoms of attack, namely, the formation of conidia external to the host, were not developed until the second or third year of growth, but microscopic examination of seedlings revealed the characteristic mycelium at the growing point and in the leaves. Some plants which remained barren for three successive years also revealed mycelium in the vegetative organs.

Mycelium similar to that found in other parts of the plant has been traced in the floral organs and in the ripe seed. So far mycelium has not been absent from any seed examined from an infected plant.

The mycelium occurs as scattered strands in the pales and pericarp, but it is most abundant immediately outside the aleurone layer and between the endosperm and the scutellun. The mycelium does not appear to penetrate the cells. It has been traced within the tissues of the embryo itself, and in the first leaf of seedlings grown from infected seed under aseptic conditions.

The cytological relationship of the host and parasite as revealed under the microscope does not betoken any decided parasitic tendency on the part of the fungus, but an examination of the seed produced by infected plants gave definite statistical evidence of the adverse influence of the parasite.

The invasion of *Festuca rubra* by *Epichloe typhina* and its transmission by the seed are of particular interest in comparison with the endotrophic fungus of the genus Lolium investigated by Freeman and by McLellan.[1] Certain points of difference, notably the intracellular mycelium of the Lolium fungus, and its more thorough invasion of the seed, make it unwise in the present state of knowledge to push the comparison too far. Another parallel might be drawn between the behaviour of *Epichloe typhina* and the mycorrhizal fungus of Calluna described by Rayner.[1]

A further point of interest arising out of the present studies is the discovery of a fungus, in the roots of *Dactylis glomerata*, *Alopecurus pratensis*, and *Festuca rubra*. The fungus has an intracellular mycelium of the Phycomycete type and resembles that recently described in the mycorrhiza of various plants including wheat, *Holcus mollis*, *Festuca ovina*, and the genus Lolium.[1] In my opinion this fungus has no genetic connexion with *Epichloe typhina*.

KATHLEEN SAMPSON.

Welsh Plant-Breeding Station,
Aberystwyth, Dec. 14.

Activation of Hydrogen by Electric Discharge.

IN a recent paper, Mr. G. A. Elliott (*Trans. Faraday Soc.*, **23**, 60; 1927) describes experiments on active hydrogen in an ozoniser. The activation was determined as usual by leading the active hydrogen over solid sulphur (which was placed very near to the discharge tube).

A mechanism of activation is herewith proposed which does not need such hypothetical species as H_3 (see F. Paneth, etc., *Zeit. f. El. Ch.*, **33**, 102; 1927) and only involves ions and electrons. If the stream of hydrogen leaving the discharge tube carries ions (H^+_2, H^+, or both) and electrons, due to the fact that they have not all recombined, then the electrons may readily combine with the sulphur atoms, because the latter have a decided affinity for electrons. Sir J. J. Thomson uses this idea to explain certain phenomena in the electrodeless discharge in gases (*Phil. Mag.* [7], **4**, 1153 and 1157; 1927). The next step in the ozoniser reaction is then a simple ionic combination (see S. C. Lind, "Chemical Effects of Alpha Particles and Electrons." Second edition, Jan. 1928, Chemical Catalog Co., New York) between H^+ and S^- with the resultant production of H_2S. With the sulphur placed close to the discharge it is very likely that it is under an electric field due to leakage, and it is not necessary then to regard a slow rate of recombination of gas ions as essential.

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[1] References to the original papers on these topics may be found in the recent book by Dr. M. C. Rayner, entitled "Mycorrhiza, an Account of Non-pathogenic Infection by Fungi in Vascular Plants and Bryophytes," *New Phytologist Reprint*, No. 15, 1927. The references are too numerous to print here.

Oxfordshire Flowers and the Plot Memorial Windows.

In NATURE of May 28, 1927, p. 798, in the excellent account of the unveiling of the Wren-Ashmole-Plot Memorial Windows at Oxford, it is said that "the surrounding wreath is of two Oxfordshire flowers which Plot was the first to recognise as new to the British flora"—*Viola palustris* and *Geranium dissectum*.

I have dealt with these in my Oxfordshire Flora (lxxvii) and quote Morison's remark upon the Viola. He says (*Pl. Hist. Un. Ox.*, iii. 475, 1680): "Detecta fuit a Jacobo Bobert decennio abhinc"; moreover, it is doubtless Parkinson's ("Theatrum," 755, 1640) *Viola rubra striata Eboracensis*. So, too, with *Geranium dissectum*, Morison does not give Plot, but Bobart as its discoverer. It was actually included in Thomas Johnson's "Catalogue of Kentish Plants," published in 1629. So that neither of the two plants selected to appear in the wreath were actually new to Britain.

Plot, however, did discover a new species of elm (*Ulmus Plotii* Dr.) as well as *Potentilla procumbens*, *Sagina apetala*, and *Eleocharis acicularis*, the two latter not very adaptable for depiction in a floral wreath. The viola, however, and geranium are both figured in his History.

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Crick Road, Oxford.

Experimental Measurement of the Surface Tension of Solids.

IN previous publications I have shown that the surface tension of solids can be determined experimentally by methods which do not involve any hypothesis as to molecular structure. As there is evidence that the structure of rock salt is more complicated than it appears at first sight, I devised a method which enables the molecular forces to be determined in a direct way. The method is limited to a certain range of values and is not applicable when the substances used act on each other; I have determined the surface tension of glass and rock salt. Now I find that this method, described in the *Phil. Mag.*, June 1926 and Oct. 1927, suitably modified, can be also used for many other substances and some metals in particular. Thus it is possible to determine the surface tension of antimony, bismuth, lead, tin, aluminium, cadmium, and zinc. For metals with higher surface tension, certain adjustment of physical properties is still necessary, and this will be done in due course.

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The Hungarian Biological Research Institute.

AN unfortunate error has crept into the last paragraph of my article (NATURE, Dec. 31, 1927, p. 969). 125 pengö (not penzö) approximately equals, not 14*s.* 4*d.*, but £4 4*s.*, and 25 pengö is about 16*s.* 8*d.* Since the article was written in Budapest, I am at a loss to account for the error, and I apologise for having overlooked it in proof.

F. A. BATHER.

Light and Sight.

By Sir JOHN PARSONS, F.R.S.

AN opportunity for exemplifying one aspect of the relationship between physics and physiology, namely, that of the physical stimulus to a sense organ and the physiological response, was afforded by the Tyndall Lectures upon "Light and Sight," delivered by me at the Royal Institution on Nov. 1, 8, and 15. John Tyndall, in addition to being a physicist, drifted into biology, and by his experiments on spontaneous generation may be regarded as a pioneer in bacteriology. He was also a philosopher. He himself expressed his indebtedness to three men—Carlyle, Emerson, and Fichte. "These three unscientific men," he said, "made me a practical scientific worker." His philosophy led him strongly to support the pioneers of the evolutionary theory—Darwin and Wallace, Herbert Spencer and Huxley. Specially strongly did he support that canon of scientific discipline which was so ably enunciated by Huxley and rather unfortunately branded by him with the contentious name, agnosticism. Here Tyndall was overshadowed by his great contemporaries, and the immense effect of his Belfast address is liable to be overlooked by the historians of science.

The essence of the agnostic creed was a judicial suspicion of authority and the cultivation of suspension of judgment in regard to matters which are not yet susceptible of rigorous scientific proof. It cannot be doubted that the rise of the theory of relativity and the deductions therefrom have led to a weakening of scientific discipline and a too facile acceptance of plausible speculations. A reversion to the stricter canon of Tyndall and Huxley would be beneficial to all branches of science, and not least to physics, where hypotheses as to atomic structure, the constitution and life history of the stars, etc., are asseverated as facts with all the adamantine validity of the laws of the Medes and Persians. As Sir Arthur Keith has recently said, "The unfortunate position is that in this world there are men who will not be satisfied with not knowing"—an ambiguous remark which, however, as meant, embodies a great truth.

Our consciousness of the world around us is derived from impressions conveyed to our sense organs, of which the most important for us are the organs of vision. The integrated results of our sensory impressions are perceptions, which thus originate in the absorption of energy in various forms by the sense organs and its transformation into physiological impulses which are conveyed by sensory nerves to the brain.

In considering the radiant energy emitted by sources of light, such as the sun and artificial illuminants, and its distribution throughout their spectra, it is interesting to note that the human eye has become specially adapted to sunlight, as shown by the fact that the brightest part of the spectrum, as seen by the light-adapted eye, coincides more or less accurately with the summit of the curve of radiant energy.

As Helmholtz long ago pointed out, the eye shows many defects as an optical instrument. The refracting surfaces are not accurately spherical; they are not accurately centred on the optic axis; they are not completely homogeneous and therefore give rise to irregular astigmatism, or completely transparent; the cornea and lens are not free from spherical or from chromatic aberration. Hence Helmholtz's oft-repeated dictum that if an optician delivered so faulty an instrument it would be justifiable to return it to the maker. Even Homer sometimes nods, and it is regrettable that Helmholtz should have uttered so unjust a sarcasm. For the true criterion of the eye as an organ of vision is its biological utility, *i.e.* its capacity to fulfil its manifold functions in the interests of the individual and ultimately of the race. An instrument approximately a sphere of 11 mm. radius, which combines the advantages of being a camera with automatic adjustment from infinity to a distance of 3 or 4 inches and unparalleled range of sensitivity, an efficient photometer, colorimeter, kaleidoscope, stereoscope, and range-finder cannot be regarded as inefficient.

The criterion of visual acuity is the capacity to distinguish two points of light as separate, *i.e.* the *minimum separabile*. This depends on the resolving power of the eye and the fineness of grain of the screen upon which the image is formed, *i.e.* the neuroepithelium of the retina. Experimental observations showing a minimum visual angle of 40″ of arc coincide well with the mean diameter of the foveal cones, 3μ. But contour discrimination, with a minimum visual angle of 10″, or even binocularly of 2″ (Andersen and Weymouth), is much less easy to explain. As shown by Hartridge, the key to the problem is found in the *difference* of illumination which is perceptible to cone vision. It is a striking example of the law that all perception is perception of change.

It can be safely stated that there is no form of sensory discrimination which is so highly developed as that of contours; and it is noteworthy that it has been employed empirically by physicists in the vernier. When the vernier method is inapplicable, as in photometry, the error of experiment is greatly increased. It is well for physicists to remember that the accuracy of their measurements depends upon a biological foundation (see NATURE, **110**, 824; 1922).

The bearing of these facts on the physiology and psychology of reading elicits many interesting conclusions. The defects of the optical apparatus lead to diffusion images, and cause irradiation, whereby the image of a dark object is encroached upon by the surrounding white. Irradiation in print is largely counteracted by the use of serifs and by careful design of the letters and spaces. Thus, the interspace between round letters like *o* and *e* should be less than that between square letters. Moreover, the significant parts of letters are usually

in the upper half, so that a line of print can be easily read if the lower halves of the letters are covered, but is illegible if the upper halves are covered.

The eye is not only automatically adjustable to distances, but also its sensitivity is automatically adjusted to the amount of light entering it. The sensitivity of the retina increases enormously in dark adaptation, and scotopic or twilight vision differs in many respects from photopic vision. Evidence derived from physiological and pathological observations supports the view that the rods are responsible for scotopic, the cones chiefly for photopic vision. This is the so-called duplicity theory. Thus, the rod-free area of the macula is night-blind, as was long ago discovered by astronomers, and it is generally held that the Purkinje phenomenon is absent at the fovea. Further, the rate at which the eyes become adapted to dim light varies somewhat in normal people, and there are diseased conditions in which it is very slow or almost absent. Such people are night-blind. They are practically incapacitated in dull lights, and cannot get about after dark. In one rare group the eyes appear to be otherwise normal and the disease is transmitted from one generation to another. The most famous and most extensive pedigree of any diseased condition is that of some congenitally night-blind people in the Montpellier district in the south of France. The pedigree was started by Cunier in 1838 and brought up-to-date in 1907 by Nettleship. It consists of ten generations of 2121 persons, 135 of whom were night-blind. Much commoner is the night-blindness associated with the disease of the retina called retinitis pigmentosa.

An interesting antithesis to night-blindness is found in the rare cases of congenital total colour-blindness. For the normal sighted the colourless grey spectrum of scotopic vision becomes suffused with all the colours of the rainbow as the intensity of the light is increased. For the totally colour-blind, although the brightness increases under these conditions, no colours are seen. Moreover, there is no shift of the maximum brightness from the green to the yellow region of the spectrum, such as occurs in the normal.

On the duplicity theory, the congenital night-blind may be regarded as having only cone vision, and the totally colour-blind only rod vision. There are, however, difficulties in accepting this simple explanation.

The discovery of the visual purple indicates forcibly that the first stage in the energetics of the retina is photo-chemical. It is associated with electrical changes of great complexity; and whereas Adrian has shown that the electrical changes in the optic nerve are in all respects like those in an ordinary nerve under excitation, the correlation of these changes with those of the more complex retina has yet to be elucidated.

Stimulation of the retina by an instantaneous flash of light elicits two facts—the persistence of the visual impression for an appreciable time beyond that of stimulation, and the recurrence of vision. The latter is due to the pulsatile nature of the sensory response. It accounts for such peculiar phenomena as 'Bidwell's ghost,' Charpentier's bands, and so on. One of the most striking phenomena is the production of a colour sensation by pure black and white stimulation, as in Benham's top; and this has recently been partially explained by Piéron on the same principle.

The relations of these scientific observations on light and sight to such practical problems as the illuminations of rooms, factories, art galleries, etc., and the hygiene of vision in relation to flickering lights, the cinema, etc., is full of interest, but also often very obscure. The investigation of such problems is the chief work of the Physiology of Vision Committee of the Medical Research Council.

The Second Danish-Icelandic Expedition to Iceland, 1927.

By Dr. NIELS NIELSEN, Copenhagen.

OUR knowledge of the interior of Iceland is of quite recent date and still in part very incomplete, even to the point that there are districts which may be said to be utterly unknown to science. This applies both to topography and to geographical and geological conditions. The reason is that it is very difficult to push into the highlands of the interior, because different difficulties, each of which requires to be met by a special technique on the part of the traveller, combine to present obstacles to his passage as well as to his closer scientific investigation of the country.

In a purely practical way the coast districts have been known ever since the country was first inhabited, that is, for about a thousand years, and similarly certain tracks through the inner highlands, which one may suppose were considerably better known seven or eight hundred years ago than they were in the eighteenth and nineteenth centuries. Meanwhile, the last fifty years have made great changes in our knowledge of this region, inasmuch as a great advance has been made in the scientific investigation of the highlands, and at the same time in a practical knowledge of the country. This advance is due to a considerable number of able and energetic men of science and travellers, among whom one may name Winkler (1858), Preyer and Zirkel (1860), Keilhack (1883), Watts's various expeditions in the 'seventies, and Biziker (1900). Above all, one must mention the great work carried out by the distinguished Icelandic investigator, Thorvaldur Thoroddsen, who in the last two decades of the nineteenth century travelled over a very great extent both of the highlands and of the coast districts, and published numerous papers on the geography and geology of Iceland. We further owe to Thoroddsen a number of excellent handbooks which are among the most important aids in Icelandic exploration. Since 1898, when Thoroddsen's journeys ended, the work has been continued by

German, British, Icelandic, and Danish men of science, who have all contributed to our knowledge of the peculiar natural conditions of the interior of Iceland. During the War, Icelandic investigation came almost to a complete standstill, but since then a number of investigators have made journeys into the country, and the results are beginning to appear in various journals.

One link in the series of these resumed investigations of Iceland is contributed by the journeys accomplished in the years 1924 and 1927 under the name of the First and Second Danish-Icelandic Expeditions, under the leadership of the author of this article and the Icelander Palmi Hannesson. The costs of these expeditions were provided by the Danish-Icelandic Confederation Fund and the Danish Carlsberg Fund. With regard to the expedition of 1924, the reader may be referred to the articles already published,[1] but in what now follows a short synopsis will be given of the work accomplished in the expedition of 1927.

FIG. 1.—Surface of lava-gravel near Fiskivötn, Iceland. The storms, joined with the great porosity of the surface, make vegetation very scarce. In the foreground may be seen a little stunted Armeria.

The main lines of the plan were to push from the district near Hecla towards the western part of the great ice-field of Vatnajökull and to make investigations in the ice-free country west of the ice-field and its western part, the intention being to explore westward until contact was established with the districts south of Hofsjökull explored in 1924.[2] That has now been done, and the plan proved on the whole to be workable with the means and the man-power which were at our disposal.

The participators in the scientific work were Steinthor Sigurdsson, Palmi Hannesson, and Niels Nielsen. They were accompanied by a non-scientific colleague, an Icelandic schoolmaster, Sigurdur Jonsson. The work lasted from the beginning of July until the middle of September, and from July 18 to Sept. 3 the expedition was cut off from all connexion with the inhabited district except that the Danish minister in Iceland, Fr. de Fontenay, was from July 30 to Aug. 5 the guest of the expedition and took part in the work.

By far the greatest part of the highlands of Iceland is extremely deficient in vegetation and may be described as desert; but this differs very much, as great parts are covered with ice the whole year through, especially the higher altitudes of the plateaux, which embrace most of the country and in many places extend right down to the coast. The parts of the highlands which are free from snow in summer are for the most part very sparingly overgrown, and it is only at long intervals that one comes upon oases. These conditions completely govern the technique of travel in Iceland, which is based on the use of Icelandic ponies, because it is only with their help that one is able to overcome the obstacles presented by ice-fields, lava-fields, barren stretches of sand and gravel, and, not least, the great number of rivers springing from the margins of the ice-fields.

On long journeys in country free from snow it is impossible to transport fodder for the horses,[3] because a horse can only carry fodder for himself to last about ten days, so that one must depend on the few and scattered oases already mentioned. The explorations of 1927 set out from two such oases near Fiskivötn and Illugaver, both known before. On these spots we established a base whence the work was carried on, partly on horseback, partly on foot, partly by the setting up of small intermediate stations in the desert tracts around.

The equipment consisted of tents, with watertight floors, sleeping-bags of lamb-skin, and vegetable provisions for nine weeks: on the other hand, the supply of meat was quite small, the intention being to furnish the expedition with animal food by hunting and fishing. We succeeded, thanks especially to our catches of trout, in getting what we needed. For transport of men and goods, seventeen horses were employed, of which, however, immediately after our arrival at Base No. 1, four had to be sent back to the inhabited district, because there was not grass to feed them all. So the number of our horses was properly thirteen. The scientific equipment consisted, *inter alia*, of a complete outfit for mapping and astronomical determination of position (wireless receivers for

[1] *Geografisk Tidsskrift*, Copenhagen, 1924; Niels Nielsen: "Der Vulkanismus am Hvitárvatn und Hofsjökull auf Island." Meddelser fra Dansk Geologisk Forening, Copenhagen, 1927.

[2] Niels Nielsen: "Plan til en Ekspedition til den vestlige Del af Vatnajökull og tilgrænsende Egne i Centralisland." *Geografisk Tidsskrift*, Copenhagen, 1927.

[3] Conditions are quite different when one has to do with ice-tracts and can employ sledges drawn by horses; cf. J. P. Koch's journey over the inland ice of Greenland with Icelandic horses, 1912–13.

determining time and for meteorological intelligence), apparatus for meteorological observations, and a set of instruments for limnological work. We carried, besides, a good photographic equipment, both the usual plates and cinema-films.

Those who took part in the scientific work worked to some extent collectively and to some extent singly. Thus the cartographical work was mainly carried out by Sigurdsson, the limnological, as also the zoological and botanical investigations, were made by Hannesson, while I mainly occupied myself with geomorphological inquiries, especially concerning the morphology of vulcanism and tectonics. But collective work was much needed both for practical and for scientific reasons.

The results of the investigation can naturally not appear in their completed form until later, and then will probably be published as articles in journals in a widely used language, but a short survey of the materials collected can be given at once.

1. The results obtained give a series of new lights on topographical facts in the country west of Vatnajökull and the western part of that ice-mass; and on the basis of the triangulation carried out for the whole district and the detailed measurements carried out in certain cases, it will be possible to make a general survey map of the whole district and a map to smaller scale of different areas of especial geographical or geological interest. The working sketches already made show that the chief topographical lines, mountains, rivers, ice-margins, seashores, run essentially otherwise than has been hitherto supposed, and of a great part of the district it is certain that it was never before travelled in, far less mapped out.

2. The biological, and more especially the limnological, material will probably contribute to an understanding of the rigorous conditions under which animals and plants subsist in these regions, which may be described as the border-regions of the diffusion of life on the earth. A special investigation has been taken in hand of some peculiar lakes in the neighbourhood of ice-margins, which are marked by an extraordinarily rich fauna and flora, though its richness relates only to the number of individuals, not of species. Only two species of fish are found, namely, one of stickleback and one of trout, but by way of compensation the fish were very well-grown and fat; the trout weighed up to 4 kilograms. Another special research has been made into the peculiar plant-world which is found at times in the immediate vicinity of the ice-margin, and here forms such large and continuous oases that one can feed a small number of horses there for some days, a plant-world existing amid a number of concurring circumstances of a remarkable kind.

3. The geographical-geological material is very extensive and various in character. Of the topographical part, mention has already been made. In addition, there are numerous observations concerning volcanic action, which has been very violent and varied, in this part of the country. One finds, for example, typical fissure-eruptions with a great production of lava which has formed lava-fields covering many hundreds of kilometres. Again, we have single volcanoes with a mixed formation of the same type as Vesuvius, while the excrescences found at fissure-eruptions are

FIG. 2.—In the lava-fields immediately west of Vatnajökull. The horses are standing on an old lava-stream of somewhat loose sand, while the two men behind are walking on quite recent lava which is very difficult to cross. The demarcation of the two streams is seen quite clearly.

so slight that they are difficult to find. In one of the volcanic zones the explosive activity has been very great and has led to the formation of a number of craters or 'Maarer' of many different types. The volcanic activity can be followed from the later period of the ice age down to the present day—the last outbreak which can be dated with certainty took place in 1913. Consequent on the volcanic phenomena, many fumaroles and hot springs are found.

The country west of Vatnajökull is further remarkable for being a very disturbed country in a tectonic sense. A great part of the region is broken up by earthquakes. The displacements have especially taken place along lines running in the direction S.W.—N.E. and have divided the country into a number of ridges with intervening depressions. Some of these displacements go back to the ice age, while others are quite recent, in any case not more than some few thousand years old.

As a third factor in landscape-formation one may mention the ice, which has many times spread from the neighbouring Vatnajökull over the whole country, and the effect of which, both in earlier times and in modern times, has been the subject of study.

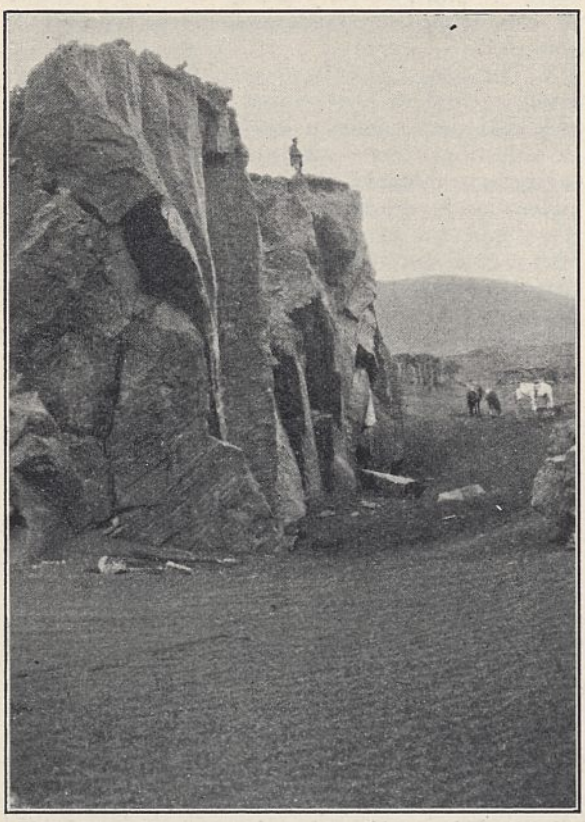

FIG. 3.—An earthquake-rift in the lava-fields west of Vatnajökull.

In this landscape, the origin of which, as has been stated, must be referred to three different sets of factors, a whole series of transforming forces are at work at this moment, and some of these have been specially investigated, because the conditions here in certain respects are abnormal. A very special rôle, for example, is played by the wind, the erosive power of which is very violent and is the cause of production of frightful sandstorms, which in their strength remind one of those that take place in the great desert regions of Asia and Africa. Another very real factor in erosion is the snow, which, together with the masses of water set free by its melting, greatly contributes to the transformation of the landscape. The reason why the above-mentioned factors play so great a part in this work, and can be studied with comparative ease, is that nearly the whole district is deficient in surface streams. Apart from the great rivers of melted ice, one finds only a few short streams, since the whole surface consists of very porous kinds of rock which absorb water with avidity and carry it underground a great distance until it emerges as springs of surprising abundance.

The expedition has met with great kindness and support on many sides both in Iceland and in Denmark, the conditions of work have on the whole been good, and the work has been carried out without serious misfortune to man or beast.

Obituary.

PROF. P. H. VON GROTH, FOR. MEM. R.S.

GEHEIMRAT PAUL HEINRICH RITTER VON GROTH, who died on Dec. 2, 1927, was born on June 23, 1843, at Magdeburg. His father was a portrait painter. His early academic studies were pursued first at the Bergakademie at Freiberg (1862–65) and then at the University of Berlin (1865–67), where he obtained his Ph.D. degree in 1868. He was successively assistant in the Department of Physics in the University (1868–70), reader of mineralogy and geology at the Bergakademie in Berlin (1870–72), and in 1872 was appointed professor in the newly constituted University of Strasbourg, where he remained for eleven years until his promotion to the chair at Munich. It was during Groth's tenure of office at Munich that the most important work of his life was accomplished. In 1874 he published his "Tabellarische Übersicht der einfachen Mineralien"—a comprehensive list of the mineral kingdom, containing not only a systematic classification of species, but also a critical survey of views on their chemical composition; subsequent editions with much new material appeared in 1882, 1889, 1898, and were followed in 1921 by a new survey, "Mineralogische Tabellen," in conjunction with Mieleitner. In 1876 he published his famous "Physikalische Krystallographie," a most readable and suggestive treatise which was for many generations of teachers and students an attractive introduction to a science that had previously been presented in a very unattractive form. Sir Lazarus Fletcher has recorded the fact that he was led to take up the study of the subject by happening to see a copy of the book in that year. Subsequent enlarged and revised editions appeared in 1885, 1895, 1905.

In 1877, Groth started the first volume of the *Zeitschrift für Krystallographie und Mineralogie*, which became universally known as Groth's *Zeitschrift*. This he edited with great skill for thirty-nine years, enlisting the co-operation of a large number of mineralogists from all countries; it was conspicuous for its international character and for the value not only of the original papers, but also of the abstracts which it contained. In a memoir which appeared shortly before his death in the *Zeitschrift*, he gave an account of its inception and a history of its progress during the period of his editorship. The fiftieth volume (1923) was a

(*Continued on p.* 107.)

Supplement to NATURE

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On the Rotation of the Earth and Astronomical Time.

By W. DE SITTER, University of Leyden.

ABSOLUTE TIME AND PRACTICAL MEASURES OF TIME.

NEWTON'S "Principia" begins with the definitions of some technical terms, such as 'mass,' 'force,' etc. Newton then continues as follows :

"Nam Tempus, Spatium, Locum et Motum, ut omnibus notissima, non definio. Notandum tamen, quod vulgus quantitates hasce non aliter quam ex relatione ad sensibilia concipiat. Et inde oriuntur praejudicia quaedam, quibus tollendis convenit easdem in absolutas et relativas, veras et apparentes, mathematicas et vulgares distingui.

"I. Tempus Absolutum, verum, et mathematicum, in se et natura sua absque relatione ad externum quodvis, aequabiliter fluit, alioque nomine dicitur Duratio : Relativum, apparens, et vulgare est sensibilis et externa quaevis Durationis per motum mensura (seu accurata seu inaequabilis) qua vulgus vice veri temporis utitur, ut Hora, Dies, Mensis, Annus."

The few words which Newton puts in parentheses contain the great problem : How are we to decide whether a given measure of time is accurate or not ? We measure time by different 'motions,' of the sand in an hour-glass, of the hands of a clock (hours), of the earth on its axis (day), of the moon round the earth (month), the earth round the sun (year), or others. If these different methods do not give the same result, *and they do not*, how are we to know which is to be preferred, which is the best approximation to the true, absolute, mathematical time ?

It is one of the fundamental characteristics of natural science that we never get beyond an *approximation*, and this for two reasons. The first of these is that the motions that we use for measuring time must be observed, and all observations are affected by errors, and can never be absolutely accurate. The other is that Nature never offers us simple and undivided phenomena, or 'motions,' to observe, but always infinitely complex compounds of many different phenomena. Each simple phenomenon can be described mathematically in terms of the accepted fundamental laws of Nature ; to interpret the complex phenomena of daily experience we must analyse them into their simple components, isolate these, and from each separately draw our conclusions. We can never be sure that we have carried this analysis to its full exhaustion and have isolated one single simple phenomenon, to which we can apply our mathematics. We might, indeed, take a different point of view and argue that the phenomena of Nature are simple, and that it is we who introduce the complication, forced to do so by the limitations of our power of mind and our mathematics, which do not allow us to grasp the sublime simplicity of Nature otherwise than by the devious route of first splitting it up into partial aspects, so chosen that we can master them by our mathematics, and then recombining these to an approximate representation of the whole. However this may be, we cannot but use the only means at out disposal, and if the truth be one and simple, we can only comprehend it as a synthesis of many constituent truths.

The simple constituent motions into which we decompose the actual phenomena are described in terms of the laws of mechanics and the time. This time, which is thus the 'independent variable' of our differential equations, or laws of Nature, is Newton's mathematical (or true, or absolute) time. Once the observable quantities have been expressed mathematically in terms of the time, it is very easy inversely to derive the time from the observed values of these quantities.

In our choice between different motions used to measure time, or, as we may say, between different 'clocks,' we are thus guided by two considerations : which can be most accurately observed, and which 'runs' most accurately, that is, which represents the best approximation to an isolated simple phenomenon of which we know the laws.

Astronomical Time.

The standard clock, to which all other measures of time are referred for comparison, is the rotating earth. In fact, we know of no other motion which is so purely representative of an isolated simple phenomenon, so free from 'perturbations.' The time measured by the rotation of the earth has for immemorial ages been used by astronomers as their standard of reference. It is called *astronomical time.*

The motions of the other heavenly bodies can, of course, also be used as a measure of time. Their mathematical expression in terms of the time is less simple, and the determination of the time from the observed motions thus demands a greater amount of computation. Also they cannot be observed with the same accuracy, the motions being slower and the bodies far away. But within the limits of uncertainty, they all ought to give the same time; that is, the ratio of the day and the month, and of the day and the year, ought to be constant through all ages, after due allowance has been made for known perturbations.

Time measured by the Moon: The Secular Acceleration.

These ratios, however, are *not* constant. The great astronomer Halley discovered that the month, measured in astronomical time, is continually getting shorter. Whether, measured in the true or mathematical time, the month gets shorter or the day longer, or both change, we have no means of saying: we only know that the number of days in a month is becoming smaller. The change is very minute: if it continues at the same rate, it will take 250 million years for this number to diminish by one unit. The length of the month at the present time diminishes by $\frac{1}{33}$ of a second per century; in other words, the motion of the moon referred to astronomical time is accelerated.

When two clocks do not show the same time, the difference may be constant, or it may be variable. If it increases or diminishes regularly, the two clocks have different *rates*; one of the clocks, say A, loses time as compared with the other, say M; or one hour of A is longer than one hour of M. If also the difference of the rates is not constant, but changes regularly with the time, then one of the clocks is *accelerated* with regard to the other, and the other is retarded with reference to the first. If we call T the time as read from clock A and t that given by clock M, the three cases considered are represented by the following mathematical formulæ:

$$(1)\ t - T = a,$$
$$(2)\ t - T = a + bT,$$
$$(3)\ t - T = a + bT + cT^2.$$

The formula (3) represents the case of the earth and moon, used as our clocks A and M. The time as derived from the moon's observed longitude is not uniform as compared with astronomical time, but contains a term $20^s \times T^2$, if T is expressed in units of a century. This is technically known as the *secular acceleration* of the moon's motion. It was discovered by Halley, who found that he needed it in order to represent by one formula the modern observations as well as eclipses observed by the ancient Babylonians and by the Arabian astronomer Albategnius (ninth century A.D.).

The presence of this term proves that our simple theory of the motion of the moon, taking account of no other forces than the general attraction by Newton's law, is incomplete. Consequently, either some minute gravitational effect has been overlooked in elaborating this theory, or some other cause must be acting in addition to it. Newton[1] suggested that this other cause might be a slow increase of the mass of the earth by the addition to it of the "vapours escaping from the atmospheres of the sun and the stars and the tails of comets, which by their gravity fall down into the atmosphere of the earth and the other planets and may there be condensed and converted into water and watery vapours, and subsequently by slow heating be changed by and by into salts and sulphurs, and tinctures and mire, and mud and clay, and sand and stones, and corals and other terrestrial substances."

We now know that this cause—which in modern language we would call the fall of meteorites—is real, but incapable of explaining even a very small fraction of the observed acceleration. Tobias Mayer, in the middle of the eighteenth century, was the first to suggest that the change might not be primarily in the month, but in the day, the rotation of the earth being retarded by the friction of the tides. This suggestion, however, does not appear to have attracted any attention at the time. Laplace, in 1787, found a perturbation by the gravitational influence of the planets on the motion of the moon, which had been hitherto overlooked. According to his computations, this would be just sufficient to explain the observed acceleration of the moon's motion, the day not being affected. If this were so, there would be no discrepancy; the two clocks would be in perfect agreement. Adams,

[1] "Principia," Book III., just before the *Scholium Generale.*

however, in 1853, carried Laplace's computations to a further order of approximation and found that this cause explains little more than one-half of the observed acceleration, giving in fact a term $11^s \times T^2$. There thus remained unexplained about $9^s \times T^2$.

Fluctuations of the Moon's Longitude.

This, however, is not the only unexplained discrepancy in the moon's motion. In addition to it, the moon shows irregular deviations from its path as prescribed by theory. It is sometimes in advance of its theoretical position and sometimes it is left behind. The difference can run up to 15 or 16 seconds of arc. In other words, since the moon takes about two seconds of time over one second of arc, the time shown by the 'clock *M*' may occasionally be about half a minute slow or fast on astronomical time. These irregularities, called *fluctuations*, were discovered by Newcomb. He suspected them already in 1875, but it was only in 1903 that he published an entirely convincing proof of their reality. Before about 1630 the observations are too inaccurate to enable any conclusions to be drawn. At that time the moon was about 30 seconds slow on astronomical time. About 1670 it began to gain, so that in 1720 it had made up its arrears. It then continued to gain, and was nearly 30 seconds in advance by 1785. Then it started to lose again, being caught up by the theoretical moon in 1865, and left behind more and more until about 1900, when it started to gain again. It has, however, only succeeded in diminishing its arrears from about 30 seconds in 1900 to about 18 in 1918, and has lost again in the last few years, being some 23 seconds slow at the present time.

It should be understood that these fluctuations are additional to the secular acceleration, and they are of a very different nature. The secular acceleration is a steady increase of the rate of the lunar 'clock.' If it is graphically represented by plotting on co-ordinate paper the deviations of the moon's observed position from the theoretical one, the resulting curve is a parabola. If the change of the rate is not uniform, then the curve will differ from a simple parabola, but it will always be a smooth curve with a continuous curvature and without any sharp bends. The fluctuations, on the other hand, show a very different character. When plotted on co-ordinate paper, they have the appearance of a series of straight lines with sharp bends where two lines meet. Thus from the appearance of the observed deviations we would be inclined *a priori* to ascribe them to two different causes.

It has already been remarked that the observations prove only that there is a difference between the time as shown by the two 'clocks' *A* and *M*, but do not enable us to decide which of the two is correct. There is, however, one crucial test, which is very obvious, though not so very easily applied. If the clock *A* is in error, that is, if the astronomical time differs from the mathematical time, then not only the moon, but all the other heavenly bodies as well, must show deviations from their theoretical motions. Now the moon is not only our nearest neighbour, in consequence of which the observations of its position are more accurate than those of other bodies, but it also moves much more quickly than most others, so that the irregularities run up to a larger amount in the same time. The consequence of this is that irregularities in the moon's motion have been discovered earlier than in the motions of other bodies.

The Sun and the Planets.

It was only in 1906, about two centuries after Halley's discovery of the secular acceleration of the moon, that Cowell detected a secular acceleration in the longitude of the sun. His result has been confirmed by later researches, and it has also been found that the planet Mercury, which can be very accurately observed on the occasions of its transits across the sun's disc, shows a similar acceleration. The most recent discussions lead to a secular acceleration of the longitudes of the sun and Mercury corresponding to a term $40^s \times T^2$, *i.e.* about 4·4 times as much as the unexplained acceleration of the moon. If this is ascribed to a retardation of astronomical time, *i.e.* of the rotation of the earth, then the corresponding lengthening of the day is $\frac{1}{460}$th of a second per century. On the other hand, several astronomers have found fluctuations similar to those of the moon in the longitudes of the sun, Mercury, and Venus. Brown was the first who produced strong evidence of this (in 1914), and lately many investigations have established the similarity of these fluctuations with those of the moon beyond any reasonable doubt. Whenever the moon is losing on astronomical time, the sun and planets are also losing, and when the moon is gaining, the sun and planets are also gaining. Thus, for example, from 1876 to 1897 the moon lost about 15 seconds, and from 1897 to 1918 it gained about 11 seconds. The sun and planets have in these intervals lost 19 seconds and gained 14 seconds respectively, and similarly for other intervals, the moon's loss or gain being always about four-fifths of those of the sun and planets.

All this points to the astronomical time, that is, to the rotating earth, as the chief offender, in complicity, however, with the moon. We are thus confronted with the question how a change in the rate of rotation of the earth, that is, in the length of the day, can be explained, and with the further question whether the cause which produces this change can also affect the motion of the moon. The problem certainly looks forbidding enough.

If we return to our representation by 'clocks,' we have now *three* clocks: A, the rotating earth, giving astronomical time; M, the moon; and S, the sun and planets. The sun and the planets Mercury and Venus are treated as *one* clock, S, since they agree amongst each other within the limits of accuracy of the observations, but they do not agree with M. The observations of the other planets are not sufficiently accurate to be used for comparison. There is, in fact, a fourth clock, J, namely, the satellites of Jupiter, of which accurate observations exist. This, however, does not agree with either M or S.

The problems which are raised by this further disagreement are so complicated that I will leave them out of consideration in this article. We will restrict ourselves to the three clocks A, M, and S. We find that both M and S are uniformly accelerated with regard to A, and the acceleration of M is between a quarter and a fifth (0·23) of that of S. Further, both are losing or gaining simultaneously, at irregular intervals, the loss or gain of M being four-fifths of that of S. We can, however, choose any other clock as our standard of reference instead of A. If we choose S—and I may say here at once that our final conclusion will be that S keeps true mathematical time—then our observational data are that both A and M are uniformly retarded, the retardation of M being between three-quarters and four-fifths (0·77) of that of A, and further, both A and M are alternately gaining and losing simultaneously, the gain or loss of M being one-fifth of that of A. It should be kept in mind that this division of the observed phenomena in two classes, the uniform retardation and the alternate gain and loss, is introduced by us in order to prepare them for mathematical treatment. In Nature there is only *one* phenomenon, the sum of the two, and our mode of cutting it up may be very unnatural.

It is, however, necessary to cut up our problem into simpler ones, because our mathematics would not otherwise be able to deal with it. Mathematics, after all, is only a device to relieve us from thinking, as one of my astronomical friends likes to say. We may compare it to the motor-car, which is a device to relieve us from walking. We will make a free use of this convenient vehicle, but we will thereby unavoidably lose a little of the intimacy with the landscape which the pedestrian enjoys.

Two Possible Explanations.

Amongst all the causes that have been imagined for a change in the rate of rotation of the earth, there are only two which can stand the test of critical scrutiny. These are: first, changes in the size or shape of the earth, or the distribution of mass inside the earth, leading to a change of the moment of inertia with reference to the axis of rotation; and second, tidal friction.

The first cause can act both ways: when the moment of inertia is increased, the rotation becomes slower; when it is diminished, quicker. The motion of the moon is not affected. If the changes of the moment of inertia take place discontinuously, the rate during the intervals between the changes is constant: the graphical representation of the longitudes of the heavenly bodies will be just such a series of straight lines as we found characteristic of the *fluctuations*. The only difficulty is that the moon should show exactly the same fluctuations as the sun and the planets, and not four-fifths of them, as it does. In other words, this cause affects our 'clock A' only; it should leave M just as true to mathematical time as S.

The second cause can only retard, and never accelerate. If the tidal friction remains constant throughout the ages, the retardation must be uniform, and we shall get a representation by a parabola, as observed in the secular acceleration; if it is not uniform, but changes from time to time, we shall get a series of parabolas, but they will still form a smooth curve, without sharp bends. A characteristic difference of this cause from the first is that it does influence the moon's motion. The tidal wave is caused by the attraction of the moon, and inversely it must attract the moon, thus creating a tendency to accelerate its motion. This causes the moon, by centrifugal force, to recede from the earth, and thereby, in accordance with Kepler's third law, its period of revolution is increased, *i.e.* the 'clock M' is retarded. When the moon is nearest the earth, at its perigee, the tides are higher and the ensuing force is greater than the average; consequently, the distance increases more than the average, and by the time it has arrived at the opposite end of its orbit, the apogee, it has swung farther out. Here the force is less than the average, the outward tendency is less, and the moon recedes

less than the average. The consequence is that the difference between the greatest and least distances is enhanced: the eccentricity is increased.[2] To convert this qualitative reasoning into a quantitative one, that is, to calculate the exact amount of increase of the mean distance and the eccentricity, it would be necessary to have a detailed knowledge of the forces acting.

The forces acting in the tidal friction are extremely complicated. It has been proved that neither the tides in the body of the earth, nor those in the great oceans, can produce enough friction to explain even a very small part of the observed retardation. The effective friction occurs in the shallow seas and narrow straits, such as the English Channel, the Straits of Malacca, the Bering Sea, and others. The tidal current runs up these straits or shallow seas from the ocean, and spends part of its energy in friction against the coasts and the bottom. The energy thus dissipated (which is, of course, converted into other forms of energy, for example, by a small rise of temperature of the water) is taken from the rotation of the earth, which is thus always retarded, whether the current happens to run against the rotation, or with it as in the case of the English Channel. The reaction on the moon takes place by the intermediary of the mutual attraction of the moon and the small secondary waves set up from the areas of dissipation as centres. Jeffreys has calculated the amount of energy thus taken from the rotation per second, and finds that those shallow seas in which the currents are known with sufficient accuracy to make the computation possible, explain about one-third of the observed retardation. If we reflect that more than two-thirds of this is contributed by the Bering Sea alone, and that there are many more shallow seas not included in his investigation, especially in the polar regions (for example, to the north of Asia), where presumably the friction is increased by the presence of ice, it does become very probable that this is the true explanation of the retardation of the rotation of the earth and of astronomical time. We may also remark that it is scarcely to be expected that the friction will be exactly the same throughout all time. It is thus natural to suppose the retardation to be variable. The observed secular acceleration is, from this point of view, the average over the last 20 or 25 centuries, but there may have been oscillations.

Can the variability of the secular acceleration be invoked to explain the fluctuations? To begin with, as has already been pointed out, it will never give rise to sharp bends such as occur in the observed fluctuations. But there is a much more cogent reason why it can only explain a relatively small part of the fluctuations. Friction can, of course, never *accelerate* the rotation; it must always retard it. Now the fluctuations consist of alternate retardations and accelerations, and sometimes the accelerations are larger than the retardation of tidal friction, so that the total effect is an acceleration. This circumstance sets a limit to the fraction of the fluctuations which can be due to the variability of tidal friction. Certainly not more than one-half of the observed fluctuations could be explained in this way.

Effect of Tidal Friction.

So far we have considered the effect on the rotation of the earth. We have also seen that the mean distance of the moon must be increased, and consequently its mean motion diminished, and that its eccentricity will probably also be increased. To calculate the retardation of the moon and the increase of its eccentricity corresponding to a given retardation of the earth, we would have to follow step by step the play of the forces in the small secondary tidal waves produced by the friction in the shallow seas. Here the ground becomes too difficult even for the mathematical motor-car. We must take a flying machine to cross over this jungle and land us safely at the other side. Such devices, which can lift us from the solid ground of actual computation to bring us by a short cut to some remote point without taking any notice of the intervening country, are provided by the 'general principles' of theoretical mechanics. The machine that we use in this case is called the 'principle of conservation of angular momentum.' If the earth's rotation is slowed down, the angular momentum of the system earth–moon is diminished, and the moon must make up for that by increasing its own angular momentum, which it can do by increasing its mean distance, by increasing its velocity of revolution (mean motion) or by diminishing its eccentricity. The increase of the mean distance is the most effective of these means, and it is the one that the moon will choose. It entails a decrease of the mean motion, and the exact balance between these two effects is determined by Kepler's third law. We have seen that probably the eccentricity will also be increased, and consequently the mean distance has to be increased more than if the eccentricity remained constant. How much more, the general principle cannot tell us.

[2] This explanation of the increase of the eccentricity is borrowed from Darwin, to whom it was suggested by Lord Kelvin. It is, as Darwin remarks, not a rigorous reasoning, but still it is sufficient to make an increase of the eccentricity appear more probable than a decrease.

If the eccentricity did not change, the increase of the mean distance would be such as to make the retardation of the moon's motion two-thirds (0·67) of that of the rotation of the earth. We know by observation the retardation of the rotation and we can thus easily calculate the increase of mean distance for constant eccentricity. On the other hand, we also know the actual retardation of the moon's motion, and therefore, by Kepler's third law, the actual increase of its mean distance. The excess of this over the computed value must be what is needed to compensate the increase of the eccentricity. In this way we find that to the observed ratio of 0·77 of the retardation of the moon and that of the earth, corresponds an increase of the eccentricity of the moon's orbit by one fifty-millionth, or one three-millionth of itself, per century. This, of course, is an extremely minute quantity. It can never be detected by direct observations, and can, so far as I can see, have no influence on any other observable phenomenon, but it is sufficient to increase the ratio just mentioned from 0·67 to 0·77.

Changes of the Earth's Moment of Inertia.

We return to the consideration of the first cause. How can the moment of inertia of the earth be changed? The change must be due to some displacement of mass on the surface or in the inside of the earth. But the displacements needed to explain the observed changes of rate are enormous. In 1918 the length of the day changed suddenly, or at least within a very short interval of time, from $\frac{1}{650}$th of a second longer to $\frac{1}{540}$th shorter than the average, a shortening of one twenty-five millionth of its length. If the whole of the Central Asian Highlands, from the Himalaya to the Kuen-lun mountains (both included), had at that time been sunk into the earth, their mean height being reduced to sea-level, the resulting shortening of the day would have been only one hundred millionth of its length, or one-fourth of what is required. This example shows that it is hopeless to look for local displacements of mass as an explanation of the observed changes. If, however, the displacements are world-wide, they need not be so large. A uniform shrinkage of the whole earth, decreasing its radius by about 5 inches, would be sufficient to produce the shortening of the day which happened in 1918. Even this would be rather a crude way of producing the required effect. It can be attained by a very slight adjustment of the shape of the layers of equal density in the inside of the earth, of which the effect on the dimensions of the outer surface need not exceed a fraction of a millimetre. But in any case the origin of the change must be in the deeper layers, and it must be of a world-wide, and not of a local, character.

This, then, must be the explanation of the sudden changes of rate of our 'clock *A*,' which are revealed by the fluctuations in the observed motion of the moon, the sun, and the planets. There is, in this case, no change of angular momentum: the rate of rotation adjusts itself instantly to the altered size or shape of the earth, so that the angular momentum of the earth by itself remains constant, and no call is made on the moon for any compensation. The true length of the month is not affected; the 'clock *M*' is not concerned at all.

Combination of the Effect of the Two Causes.

We found, however, that the clock *M does* show real fluctuations to the extent of one-fifth of those of the clock *A*. Now it must be remembered, as has already been remarked above, that the splitting up of the total deviation from uniformity into a uniform retardation—of which about four-fifths is transferred to the moon—and fluctuations—in which the moon takes no part—that this division into two parts is entirely artificial. If the retardation is not uniform, it can explain a part of the fluctuations (not more than one-half, as we have seen), and of this part four-fifths will be transferred to the moon. Our conclusion is thus that three-quarters of the fluctuations in astronomical time are produced by changes of the size and shape of the earth, and one-quarter by variability of the coefficient of tidal friction. Four-fifths of this quarter, or one-fifth of the whole, is then transferred to the moon.

Thus all observed phenomena are satisfactorily explained by the simultaneous action of two causes. It should be remarked that the two causes are entirely independent of each other, acting at different times. But we can only observe the sum of their separate effects.

The word 'satisfactorily' perhaps requires some qualification. When do we call an explanation satisfactory? If we are satisfied when it shows how the observed phenomena follow naturally from causes which we know are acting, or at least are possible, then the explanation here offered is satisfactory. But if we require that the explanation will enable us to *predict* the phenomena for the future, or even for the present or the past, *i.e.* to assert that they must of necessity occur or have occurred, and to calculate their amount from known data, then the explanation is very unsatisfactory indeed, for if it is true, then the phenomena

are essentially *unpredictable*. We have no means of saying when a new change of the size or shape of the earth may happen, or in what direction or how large its effect will be, nor can we predict when the coefficient of tidal friction will change, or by how much.

The accompanying diagram (Fig. 1) gives a representation of the observed facts compared with the explanation. For the interval of nearly three centuries from 1637 to 1927, seven changes in the rate of rotation and two in the rate of retardation have been assumed. These are sufficient to represent the observations, with only very few exceptions, within their limits of uncertainty. Of course,

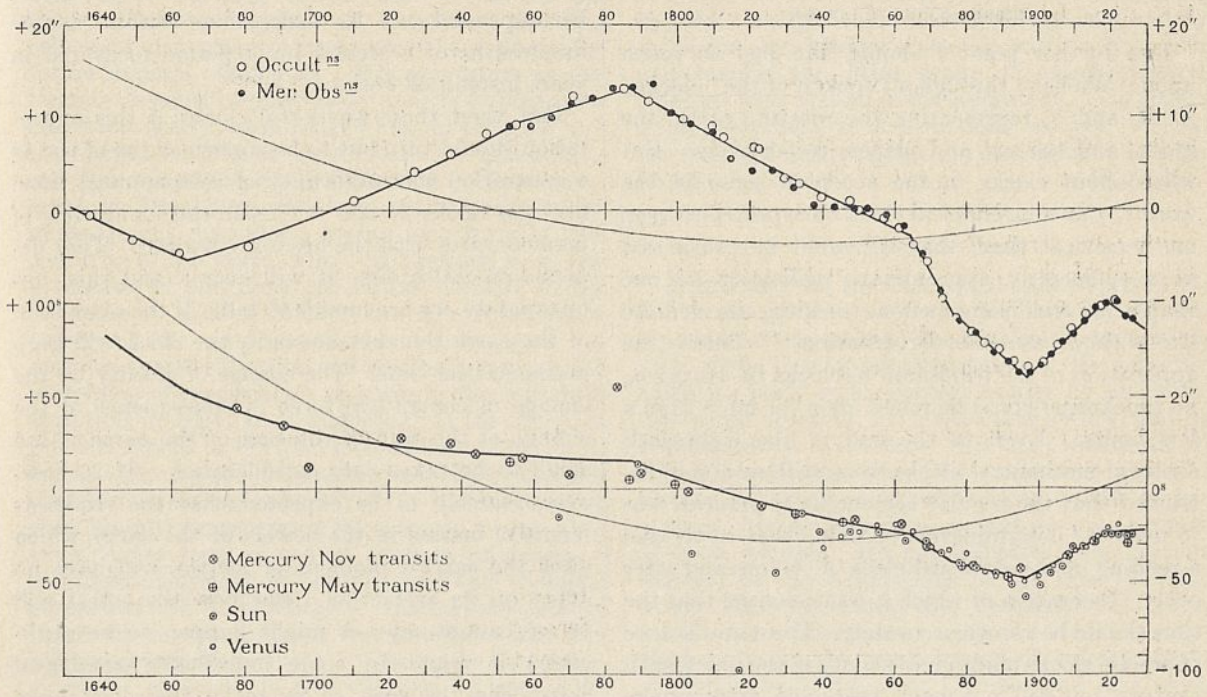

FIG. 1.—SECULAR ACCELERATIONS AND FLUCTUATIONS IN THE LONGITUDES OF THE MOON, THE SUN, VENUS, AND MERCURY.

The curves represent the combined action of two causes (A) and (B). The cause (A) consists in changes of the size or shape of the earth or the distribution of mass inside the earth. It produces discontinuous changes in the length of the day. The adopted excesses $\Delta\tau$ of the length of the day over its average value are :

(A)	Before 1664	$\Delta\tau = 0^s{\cdot}00000$
	from 1664 to 1755	$+0{\cdot}00134$
	„ 1755 „ 1786	$+0{\cdot}00089$
	„ 1786 „ 1864	$-0{\cdot}00091$
	„ 1864 „ 1876	$-0{\cdot}00357$
	„ 1876 „ 1897	$-0{\cdot}00186$
	„ 1897 „ 1918	$+0{\cdot}00153$
	after 1918	$-0{\cdot}00186$

The cause (B) is the retardation by tidal friction. It produces a continuous lengthening of the day, of which the adopted amounts are :

(B)	Before 1745	$d\tau/dt = +0^s{\cdot}0024$ per century
	from 1745 to 1870	$+0{\cdot}0013$ „
	after 1870	$+0{\cdot}0037$ „

The average over the last 25 centuries is an increase of $+0^s{\cdot}0022$ per century.

The upper curve is (A) + 0·23 (B), and the lower one is (A) + (B). Against the upper curve are plotted the observed deviations of the moon's longitude from its purely gravitational value, computed with astronomical time as independent variable. Against the lower curve are similarly plotted the observed deviations of the sun, Venus, and the transits of Mercury. A scale of seconds of arc is added to the upper curve, and a scale of seconds of time to the lower one. This latter thus gives the correction that must be applied to astronomical time in order to reduce it to uniform (or 'absolute') time.

The lower curve has been drawn on a smaller scale than the upper one, corresponding to the smaller accuracy of the observations of the sun and planets compared with those of the moon. In forming a judgment of the deviations, it should be borne in mind that the older observations are far less accurate than the modern ones; especially, the observations of the sun previous to about 1835 (the date of Airy's accession to Greenwich) are very untrustworthy. Of the modern observations, only those of the sun of 1896·5 and 1900·5 deviate more than would be expected by the accidental errors of observation. Of the transits of Mercury, that of November 1782, which was almost a grazing transit, and very difficult to observe, is the only one showing a serious deviation from the curve.

The thin lines are the secular accelerations. The null-line has been so adjusted as to make these zero for 1750·0 and 1917·1.

there have probably been many more smaller changes, the effects of which are indistinguishable from the unavoidable errors of the observations.[3]

Mechanical Clocks.

One further point I should like just to touch upon. We have throughout spoken of the 'clocks' A, M, and S, representing the rotating earth, the moon, and the sun and planets respectively. But what about clocks in the accepted sense of the word? Can a mechanical clock be expected to keep mathematical time, that is, can it be considered as a sufficiently approximate realisation of one simple natural phenomenon, obeying one definite law without sensible perturbations? Before the application of the pendulum to clocks by Huygens, no timekeeper could be relied upon for more than a few hours. Even in the end of the eighteenth century, mechanical clocks were still so much distrusted that the regular astronomical practice was to make a 'determination of time,' that is, to take a reading of the standard clock A, before and after every observation of which it was essential that the time should be known accurately. The manufacture of precise clocks made great strides in the nineteenth century, but still, not many years ago, astronomers used to get rather uneasy when, as a consequence of bad weather, they had to rely on their clocks for any length of time, say a week or a fortnight. The invention of the free pendulum clocks has suddenly altered the aspect of the problem. One of these clocks has been left entirely to itself, being, however, kept under rigorous control, at the Observatory at Greenwich during the greater part of a year, and its rate has been absolutely invariable (apart from a very slight retardation due to a slow lengthening of its pendulum by sagging to the extent of, if I remember rightly, something like a fifth of a micron per month). It looks as if this clock could be depended on to keep time within a few hundredths of a second for a period measured in years instead of weeks.

Can, then, these wonderful clocks, if this expectation should turn out to be confirmed, be of use as a control on the uniformity of astronomical time, like the clocks M and S? Can the handiwork of man compete with the heavenly bodies? That depends on *which* time it will keep; and this, unfortunately, we are unable to tell. If the attraction of the earth remains constant, the clock will keep mathematical time. The change of gravity by the change of centrifugal force in consequence of the change of the rate of rotation of the earth is too small to be taken into consideration. It is, however, scarcely to be expected that the readjustments of masses in the bowels of the earth, which alter the earth's moment of inertia, will have no effect on its attraction. But how this effect will be we cannot say; it might happen to be negligible; it might by some improbable accidental coincidence be such as to make the clock keep astronomical time instead of mathematical time: it cannot be predicted.

It seems probable that such a change of rate as occurred in the rotation of the earth in 1897 and in 1918 would be shown unmistakably by the free pendulum clock. We must expect, then, that these clocks will show discontinuities in their rates at the same epochs as the earth. They will probably *not* be the *same* discontinuities, but of the same order of magnitude, and the comparison of the pendulum with the earth may perhaps help us a little towards the understanding of the causes which produce these changes.

[3] This article was in print before the recent transit of Mercury of Nov. 10, 1927. The observed times of this transit, so far as they have been published, appear to confirm the 'prediction' by the formulæ on which Fig. 1 is based. It has generally been observed from 20 to 40 seconds too early, the formula giving 29·8. Evidently no considerable sudden change of the moment of inertia has yet occurred since the one in 1918.—W. de S.

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Festband in honour of his eightieth birthday and contained papers by many of his old pupils, representing twelve countries.

In 1878, Groth's "Catalogue of the Strasbourg Collection" not only showed how active he had been in getting together an important teaching collection in six years, but also served as a model for future mineral catalogues. His reputation as the foremost teacher of mineralogy and crystallography had been firmly established when, in 1883, he was transferred to Munich as professor of mineralogy and Director of the State Collection. His department at Strasbourg had been remarkable for its international character; young men from all the countries of the world, who were destined to be the professors of the next generation, flocked to his laboratory; and at Munich the new department preserved the same character. Here again he built up a great collection and inspired a remarkable succession of researchers; a guide to the collection appeared in 1891, an introduction to the study of precious stones in 1887, an introduction to chemical crystallography in 1904, the elements of physical and chemical crystallography in 1921. But his energies were mainly concentrated on a sequel to his life's work in the form of a vast book of reference—a complete dictionary of the physical and chemical characters of crystallisable substances—mainly based upon the material contained in fifty-five volumes of the *Zeitschrift*. "Chemische Krystallographie" appeared in five volumes between 1906 and 1919, and is an invaluable work of reference.

A life so strenuously devoted to teaching, to the writing of treatises and text-books, to the organisation of university departments, to the inspiration of students, and to the supervision of their investigations, left little time for research. Except through the work of his pupils, the name of Groth is not associated with any great discovery. But he was always occupied in welcoming and in fostering new ideas, and he always had problems for his students to work out. At the beginning of his career he made a striking study of changes of form in the crystal produced by the substitution of one element or radicle for another, especially among organic compounds, and introduced the term 'morphotropy' for this effect; it guided his masterly studies on the composition of minerals; and the connexion between chemical composition and crystalline form was always his chief interest. The avidity with which he absorbed the new experimental work and theories about crystal structure in his old age is evidenced by his latest publications.

Devotion to academic duties and to the *Zeitschrift* left comparatively little time for travel, but Groth made mineralogical expeditions in France and Italy. In 1904 he visited England for the British Association meeting and made a tour in Wales. In Great Britain his position in the scientific world was fully appreciated fifty years ago when he was elected an honorary member of the Mineralogical Society. He was afterwards elected foreign correspondent (1895) and foreign member (1900) of the Geological Society (and received its Wollaston Medal in 1908), and foreign member of the Royal Society in 1911. He received the Hon. Sc.D. degree from Cambridge in 1904.

The present writer has a vivid recollection of Groth as an active young professor at Strasbourg in 1881; energetic and busy with his class and his collection, but always accessible and ready to help and inspire the little group of eager research students who worked in his laboratory. He always impressed them as a strenuous worker, a great teacher, and a most genial, sympathetic, and loyal friend. H. A. M.

MR. THOMAS BAIRD.

A TRAGEDY on the Cairngorms has deprived the University of Glasgow of two brilliant and promising men, of whom one, Thomas Baird, was on the staff of the Geological Department. He attracted attention early in his geology course by his quickness as an observer, his intellectual ability, and his enthusiasm as a student. His early death at the age of twenty-two years has prevented him completing any of the research work on which he had entered, but he had done enough to give promise of great success. He has recorded some sections exposed in the foundations of the new buildings of the National Bank, and described the glacial sands there interbedded with the boulder clays. He had begun the investigation of volcanic necks at Yieldshields Hill, near Carluke, and was working out their inclusions with some help from Dr. Tyrrell.

Baird's special interest was in mountain structure, and he was studying some Dalradian rocks in the Grampians to the east of Kinloch Rannoch, of which the correlation is in doubt. Mr. Baird's interest in mountain geology led him to take every opportunity of training as a mountaineer. He had made some winter ascents and gained experience in ice-climbing. It was his ambition ultimately to explore some of the Asiatic mountain ranges of which the structure is still unravelled.

With this end in view, Baird arranged the recent excursion to the Cairngorms in order to gain further experience of mountaineering under winter conditions. He and his companion, Hugh Barrie, a medical student and graceful poet, were both thoroughly competent for the expedition. They appear to have spent three nights at the Corrour bothy between Ben Macdhui and Cairn Toul, and from such clues as are available they probably gained the summit of Braeriach on the return route to Aviemore on Sunday, Jan. 1. Some accident must have happened there, for Baird's left hand was injured as if he had caught hold of some rock or rough ice. He probably exhausted himself either in the effort to help Barrie to shelter, or, as appears more likely, when trying to find his comrade after their separation by the accident. Baird had reached the floor of Glen Eunach, and there, caught in a furious blizzard, collapsed on the roadside a few hundred yards from a hut. He was found next morning, but died before help could arrive from Aviemore.

News and Views.

IN a supplement to this issue we publish an article by Prof. de Sitter in which a comparison is made of the time as determined by the rotation of the earth, the revolution of the moon round the earth, and of the inner planets round the sun. The application of the theory of gravitation and the laws of motion to the various bodies shows that equal intervals of time determined by one body are not exactly equal according to the others. The application of the laws of dynamics is complicated by the fact that the earth is not a rigid body and that tidal friction is slowly decreasing the rate of the earth's rotation and at the same time that of the moon's revolution. It is not possible to compute the numerical coefficient exactly, but work by Jeffreys on the tidal friction in narrow seas gives a coefficient of the right order of magnitude. Prof. de Sitter finds that the observations are best explained if the coefficient for the three intervals, before 1745, 1745–1870, after 1870, are approximately in the ratio 2 : 1 : 3. It is, however, difficult to explain why the coefficient should have altered to this extent. Tidal friction can only slow down the earth's rotation, while observations of the moon and planets indicate that at times this rotation is accelerated. This can only be done by reduction of the earth's moment of inertia. Prof. de Sitter finds that the reduction of the whole mountain range of Central Asia to sea-level would have produced only one-quarter of the change in the length of the day which observations of the moon indicate took place in the year 1918, but that an alteration of the earth's radius by five inches would suffice. Both explanations almost appear to call for observable effects on the earth itself.

EXPRESSED in time, observations of the moon indicate that the earth's period of rotation altered by 0·00339 sec. either suddenly or in the course of a few months in the year 1918. This means that the earth's rate of rotation altered by approximately 1 part in 25 millions. Prof. de Sitter raises the question whether this is sufficiently large to be tested by an actual clock. The free pendulum clock, Shortt 3, installed at Greenwich, has shown a great advance on all previous clocks; for example, its daily rate has remained constant for more than six months to the order of 0·001 sec., except for a secular term which altered the daily rate by 0·032 sec. in 100 days. This coefficient, as well as the rate, has to be determined from astronomical observations. It corresponds to a slow lengthening of the invar rod and is probably decreasing with time. The clock has, however, a rather large temperature coefficient, namely, about 0·007 sec. daily per 1° C. The cause of this is unknown, but it may be due to the impulse varying with the temperature and consequently changing the arc of vibration. To produce a change of 0·007 sec. in the daily rate the semi-arc, at present about 55′, has to alter only 10″, a quantity too small to be observed accurately with the Greenwich clocks, but possible with later ones.

THE election of Prof. D'Arcy W. Thompson as president of the Classical Association for this year calls for the congratulations of his scientific friends. Not all men of science are devoid of some tincture of letters, as the pages of NATURE testify, but it is sometimes hinted that it is not hard to pass for a scholar in their company. Prof. Thompson's election shows, however, that he is esteemed as a scholar by literary men. He is, indeed, peculiarly fitted to link the older with the newer humanities. His contributions to the history of Greek science—his "Glossary of Greek Birds," his translation of Aristotle's "Historia Animalium," and his Herbert Spencer Lecture on "Aristotle as a Biologist," to name only a few—are well known and valued. On the other hand, he brings to his scientific work not only a polished style but also a sense of the historic background of knowledge which illuminates even the pages of reports on fishery statistics. His "Growth and Form" showed that he could handle and correlate, as few men can, the results of research in the most diverse branches of modern science. Prof. Thompson's love for the classic literatures is inherited, and those who have read the "Daydreams of a Schoolmaster" will know how it would have gratified the author could he have seen his son in the position to which he has just been elected.

AN article from the *Times* correspondent at Delhi, in the issue of Jan. 12, conveys the welcome news that a great new meteorological observatory at Poona is to be brought into use this summer, thus carrying into effect a scheme proposed in 1924 for transferring the headquarters of the Indian weather department thither from Simla. The difficulties that have led to the transfer are not limited to the tropics. On one hand, it is vital that the routine work of daily forecasting and of administration shall be well carried on, for it is on performance of these tasks that revenue depends, and with that the chance of scientific progress. Further, there is a material gain of efficiency if the staff can be collected into the same station, facilitating co-operation as well as access to laboratories and libraries. There is, therefore, a tendency for the ablest men to gravitate to headquarters. But Simla cannot employ kites because winds are too light, or instrument-carrying balloons because of the wild mountain regions in which they would be lost: so experimental examination of the physical processes of weather can scarcely be effected there, and bringing up an officer from a provincial observatory very seriously reduces his chance of advancing knowledge and of keeping in living contact with science. The remedy adopted by the department in India has been to give up the advantage of being at the seat of government and to transfer its headquarters to Poona, where upper air work is possible and monsoon conditions, unlike those of the western Himalayas, are representative of India. Poona has the further advantages of a good climate and of proximity to Bombay, so that closer relationships can be maintained with shipping and commercial interests.

THE *Times* correspondent says, however, that the object of the new observatory is "special research

work with a view to elaborate and accurate forecasting of the south-west monsoon." Also "The Meteorological Department . . . is now able regularly to forecast in mid-October the quantity of rainfall in Northern India in the next five months. The indications are given to within a fraction of an inch, and during twelve years wherever the system has been followed it has never proved fallacious." On reading this surprising account, it is natural to inquire into the recent success of the method, and we find Mr. Field in his forecast of Jan. 6 last, after rightly deprecating undue confidence, saying that the high-level winds were "about normal in character." The total actual precipitation, as described on June 27, was, however, not normal but "in moderate defect." Again, in the previous year the high-level winds were "stronger than usual"; and the total actual precipitation was not in excess as it should have been, but "in slight defect." In spite of this lack of perfection, we are convinced that upper-air data promise to be of great value for seasonal forecasting after twenty or thirty years of data have been accumulated; but friends of the department should lay stress on the value of the upper-air work done at Poona for aerial navigation and daily forecasting, rather than arouse expectations of an early revolution in methods of seasonal prediction. Confidence in long-range forecasts can only be built up slowly, and is more easily lost than won.

THE award of the Progress Medal of the Royal Photographic Society to Dr. S. E. Sheppard in recognition of his researches and publications, which have resulted in important advances in the science of photography, will be generally welcomed. Dr. Sheppard is still, in the modern sense, a young man, whose name first came into prominence in connexion with the extended series of researches in photographic subjects, carried out in conjunction with Dr. Mees. The results were published in the *Photographic Journal*, in the *Proceedings of the Royal Society*, and in the *Journal of the Chemical Society*, and were then collected, together with additional work, and published in 1907 as a book entitled "Investigations on the Theory of the Photographic Process." Dr. Sheppard is also the author of the volume on "Photochemistry" in the series of textbooks on physical chemistry edited by Sir William Ramsay. Dr. Sheppard was elected to an 1851 Exhibition research scholarship and proceeded to Germany for further study. Shortly after returning to England he was offered a position in the Research Laboratories of the Eastman Kodak Company, Rochester, N.Y.

SINCE taking up his duties at Rochester, where he is assistant director of research, Dr. Sheppard has been responsible for researches covering many phases of the photographic process, which culminated comparatively recently in his important discovery of the rôle played by sulphur compounds contained in gelatin in conferring sensitivity on the silver halide grain. In addition to the books already mentioned, Dr. Sheppard has been responsible for two others, namely, "The Silver Bromide Grain of Photographic Emulsions," and "Gelatin in Photography," vol. 1, published by the Eastman Kodak Company, and has done valuable work in connexion with the electro-deposition of rubber. Previous recipients of the Progress Medal have included Sir William Abney, Dr. J. M. Eder, Prof. Gabriel Lippmann, Ferdinand Hurter and Vero C. Driffield (jointly), Mr. Alfred Watkins, A. Lumière et ses fils, Dr. C. E. K. Mees, Mr. William B. Ferguson, and the present president of the Royal Photographic Society, Mr. F. F. Renwick.

ON Tuesday, Mar. 20, H.M. the King will open the eastern block of the new buildings of the Science Museum at South Kensington. First formed in 1856, the collections have occupied various buildings, but now for the first time they are shown in one designed for this purpose, though about a quarter of the collections still remain in buildings which were originally constructed for the exhibition of 1862. In 1898 Parliament voted £800,000 for completing the Science and Art Buildings at South Kensington, and in 1908 the Victoria and Albert Museum was opened by H.M. King Edward VII. As nothing had so far been done for the science collections, a number of men eminent in science and in technical industry strongly urged the need for action in the matter. Sir Henry Roscoe headed a deputation fully representative of science and its applications, which was sympathetically received by the President of the Board of Education, and in the following year the President appointed a committee, of which Sir Hugh Bell was chairman, to inquire into the Science Museum and to report upon its needs. This Committee recommended that new buildings should be erected on the existing site, which should ultimately extend from Exhibition Road to Queen's Gate.

IT is the eastern block, the first instalment of this scheme recommended by the Committee, which is to be opened in March, doubling the exhibition area of the Museum. Though the space available is still considerably less than that which the Committee laid down as being immediately needed, it has made it possible to develop the collections extensively, and to improve very greatly the setting out and exhibition of them. The result of this is reflected in the greatly increased numbers of visitors, of whom more than 709,000 visited the Museum during 1927 as compared with 450,000 in 1925. The new galleries are exceptionally well lighted, and the provision of compressed air and electricity in each gallery makes it possible to show objects in motion or specially illuminated at any point in the Museum.

IN February 1927 the Government of Queensland appointed a Land Settlement Advisory Board of three members, with the powers of a Royal Commission, to inquire into and report upon various questions in connexion with the administration of land leased for grazing sheep in Central and Western Queensland, and "generally what action should be taken by the Government to further develop the wool industry in Queensland." In the Board's report, which has been presented by the Premier to the Queensland Parliament, it is stated that the total number of sheep in

Queensland remained almost the same (20 millions) between 1891 and 1925, in spite of the fact that in the same period the population of the State increased by 109 per cent. and the railway mileage by 165 per cent. Owing to the severe drought that has prevailed over much of the sheep country since 1925, it is estimated that the number of sheep is now only 14 millions. Since, during the last five years, wool constituted 60 per cent. of the State's exports, it is obvious that the prosperity of the industry is of vital importance to Queensland.

THOUGH none of the members of the Board were scientific men, it is gratifying to find that a section of the report is devoted to the advocacy of scientific research. It is stated that "the valuable results obtainable from the practical application of science to industry have already been demonstrated sufficiently in Queensland to urge all authorities to further efforts. The banana bunchy-top investigations and the chemical and biological agencies for prickly pear destruction are instances of scientific endeavour of first-rate importance to this State. In each of these investigations the scientists of the University of Queensland played their part. Another field of endeavour is now presented to scientists in stemming the annual wastage in the wool industry." Among the problems which are mentioned as requiring scientific investigation are the provision of suitable stock licks for different types of country, the effect of artificial feeding on wool production, the effect of different grasses on the quality of the wool, the varying mineral and protein contents of pastures on the different geological types of country, the effect of overstocking on natural grasses, particularly as regards their re-growth, and the prevention of losses due to blow-fly, worms, and other parasites and diseases. It is stated that the Premier of Queensland has offered to the Commonwealth Council for Scientific and Industrial Research an area of about 25,000 acres of land in Central Queensland, free of rent for any term desired, to be held in trust as a central scientific station for investigations on the above and kindred subjects, and the hope is expressed that the offer will be accepted either in whole or in part.

WITHIN a fortnight from the date of his first dispatch on the season's work at Ur, Mr. Woolley is able to chronicle in the *Times* of Jan. 12 a further discovery of almost sensational interest which throws an entirely new light upon the customs and religious beliefs of the Sumerians. Although the body of the king has not been found in the Royal Tomb now being excavated, as probably it was plundered at an early date, a large number of objects interred at the time of the burial for his use have been unearthed. Among these are a harp, largely composed of wood, the form of which has been recovered by the use of plaster to fill up the cavities left by the decay of the wood; a chariot, on the rein ring of the pole of which was a wonderfully realistically executed donkey in silver; a gaming board; a clothes' chest; and piles of copper bowls and tumblers. The remarkable feature of the burial, however, is that, scattered among these relics are the remains of the king's attendants, evidently lying as they fell when sacrificed for his service in the next world. The harper is crouched near his harp, two asses lie at the chariot pole, and with them their three grooms; and by the clothes' chest is an officer of rank, as shown by his ornaments, possibly the Keeper of the Royal Robes, and other attendants. In a trench lie thirteen bodies, of which two are those of children, the rest women, no doubt the members of the Royal Harem. Mr. Woolley is of the opinion that this form of burial, accompanied by the sacrifice of the Court attendants, must be regarded as a survival, as there are no evidences of similar sacrifices to be found in the graves of common people.

ON Feb. 14 the Royal College of Surgeons of England celebrates the bicentenary of John Hunter, who may be described as the patron saint of the College. Hunter left one of the most remarkable collections of anatomical preparations and natural history specimens ever assembled by one man. In 1800, seven years after his death, this collection was purchased by Government and handed over to the College of Surgeons in trust. The Hunterian Collection forms the basis of the great museum now housed by the College in the south side of Lincoln's Inn Fields, but the additions made under a long line of conservators, which includes Owen, Quekett, and Flower, now overshadow the original collection. There is a doubt as to the exact date of Hunter's birth, but as he celebrated it on Feb. 14 the Hunterian oration given in his memory every alternate year has always been given in the theatre of the College on this date. On the present occasion the oration is to be delivered by Sir Holburt Waring, surgeon to St. Bartholomew's Hospital, and a former Vice-Chancellor of the University of London. A lecture on the "London Homes of the Hunters" will be given by Mr. G. C. Peachey. A special exhibition of specimens will illustrate John Hunter's chief discoveries. Visitors will also have an opportunity of examining his portraits, busts, published works, manuscripts, and personal relics.

IN a letter to the Editor, Prof. Henry J. Spooner discusses our comment in the issue of Dec. 24, p. 928, on his paper in the *Society of Industrial Engineers' Bulletin* (vol. 9, No. 9), in which he stated that the economic loss through the effects of noise is estimated at £50,000,000. We asked how this figure was obtained. Prof. Spooner states that men of affairs "have their capacity for clear thinking without a doubt perceptibly weakened by the incessant if unconscious strain upon the nervous system" caused by noise, and he says he has had countless letters from mental workers explaining how their health and work suffer through working in a noise. Such remarks, though true as personal expressions of opinion, do not, however, constitute scientific proof. The one piece of research quoted, that of Dr. Laird, would seem to be suggestive rather than conclusive. The control group is always necessary. If one has a personal interview with all the workers in and near a noisy room and inquires about noise among other

conditions of work, one does not get a uniform reaction; some dislike it, some are indifferent, some prefer it. There are heads of departments, creative workers of all kinds, as well as the actual noise producers, who are frankly surprised at the idea of their work being affected by noise. To say it must be unconsciously affected is again opinion, not evidence. In the interests of those who either are, or think they are, detrimentally affected, let us minimise noise, but the proof of its effect is not easy.

GAS undertakings deserve more publicity than is usually accorded them concerning the extent and intricacy of the organisations necessary to maintain an unfailing service of their chief products, and to provide an important supply of the great number of other materials in everyday industrial demand. The consumer's end of the pipe-line is so easily manipulated, day or night, in war and peace, strike or lock-out, with the same anticipated result, that it is not surprising that public attention should be focussed more frequently on cost than on supply. For use on the occasion of the visit of the Science Masters' Association to the Chief Offices, the Central Store, and the Fulham Works of the Gas Light and Coke Company on Jan. 6, the Company prepared an illustrated brochure giving a short account of its activities, and briefly describing the sections visited.

THE Gas Light and Coke Company received its charter so long ago as 1812; its authorised capital is now more than £40,000,000, its employment roll about 20,000, and its area of supply to 1,250,000 consumers is 265 square miles, extending from Windsor Great Park to some miles east of Epping Forest. Every year some 2½ million tons of coal—mostly borne direct by the Company's own fleet—are required. Of the thirteen works, those at Beckton are responsible for the output of about 40 per cent. of the gas produced, whilst those at Fulham, which are probably the oldest in London, are now representative of the most modern practice in gas-works construction, having a capacity (shortly to be largely increased) of 17½ million cubic feet of 500 B.Th.U. quality (*i.e.* 87,500 therms) a day, and treating 900 tons of coal daily on an area of 30 acres. Usually 40,000 tons of coal is held in stock at Fulham; the coal gas, maintained at a constant quality with water-gas of variable composition, is conveyed by means of more than 100 miles of high-pressure mains (at pressures of the order of 3 lb. per sq. in.) to convenient storage centres, and thence in 3700 miles of supply mains at pressures of about 4 in. water gauge. The brochure gives an account also of the housing of the experimental plant and the various research laboratories; it describes the training and welfare work, and refers to the measures which have been taken to give effect to a spirit of copartnership which exists between the Company and its employees.

DR. J. STEPHENSON, lecturer in natural history in the University of Edinburgh, has been appointed editor of the "Fauna of British India" series in succession to the late Sir Arthur Shipley.

DR. EDWARD RAY WEIDLEIN, Director of the Mellon Institute of Industrial Research, University of Pittsburgh, has been re-elected president of the American Institute of Chemical Engineers and will therefore serve in this office during 1928.

DR. MAX WOLF, Director of Heidelberg Observatory, distinguished especially for his originality and activity in observational astronomy, has been elected an honorary member of the American Astronomical Society. The constitution of the Society permits the election of one honorary member at each annual meeting, but no election has been made since 1924.

AT a meeting of the Quekett Microscopical Club, held on Jan. 10, Mr. E. M. Nelson, Dr. A. Mann, and Dr. Karl Viets were elected honorary members. Mr. Nelson was president of the Quekett Club from 1893 until 1895, and also president of the Royal Microscopical Society from 1897 until 1899. He is the author of numerous papers dealing chiefly with the practical optics of the microscope and microscopical technique, which have appeared in the *Journal of the Royal Microscopical Society*, the *Journal of the Quekett Club*, and in the *English Mechanic*. Dr. Mann, of Washington, D.C., is well known as an authority on Diatoms; and Dr. Viets, of Bremen, has done a large amount of original work on the Hydracarina and Halacaridæ.

THE British Empire Cancer Campaign announces an international convention on cancer research to be held under its auspices in London next July. Of the value of such international meetings, especially on the personal side, there can be little doubt, though there seem to have been rather many lately on this particular topic, and the amount of time which those who are actively engaged in cancer research can profitably spend in travelling to meetings across the world obviously has its limits. In this case we are glad to note that none of the considerable expense of the convention will fall on the funds of the Campaign, owing to a generous donation from Sir Richard Garton.

THE Gold Medal of the Royal Astronomical Society has been awarded to Prof. R. A. Sampson, Astronomer Royal for Scotland, for his theory of the four great satellites of Jupiter. This extensive work is contained in three separate memoirs in the *Harvard Annals* and the *Memoirs of the Royal Astronomical Society*. With the tables to which the theory is reduced, it completes a self-consistent revision of the whole problem of the four great satellites. A bronze (Jackson-Gwilt) Medal has been awarded (1) to Dr. W. H. Steavenson, for his work on faint variable stars and on the Herschel instruments; and (2) to Mr. W. Reid, of Cape Town, for his discovery of six new comets.

THE seventh International Congress of Photography will be held in London on July 9–14, under the auspices of the Royal Photographic Society. There will be three sections: (1) scientific and technical, (2) pictorial photography, (3) bibliography and record work; the scientific and technical section will

be further subdivided into groups dealing with theoretical aspects, photographic practice, scientific applications of photography, and industrial and special applications. Papers for the Congress, accompanied by abstracts, both in duplicate and typewritten, must be submitted to the honorary secretary to the organising committee, Dr. W. Clark, The Science Museum, South Kensington, London, S.W.7, before June 1.

AN exhibition indicating the possible utilisation of Overseas Empire timbers in industry will be held at the Exhibition Pavilion of the Imperial Institute, South Kensington, on Feb. 3–April 30. This exhibition is the second of a series arranged to direct attention to specific resources of the Empire, with the object of increasing the usage of Empire raw materials in Great Britain. Samples of selected timbers from some of the Dominions and Colonies will be shown in conjunction with the articles which can be made from them. An important feature will consist of exhibits illustrating the work carried out at the Imperial Forestry Institute, University of Oxford; the Forest Products Research Laboratory (Department of Scientific and Industrial Research) at Princes Risborough; and at the Imperial Institute.

THE council of the Geological Society has this year made the following awards: Wollaston Medal to Dr. D. H. Scott, lately honorary keeper of the Jodrell Laboratory, Royal Botanic Gardens, Kew, in recognition of the value of his researches in fossil botany; Murchison Medal to Dr. J. J. Sederholm, Director of the Geological Commission of Finland, in recognition of his researches in petrology, especially of the granites and gneisses of the pre-Cambrian complex of Fenno-scandia; a Lyell Medal to Prof. S. H. Reynolds, C. Wills professor of geology in the University of Bristol, in recognition of the value of his researches in the stratigraphy of the Palæozoic rocks, and in vertebrate palæontology; a second Lyell Medal to Dr. W. D. Lang, keeper of the Department of Geology in the British Museum, for his researches in stratigraphy and palæontology, especially with reference to the Bryozoa; the Wollaston Donation Fund to Mr. James Wright, for his researches on the Crinoidea of the Carboniferous Limestone of Scotland; the Murchison Geological Fund to Dr. George Slater, in recognition of the value of his researches in glaciology; and the Lyell Geological Fund to Mr. Ben Lightfoot, for his researches on the economic geology of Southern Rhodesia.

THE natives of Teheran (Persia) have discovered a new, if rather primitive, method of making ice in the winter months and storing it for summer use, according to a writer in *La Nature* for Jan. 1. Long ponds, running east and west, are dug in the earth and filled with water. Due to the slight night frost, a very thin coating of ice forms. The next night this ice is watered, and the layer of ice increases, until it gradually attains a thickness of about 16 inches. The ponds are protected on the south side by high earth walls to prevent the sun getting to the ponds even at its maximum elevation. The ice thus formed is broken up and stored in blocks in large galleries dug in the earth and separated into compartments, broken ice being placed between each block. When the summer comes, the ice blocks are broken up and retailed in small portions. The insulation provided by the storage galleries is stated to be sufficient to keep the ice without appreciable loss for two years.

FROM the *Report* for 1926 of the Museums of the Brooklyn Institute (N.Y.), we learn that the Children's Museum has obtained the full-time services of a scout instructor. He gave one day each week to the instruction of the Boy Scouts in their summer camp. More than 6000 Boy and Girl Scouts prepared in the Museum for their tests in nature study. Scout captains use the exhibits for demonstrations. This is only one of many lines along which this little Museum does admirable work in promoting a love of Nature among young people of all classes.

THE January issue of the *Journal of the Institution of Electrical Engineers* contains three "Progress Reviews," namely, "Electricity in Mines," by J. A. B. Horsley; "Co-operative Research in 1927," by E. B. Wedmore; and "Electrical Standardization, 1927," by P. Good. These reviews can be obtained in pamphlet form (1*s*. each) from the Secretary of the Institution.

MESSRS. Baird and Tatlock (London) Ltd., of 14-15 Cross Street, Hatton Garden, London, E.C.1, have issued a new edition of vol. 1 (Chemistry) of their Standard Catalogue of Scientific Apparatus. This work—it is a work of no small merit scientifically, commercially, and artistically—is intended to be used in conjunction with the other volumes of the Standard Catalogue, namely, vol. 2, Physiology; vol. 3, Biological Sciences; and vol. 4, Physics. The volume just issued is subdivided into nine separate sections, covering respectively laboratory fittings, general equipment, general chemical apparatus, physical chemistry, industrial chemistry (two sections), meteorology, books, and chemicals. The preface is dated October 1927, so that although such a catalogue of between eleven and twelve hundred large pages must of necessity take months to prepare, the prices which are quoted have yet had but little time in which to undergo their inevitable fluctuations. The illustrations are particularly good, and this fact, together with the comprehensiveness with which the whole publication has been conceived, makes the catalogue a noteworthy addition to the library of any educational institution or industrial laboratory in which experimental chemistry and the allied sciences are pursued. Descriptive paragraphs concerning the operation of the more complex and less well-known pieces of apparatus are a welcome feature. These paragraphs sometimes attain almost monographic proportions; the article on the theory and use of the polariscope, for example, consists of two closely printed pages, with diagrams, and even a reference to a paper in the *Berichte*, whilst that on the determination of hydrogen ion concentration covers three pages. Many new pieces of apparatus not hitherto catalogued are included; even more recent additions to the

chemist's armoury will be dealt with from time to time in separate leaflets. The whole publication is adequately indexed, with cross-references to the companion volumes.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A gas engineer and general manager under the Rotherham Corporation—The Town Clerk, Rotherham (Jan. 25). An inspector under the Ministry of Agriculture and Fisheries for the purposes of the Diseases of Animals Acts, 1894–1925—The Secretary, Ministry of Agriculture and Fisheries, 10 Whitehall Place, S.W.1 (Jan. 30). Assistant Veterinary Inspectors under the Surrey County Council to carry out duties under the several Acts and Orders relating to (1) Milk and Dairies ; (2) Diseases of Animals ; and (3) such other veterinary duties as the Council may require—The Clerk of the County Council, County Hall, Kingston-on-Thames (Jan. 30). A junior scientific officer under the directorate of scientific research of the Air Ministry primarily for work in the engine research department of the Royal Aircraft Establishment, South Farnborough—The Chief Superintendent, Royal Aircraft Establishment, South Farnborough, Hants (Feb. 11, quoting A.256). A lecturer in mycology at the Imperial College of Tropical Agriculture, St. Augustine, Trinidad—The Secretary, Imperial College of Tropical Agriculture, 14 Trinity Square, E.C.3 (April 1). A senior lecturer in physical and inorganic chemistry in the University of Melbourne—The Registrar, The University, Melbourne, Victoria (April 23). A principal of the Australian School of Forestry, Federal Capital Territory, Canberra—The Secretary, Department of Home and Territories, Canberra, Australia (April 30). An additional lecturer in zoology at the Ceylon University College, Colombo—The Private Secretary (Appointments), Colonial Office, 2 Richmond Terrace, Whitehall, S.W.1. An assistant bacteriologist at the Wellcome Bureau of Scientific Research—The Secretary, Wellcome Bureau of Scientific Research, 26 Endsleigh Gardens, W.C.1. A technical laboratory assistant at the Millport Marine Station of the Scottish Marine Biological Association—The Secretary, S.M.B.A., 88 Bath Street, Glasgow. Teachers of Siamese and of Tibetan at the School of Oriental Studies—The Secretary, School of Oriental Studies, Finsbury Circus, E.C.2.

ERRATUM.—A correspondent points out that the late Mr. W. H. Dines was at Corpus Christi College, Cambridge, and not at Christ's College, as was stated in our issue of Jan. 14, p. 65.

Our Astronomical Column.

LARGE METEOR ON JAN. 9, 11h P.M.—Mr. W. F. Denning writes: "This very large meteor was seen by an observer when motoring about 6 miles east of Birmingham. The terminal portion of its flight was from near the star Sirius vertically to the horizon. The object was much brighter than Venus at its best, and the nucleus threw off a dense train of sparks at the end. The same meteor was noticed from Ilford, Essex, where the path was recorded as moving from just below Rigel and κ Orionis in a direction towards the western horizon. It was very brilliant, and gave an outburst of sparkling material.

"Further observations will probably come to hand, but it appears that the fireball must have radiated from near the bright star Sirius and that its height was about 63 to 20 miles over a line directed from south to north over the English Channel to its finishing stage over Hampshire. Further data are, however, desirable, particularly from observers near the south coast of England."

THE RECENT GREAT COMET.—Many reports are coming to hand from America and elsewhere, that show what an extremely fine comet this must have been. Its magnitude rose at least to − 6 ; some estimates make it − 10. Its tail was at least 8° long : it would doubtless have been more if it could have been seen on a dark sky.

Dr. Slipher reports in a *Daily Science News Bulletin*, issued by Science Service, Washington, that its spectrum was continuous, with no bright lines, indicating that the light was mostly reflected sunlight ; but an appreciable amount of lower temperature radiation was present. The nucleus was small, and varied from a circular to an elongated shape. Jets and envelopes were present on the sunward side of the nucleus.

The spectroscope indicated a motion of recession from the earth of 60 miles a second (exact time of observation not stated). The actual rate of recession between Dec. 20 and 21 was 54½ miles a second, which is a good agreement.

The following orbit by Dr. A. C. D. Crommelin is from a combination of observations ranging from Dec. 3 to 20:

T	1927 Dec. 18·008 U.T.	
ω	46° 9·7′	1927·0
Ω	76 25·2	
i	85 27·2	
log q	9·2365	

The earliest known observation of this comet (a day before that of Mr. Skjellerup) was obtained by Mrs. K. Botes at Fraserburg, Cape Province, on the morning of Dec. 2. She slept on a verandah facing south-east and observed the comet from her bed. It was low in the south-east about dawn. Other independent discoverers were Mr. Ross Fitchet at Grahamstown, Dec. 5 ; Mr. Maristany at La Plata, Dec. 6 ; Mr. Chidambara Iyer, Kodaikanal, Dec. 15.

Dr. A. C. D. Crommelin has deduced the following elliptical orbit of comet Schwassmann-Wachmann from Bergedorf observations on Nov. 15, Dec. 4 and 28.

T 1925 May 10·9230 U.T.

ω	359° 56′ 13·7″		log a 0·8090646
Ω	322 35 2·2	1927·0	log q 0·7403755
i	9 25 37·0		log n 2·3364097
ϕ	8 24 43·0		Period 16·35298 years.

The orbit lies wholly between those of Jupiter and Saturn ; the comet has the largest perihelion distance and the smallest eccentricity of any known comet. In consequence of the small eccentricity, the date of perihelion is difficult to determine and is still very uncertain.

Research Items.

ANTHROPOMETRY IN FORMOSA.—A valuable addition to our knowledge of the aborigines of Formosa is made by Akira Matsumura and Etsuzu Miyauchi in a contribution to the *Proceedings of the Imperial Academy of Tokyo*, vol. 3, in which they give a summary of anthropometric measurements carried out by them under government auspices. The subjects measured were all men between the ages of twenty-three and forty-five years. The present communication deals with stature, cephalic index, and nasal index only. With the exception of the Ami, who inhabit the plain on the south-eastern coast, and the Yami, who live on the island of Botel Tobago, all the tribes belong to the central mountainous area. In stature the mean descends in the order Ami, Tayal, Vunam, Paiwan; in head-form the index in ascending order is Ami, Tayal and Vunam, Paiwan; nasal index, again ascending, Tayal, Paiwan, Ami. Generally speaking, proceeding from north to south, the mountain tribes become lower in stature, broader in the head and wider in the nose; but the Ami of the south-eastern plain have the greatest stature and are the most dolichocephalic and chamæprosopic of all the aborigines. Comparing them with the Philippine Islanders, the aborigines of Formosa resemble closely the Bontoc and Tagai tribes. The ranges of the means are: stature, 157·14 (Paiwan) to 165·14 (Ami); cephalic index, 76·42 (Ami) to 81·30 (Paiwan); nasal index, 75·78 (Tayal) to 86·15 (Ami).

PHILIPPINE SEA-URCHINS.—No. 100 of the *Bulletin of the United States National Museum* consists of Dr. Th. Mortensen's report on the Cidaridæ collected by the *Albatross* during the Philippine expedition of 1907–10. The delay has enabled the author to utilise the knowledge and experience gained on his own later expeditions to the Pacific and the Malay Archipelago. The cidarid sea-urchins here described fall into ten genera, of which Rhopalocidaris, with club-shaped secondary spines, and Psilocidaris, with slender primary and secondary spines, are new. Cyrtocidaris also is founded as a new subgenus of Goniocidaris. Psilocidaris links this form with Aporocidaris, of which the affinities were previously obscure. Of the twenty-seven species and varieties described, six species and seven varieties are new, but, though the descriptions and figures are worthy of his reputation, Dr. Mortensen leaves to some future worker the task of constructing diagnoses. The number of cidarid species now known from the Malayan and Philippine seas exceeds forty, and since many are represented by single specimens, the number of species will doubtless be increased. This is in strong contrast with the eight or possibly ten from the West Indies and the three or four from the whole of the north-east Atlantic. Collectors are warned against pickling echinoids with crinoids, since the pigment from the latter stains the other contents of the jar.

A NEW ECTOPARASITIC TREMATODE.—A new species of Epibdella was found on fishes in the New York Aquarium. It had been introduced into the tanks by a Pacific puffer (*Spheroides annulatus*) from Southern California, but the eyes of the spade fish (*Chætodipterus faber*) and of various species of angel fishes (Angelichthys and Pomacanthus) became infected. The Pacific puffers have eyelids which can be closed over the eyes, so that the worms can adhere within the conjunctival sac, and several worms may be present therein, but fewer are found on the eyes of the other fishes. The cornea of infected fish is pierced, and in about three weeks the eye is destroyed. The largest worms are about 5 mm. long and 3 mm. wide. Dr. G. A. MacCallum (*Zoopathologica*, Sc. Contribs. New York Zool. Soc. on the Diseases of Animals, vol. 1, No. 8, 1927) gives a description, with figures, of the external features and internal structure and of the eggs, and points out how this new species of Epibdella differs from those previously described.

BIOLOGICAL SIGNIFICANCE OF MYCORRHIZÆ.—Present-day opinion on the significance of mycorrhizæ veers all the way from a belief in the truly symbiotic nature of the association of the root and fungus concerned to an investing of the fungus with a purely parasitic rôle. Recent contributions to the subject come from Kôki Masui (*Memoirs of the College of Science, Kyoto Imperial University*, Series B, vol. 3, No. 2) and Lewis Knudson (*New Phytologist*, vol. 26, No. 5). After a detailed investigation of the ectotropic mycorrhizæ of woody plants, Masui defines two groups of mycorrhizal fungi: obligate forms such as *Hydnum affine*, *Cantharellus floccosus*, *Polyporus leucomelas*, *Armillaria caligata*, and facultative forms such as Boleti. He considers the former group as being truly parasitic, the latter group as 'hemi-symbiotic.' From microchemical observations Masui concludes that the growing points of normal roots contain large amounts of amino-acids and sugar, but these nutrients are gradually depleted by the fungi, until, in old mycorrhizæ, no nutrients are found in the root tissues. This may explain to a large extent the inhibition of root growth after infection. The roots, which still contain tolerable amounts of these nutrients, can grow further, pushing aside the fungoid mantle. On the other hand, the facultative mycorrhizæ formers supply a larger amount of phosphorus to the host plant than the uninfected root can normally absorb, whereas in the obligate ones the relation is just the opposite. Prof. Knudson severely criticises Constantin's idea of obligate symbiosis in the case of orchid mycorrhizæ. The work of the former clearly shows the dependence of the orchid embryo on soluble organic matter, and the investigations indicate that the capacity for synthesising food is lacking in the embryo. Given suitable organic food material and a hydrogen ion concentration in the medium sufficient to retain the iron in solution, orchid seeds germinate asymbiotically. The orchid fungus may be useful in making insoluble food material available for the root and in regulating the hydrogen ion concentration of the medium. Constancy of association of orchid root and fungus is taken as merely indicating the wide distribution of the orchid fungi and the readiness with which the orchid embryo and root can become infected.

POST-GLACIAL MOLLUSCA OF GENEVA.—Starting with a study of the hitherto much neglected post-glacial deposits of the Geneva basin, Dr. Jules Favre found that their elucidation required a thorough knowledge of the recent molluscan fauna of the area; and having attained this, he has now embodied the results of his researches in a most valuable monograph on "Les Mollusques post-glaciaires et actuels du basin de Genève" (*Mém. Soc. Phys. Hist. Nat. Genève*, vol. 40, fasc. 3). The greater part of the work (which runs to more than 260 pages) is devoted to a systematic description of the genera and species with their occurrences all most carefully set forth. Especial attention has been paid to that difficult group of little bivalves, the Pisidia. Here the specific descriptions of the several forms are given first and clearly illustrated by admirable and useful outline

drawings of the essential features of the hinges on which the determination of them depends, while the species occurring in the district are then gone over seriatim and their local distribution and variations discussed. The biological aspect of the fauna is not dwelt on, but the ecological is dealt with: the association of species, their vertical and bathymetrical distribution being fully treated. The description of the various post-glacial deposits and their fossil contents, which are considered to date back in age to the Upper Magdalenian, form the rest of the work. A useful bibliography and index are appended. The thirteen plates depicting the deviations in form of certain of the more variable species are well reproduced either from photographs or, in the case of the Pisidia, outline drawings by the author. The monograph is one that no worker on the European non-marine molusca can afford to neglect.

SOUTH-EASTERN ARABIA.—In a paper on "The Physical Geography of South-Eastern Arabia," read before the Royal Geographical Society on Jan. 16, Mr. G. M. Lees stated that Arabia is essentially a great table-land of simple geological structure, so far as Mesozoic-Tertiary tectonics are concerned, and the great monotony of its surface form is the direct result. The high mountain belt of Oman, sticking like a spur into the structures of the Persian mainland, appears as a foreign element on Arabian soil. Three distinctive types of topography constitute the ranges of Oman: (1) a highly dissected limestone country, the best example of which is the northern promontory or Ruus al Jibal; (2) a mountain belt formed of steep, jagged peaks of igneous rock; (3) a limestone plateau country formed of great sheets of horizontal or gently folded limestones. The mountains of Ruus al Jibal are penetrated by many narrow fiord-like inlets up to 9 miles in length and with 20 to 25 fathoms of water up to their heads. They are splendid examples of drowned valleys and indicate a relative depression of at least 1500 feet. Oman proper receives winter rains and Dhofar summer monsoon rain, while the intervening stretch of coast is almost waterless. Dhofar province has a wealth of tropical vegetation. It is the land of frankincense. The nomad tribes of the Samhan hills are non-Arab, and in appearance strongly resemble the Hadandowa tribes of the Sudan Red Sea province. The Sabæan ruins described by Bent were seen. Oman has always been regarded as part of an outer arc of the Persian Zagros system. This arc may exist in fact, but it is of subordinate importance compared with older compressive movements which followed an independent direction. These movements are of Cretaceous age. An intensively folded zone branched off from the Zagros system and passed through Oman. Its last outposts are Masira Island and Ras Madhraka, where it disappears into the Arabian Sea striking in a southerly direction. Argand and Wegener regard the birthplace of India as lying to the east of South Africa; if one assumes a drift of India away from Madagascar, the south coast of Arabia should lie in a region of tension and not of compression.

TERTIARY IGNEOUS ROCKS OF BURMA.—The *Transactions of the Mining and Geological Institute of India*, Part 3, May 1927, contain two valuable papers on the volcanic rocks of Mt. Popa (by H. L. Chhibber) and the Lower Chindwin region (by E. S. Pinfold, A. E. Day, L. D. Stamp, and H. L. Chhibber). These two regions, together with the doleritic rocks of the Pegu Yomas, constitute a petrographic province of the circum-Pacific type. The Popa district exhibits the sequence: older andesite (post-Peguan), biotite-andesite, rhyolite, hornblende- and augite-andesites, olivine-basalt; with accompanying tuffs and agglomerates. Possibly volcanic activity ceased only within historic times. The Lower Chindwin volcanics occur as conical hills; as crater-walls surrounding crater-lakes; or as sheets interbedded with Irrawadian sands. Here again there are andesitic types, occurring mainly as sheets; rhyolites and tuffs building the cones; and olivine- and picrite-basalts forming plugs. The rocks of the main volcanic axis of Burma thus present a striking contrast to those of the neighbouring Kabwet area (on the edge of the Shan Plateau), which resemble in a general way the analcitic and titaniferous basalts of the midland valley of Scotland.

TIDAL DATUM PLANES.—A useful monograph on "Tidal Datum Planes" has been issued by the U.S. Coast and Geodetic Survey as *Special Publication* No. 135, the author being H. B. Marmer. Tidal planes, such as those of mean sea-level, half-tide level, mean high water, and so on, form the most convenient datum planes for observations of elevation, because of their simplicity of definition, ease and accuracy of determination, and certainty of recovery, even though all bench-mark connexion be lost. Such planes are the basis of reference in the hydrographic and geodetic work of the United States and in other countries. The monograph provides a working manual for the actual determination of the more important planes, including a discussion of tide gauges, their use and measurement. There is also a detailed discussion of the principles involved and the accuracy attainable in the work.

FIRST-ORDER TRIANGULATION IN THE UNITED STATES.—Geodetic operations in the United States for the two years ending Dec. 31, 1926, are recorded by Dr. W. Bowie in *Special Publication*, No. 134, of the United States Coast and Geodetic Survey. The most important task undertaken was the continuation of the readjustments in the first-order triangulation net east of the ninety-eighth meridian. The total length of the arcs of triangulation included in this readjustment is approximately 13,000 miles. The necessity for the work became apparent when attempts were made to fit new work into the previously adjusted arcs. About 1909, Laplace azimuths began to be introduced into all new arcs, and it was evident that they could not be used at the beginning or end of an arc when it started from or ended in an old arc. During the next few years it is proposed to conduct similar work in the eastern half of the country and also to cut the area into comparatively small circuits, as has been done in the west. The arc of first order triangulation along the Canadian boundary was extended to the Pacific, and among other work of this nature was the continuation of the reoccupation of the old stations in California in connexion with the earthquake investigations. The survey of Alaska makes continued progress.

FUEL TESTING IN CANADA.—The Mines branch of the Canadian Bureau of Mines has issued a report (Ottawa, 1927) on the "Investigations of Fuels and Fuel Testing" carried out in 1925. This somewhat tardy report indicates a considerable breadth of activities of the staff, and although dealing with local problems, some of the work is of general value. There is an analytical survey of cokes sold in Canada as household fuels, balanced by a series of actual tests on various fuels in a typical domestic hot-water boiler. Thermal efficiencies of 70-75 per cent. on the gross calorific value were commonly obtained. The method of tabulating results in comparison with American anthracite is interesting, showing as it does the pre-eminence of Welsh anthracite, while gas

and oven cokes also proved more valuable, weight for weight, than the standard. Examination of 46 samples of lubricating oils after use in eight different motor-car engines is reported. The outstanding conclusion was that, contrary to popular opinion, "lubricating oils do not wear out." They become diluted with heavy fractions of petrol and contaminated with dust and carbonaceous matter, but by suitable treatment a new oil, almost as good as the original, may be prepared. The report records laboratory experimental work on the carbonisation of coal and shale at low temperatures.

DAYLIGHT IN BUILDINGS.—*Technical Paper* No. 7 of the Illumination Research Committee of the Department of Scientific and Industrial Research deals with the access of daylight to the interior of buildings. It is to a large extent an account of the present state of our knowledge on the subject, and at a later stage will be supplemented by an account of work done by the Committee. The principal point dealt with in the present paper is the 'sill ratio,' which is defined on p. 1 as the ratio of the internal illumination at a point in a room to "the illumination of a horizontal surface placed on the window sill of the room, all external buildings or other obstructions being supposed removed. . . . This sill ratio can be measured by some forms of portable illumination photometer." It is not made clear in the paper how this measurement can be made without the "external buildings and obstructions" being actually removed.

STREET LIGHTING.—The street lighting of London is a problem the importance of which it is difficult to overestimate. It was discussed in a paper read by W. J. Jones on Nov. 15 to the Public Works, Roads, and Transport Congress. Owing to the changes taking place in the habits of people, both the volume and speed of the traffic are ever increasing. Thoroughfares which were essentially of a residential character are quickly becoming main traffic arteries leading into the heart of London. It is now universally admitted that the eye is the final judge in assessing the effectiveness of street lighting systems. The requirements of good lighting are now well known. In this connexion it is interesting to recall that in 1716 all houses of a rental of £10 or above were required to hang out one or more lanterns with sufficient wick candles lighted therein to last from 6 P.M. to 11 P.M. In State Street, Chicago, the street illumination is very brilliant owing to the shopkeepers voluntarily taxing themselves for this purpose, the idea being that people will buy more readily when the illumination is brilliant. The author states that it is best to place the light source at a bend in a road at the outside of the bend, as this lights the road surface better. He also recommends placing a lamp with a large reflecting surface behind it at those places where a side road leads directly into a main thoroughfare, and that the London County Council should form a central organisation similar to that in Glasgow, to consider all street lighting problems in the London area.

ANOMALOUS DISPERSION AND ABSORPTION OF ELECTRIC WAVES.—An important paper by S. Mizushima on the anomalous dispersion and absorption of electric waves has recently been received (*Scientific Papers of the Institute of Physical and Chemical Research*, Tokyo, March). By using a thermionic bulb as an oscillation generator for producing waves of short wave-length, the author has made systematic measurements on the anomalous dispersion and absorption of these electric waves. He used a resonant receiver, the circuit being shunted by a small capacity the dielectric of which was to be tested. He found that when distilled water, acetone, benzene, and various mixtures were used, there was no absorption and so they could be used as standard substances in the measurement of dielectric constants. The results of measurements of the dielectric constant for glycerine, methyl, and ethyl alcohols, etc., are given at various temperatures and at given wave-lengths. Great variations in its value are found. Values ranging from that of the static field to the square of the refractive index for visible light are observed. The anomalous dispersion is accompanied by an intense absorption band. As the temperature is lowered the position of the anomalous dispersion shifts in the direction of the longer wave-length. According to Debye, the large values of the dielectric polarisation in a static field must be ascribed to the orientation of a molecule which has a permanent dipole in it. When a molecule rotates to adapt itself to external force, there must be a resistance which depends on the internal friction and the dimensions of the molecule. The experimental results are discussed from the point of view of this theory. The results obtained with alcohols are in good agreement with the dipole theory.

THE PHOTO BROMINATION OF *CYCLO*-HEXANE.—Pusch, and later Noddack, showed several years ago that in the photochemical bromination of *cyclo*-hexane vapour, each quantum of light absorbed effects the removal of one molecule of bromine. This result has been confirmed, and further data concerning the reaction have been published by B. J. Wood and E. K. Rideal in the October number of the *Journal of the Chemical Society*. Using the mercury green line, they found that the velocity of reaction varied directly with the light intensity, but was independent of temperature and of the concentration of *cyclo*-hexane. The presence of oxygen caused a reduction in the rate of reaction, and this was independent of the presence of *cyclo*-hexane. It is suggested that each quantum of absorbed radiation serves to excite one molecule of bromine, which then unites with a molecule of *cyclo*-hexane to form an excited complex $C_6H_{12}Br_2'$, which has a mean life of approximately 3×10^{-8} sec. This excited complex can either decompose spontaneously: $C_6H_{12}Br_2' \longrightarrow C_6H_{11}Br' + HBr$ and $C_6H_{11}Br' + Br_2 \longrightarrow C_6H_{10}Br_2 + HBr$; or it can, in the presence of oxygen, be deactivated by collision: $C_6H_{12}Br_2' + O_2 \longrightarrow C_6H_{12} + Br_2 + O_2 + \epsilon$.

THE SOLUBILITY OF WATER IN LIQUID CARBON DIOXIDE.—An attempt to determine the solubility of water in liquid carbon dioxide is described by H. H. Lowry and W. R. Erickson in the November issue of the *Journal of the American Chemical Society*. The method used was to determine the density of gaseous carbon dioxide coexisting with liquid, both in the presence and absence of water, since if the latter is soluble in liquid carbon dioxide, it should cause a decrease in the vapour pressure and, consequently, in the density of the co-existing gas. Known weights of carbon dioxide were sealed into glass tubes, calibrated for volume, and the volumes occupied by the gas and liquid measured. Assuming the critical temperature to be 31°, the critical density, obtained by extrapolation, was found to be 0·4683 in satisfactory agreement with previous values. Between −5·8° and 22·9° the density of saturated carbon dioxide vapour is the same in the presence and absence of water, and the solubility of water in liquid carbon dioxide must therefore be less than 0·05 per cent. by weight over this range. At about 4° the formation of a hydrate was noticed; possibly this was $CO_2 . 9H_2O$ described by Hempel and Seidel (1898).

Annual Exhibition of the Physical and Optical Societies.

THE eighteenth Annual Exhibition of the Physical and Optical Societies took place on Jan. 10, 11, and 12 at the Imperial College of Science and Technology, London. The secretary, Mr. T. Martin, is to be congratulated on the excellence of the arrangements. When space is necessarily limited, as in this journal, in an account of an exhibition on so wide a scale only some typical features can be mentioned. The reader is referred for a detailed report to the *Journal of Scientific Instruments*, where the lectures will be published in full and a description of the principal exhibits given by experts on the various subjects. A new feature in the arrangements this year was that on the second day of the exhibition the morning was devoted to a private view by the members of the co-operating societies, of which full advantage was taken, and it is to be hoped that this will prove of increasing value. A larger number of visitors attended the exhibition this year, and there was also an increase in the number of firms (eighty-one) exhibiting apparatus, which covered a wide range, and in which the high standard associated with this exhibition was maintained.

Among the exhibits in the Trade Section the following may be mentioned: Messrs. Adam Hilger, Ltd., a travelling microscope measuring to one-tenth of a micron; a quartz spectrograph of the all-metal type; and a fluorite spectrograph. Messrs. Carl Zeiss (London), Ltd., an illuminated pointer on the principle of an advanced torchlight, as used in the planetarium at Jena; a microscope affording binocular vision with one objective only, the binocular tube being interchangeable with a monocular tube. Messrs. Charles Baker, a boxform dissecting microscope with sliding arm to carry arms and arm rests. The Automatic and Electric Furnaces, Ltd. a Wild Barfield high temperature furnace suitable for pottery work and high speed steel hardening. Messrs. Gallenkamp and Co., Ltd., a variety of apparatus, including electric furnaces for metallurgical and dental work, optical glass heat treatment, an optical table of new design. Messrs. W. Edwards and Co., a new method of absorbing mercury vapour from high vacuum systems by the use of liquid alloys of the alkaline metals, rendering the use of liquid air largely unnecessary. Messrs. Bellingham and Stanley, Ltd., a spectrograph specially designed to photograph spectra of feeble intensity; a simple spectrograph for industrial work, photographing eight spectra on a quarter plate; a simple form of arc lamp, burning a special metallic alloy, giving a spectrum about five times as intense as tungsten, in the region 2900 A. and 3100 A.; an ultra-violet lamp for use in the home, for radiating the body with actinic light; and the latest form of the Hartridge microspectroscope.

Among other exhibits, new devices shown by Messrs. Elliott Brothers (London), Ltd., were a portable moving coil galvanometer, combining high sensitivity with a robust form; vacuum thermocouples of various capacities, special feature being that the heater is insulated from the thermocouple itself. Messrs. Houghton-Butcher (Great Britain), Ltd., gave a number of demonstrations of educational films; a new lantern attachment was shown in which films or lantern slides can be projected alternately by one movement of a change-over switch. Among some interesting new developments seen in the exhibits of the Igranic Electric Co., Ltd., attention may be directed to the Igranic neutro-regenerative short wave amplifier kit, by means of which high frequency amplification on wave-lengths so low as 15 metres may be obtained. The Mullard Wireless Service Co., Ltd., demonstrated a loud speaker of very high quality, a combination of the horn and cone type with a balanced armature. To mention a few more, there were exhibits in connexion with recent developments in wireless apparatus (Marconi's Wireless Co., Ltd.); electrical aids for the deaf (Mr. W. H. Pettifor); temperature recording (Siemens Brothers and Co., Ltd.); thermometry (Messrs. Negretti and Zambra). Among the many interesting exhibits of the Cambridge Instrument Co., Ltd., may be mentioned an ingenious device used in their new recording potentiometer of the slide wire type, in which a balance is obtained automatically by the recorder mechanism instead of by hand manipulation of the slide wire contact.

In the Research and Experimental Section there were sixteen stands in the group of exhibits illustrating recent physical research. Among these exhibits, typical of progress in the development of physics in its application to various modern problems, were the following: The Rothamsted dynamometer, shown by Rothamsted Experimental Station, the chief characteristics of which are its light weight and adaptability for a widely different range of cultivation implements. The Technical Optics Department of the Imperial College of Science and Technology showed an equipment for ultra-violet microscopy for instructional purposes, and other apparatus and accessories in connexion with ultra-violet refractometry. The arrangements make possible theoretically a resolving power which is double that attainable with the green light of the visible spectrum, and permit of photographic application to biological or metallographic subjects.

Among the ingenious devices developed by the National Physical Laboratory for overcoming practical difficulties were an improved portable illumination photometer in which the lamp current can be adjusted to within a small fraction of a milliampere by means of a special bridge, and in this way the illumination can be kept very nearly constant; a modification of the Haughton-Hanson thermostat furnace, in which an oscillating temperature is produced by means of a clockwork device, while an upward or downward tendency can be imposed as desired on the temperature curve by another special device in connexion with the thermostat furnace.

In the section devoted to Lecture Experiments in Physics, Mr. C. W. Hansel's exhibit, which was of considerable interest to those concerned with teaching, consisted of a demonstration of the rapid construction of scientific apparatus from simple units, couplings, and accessories suitable for use in schools and colleges, and in connexion with this he gave an explanatory lecture each afternoon and evening. Dr. D. Owen's exhibit showed very effectively the appreciable time taken to establish a current in an inductive circuit. Mr. F. W. Shurlock had a set of diffraction slides, among which was a set illustrating the principal results of the wave theory of light.

In the Historical Section, Prof. E. N. Da C. Andrade had a series of illustrations of the early history of the air pump, while another series of pictures showed how closely the present types of rotary air pump were anticipated by early water pumps. The Research Department of Messrs. W. and T. Avery, Ltd., had an exceedingly interesting series of illustrations, specimens, and reproductions from the Avery Historical Museum, Soho Foundry, Birmingham, showing the development of weighing instruments. An important section of the exhibits of the Research Department of the Gramophone Co., Ltd., was a series of gramophones illustrating development from the earliest

instruments to the present day. A striking feature in this section was a gramophone with an electric pick-up operating a coil-driven loud speaker, consisting of a light alloy sheet (stretched almost to its elastic limit) on a frame also of light metal. The coil is attached eccentrically to the sheet, thus preventing the formation of nodes and resulting in a purer tone than would otherwise be possible. This section was certainly the most audible in the Exhibition.

The lectures in the evenings again attracted large audiences. That on the first evening was given by Mr. Whitaker, of the Gramophone Co., Ltd., on "Progress in the Recording and Reproduction of Sound." The number of people interested in this subject was too large to be accommodated in the lecture theatre, and Mr. Whitaker therefore consented to repeat his address in order to avoid causing disappointment. He sketched the development of acoustic recording from the phonautograph of Scott and Koevig and the reproduction of sound from Edison's phonograph. Development up to 1925 was largely empirical, and the slow improvement in quality was demonstrated by a series of gramophones of different dates which played contemporary records. Improvement in the quality of response was traced from 1925 when electrical recording came into use, followed by electrical reproduction. An electrical reproducer was demonstrated that will give natural reproduction of tones as low as the pedal notes of an organ with very great volume. There are great possibilities in the method of recording and reproducing sound that utilises a photographic film, as moving parts are completely eliminated, except in the microphone and loud speaker. Photographs were shown demonstrating that reproducing devices which put a 'reactive' load on a record wear it excessively, proving that when special attention is given to this aspect a sound box which causes the minimum possible wear can be made, while an equally good pick-up scarcely wears a record at all.

Mr. V. E. A. Pullin, who lectured on the second evening, took for his subject "Recent Applications of X-rays." He gave an outline of the scope of the work of the Radiological Research Laboratory at Woolwich, illustrated by numerous slides typical of the matter with which he dealt. He sketched the origin of the work from a suggestion during the War that X-rays should be used to examine the bases of shells for flaws. This led to the planning of a scheme of research which involved the study and improvement of a wide range of technique. Among examples mentioned of practical applications were the study of gun steels, the effect of heat treatment and mechanical working, structure of electrically deposited metals, and a survey of many of the alloy systems. It has been found possible to develop X-ray technique so that comparatively large metal specimens can be radiographed, and to extend the use of X-rays beyond the research laboratory into the dockyards and factories of the services. Among the problems now receiving attention, the necessity of extremely high voltages for metal penetration is important. It is now possible to penetrate in a practical manner about $4\frac{3}{4}$ in. of steel, whereas in 1917 the maximum penetration that could be achieved was 1 in.

On the third evening Dr. J. W. T. Walsh, of the National Physical Laboratory, lectured on "Artificial Daylight." He pointed out the importance of artificial daylight for certain types of work. The most exacting use, he said, is for colour matching, and this demands the closest of daylight with correspondingly lower efficiency. For general lighting purposes a higher efficiency may be obtained, and accuracy of imitation may be sacrificed to a considerable extent. The spectral distribution curves of a number of actual units were shown by Dr. Walsh, as well as the units themselves. Among them was the daylight gas mantle, in which a fair imitation of daylight can be obtained at an efficiency of about 80 per cent. of that of the ordinary mantle. Dr. Walsh urged that picture galleries should be illuminated by artificial daylight.

The Science Masters' Association.

THE Science Masters' Association has recently grown in numbers so rapidly that it was decided this year to hold the annual meeting on Jan. 4-6, partly in the Chemical Department of the Imperial College at South Kensington, and partly at King's College for Women, Campden Hill Road. The trade exhibition of scientific apparatus and books—the largest ever seen at these meetings—was displayed at the Imperial College throughout the meeting. The daytime programmes of lectures, meetings, and demonstrations were all at the Imperial College, but for those in the evening the large hall of King's College for Women was used.

The meeting was opened on the evening of Wednesday, Jan. 4, by the address of the president, Sir Richard Gregory, who took for his subject the relationship between science and the humanities. In the course of the address it was pointed out that these are the warp and woof of the fabric of modern life. Though in scientific assemblies this is commonly recognised, representatives of science miss reciprocity of attitude from their literary colleagues, who more easily find fault with the non-literary scientific worker than with the humanist wholly oblivious of science.

"It is commonly assumed," said the president, "that devotion to science inhibits all sense of pleasure in emotional expression and that familiarity with the structure and processes of Nature breeds indifference to her charms, and destroys the æsthetic veil which gives her both mystery and beauty. Science and poetry thus seem to most people to be poles apart, yet Coleridge said that he attended Sir Humphry Davy's lectures at the Royal Institution for the purpose of increasing his stock of metaphors, and modern poets might well be inspired by the scientific imagination of Sir William Bragg shown in his insight into the atomic structure of crystals. Though poetry and science represent different attitudes towards Nature, they are not mutually destructive, and may be complementary to each other.

"Science does not want a divorce from literature, but closer union with it and a common understanding of the distinctive qualities by which each can contribute to the fullness of life."

Sir Richard Gregory dealt also with the respective claims of classical and scientific education. "When a student of science confesses that he knows little or nothing of classical literature," he said, "he does so in a spirit of humility; but classical scholars often seem to be supercilious in their disregard of science. This vestige of social snobbery will no doubt disappear in the course of time, and it will be understood more clearly than it is to-day that science is as necessary a part of the mental equipment of a cultured man as is classical or modern literature or any other art of expression."

During the meeting two discussions were held on the subject of scientific careers. The first dealt especially with biological openings overseas. Sir John Farmer, who opened the discussion, made it very

clear that in few directions are prospects so good for men of the right type and training, and that the present shortage of suitable candidates for work that is urgently needed is a very serious hindrance to the development in the Empire of what is by far its most important industry, namely, agriculture. Capt. Irby, of the Colonial Office, supplied details of recent appointments made in the Crown Colonies and Dependencies.

The second discussion dealt with industrial openings in chemical technology, and was opened by Prof. W. A. Bone. He pointed out that the formation of large industrial combines is tending to bring in more and more scientific research and control. The economic existence of Great Britain depends upon production, and production depends upon efficiency of control. For this the best type of men is needed, and of the qualifications required sound character is by far the more important, although adequate technical knowledge is also necessary. Prof. Bone thinks that proper training for work of this kind requires seven years after leaving school. Such a long and expensive course could be financed by industries themselves, who would find it a cheap and safe investment; some industries are moving in this direction already.

Lectures were delivered to the Association during the meeting by Dr. J. W. T. Walsh, of the Photometric Department, National Physical Laboratory, who lectured on "Some Modern Methods in Photometry"; also by Prof. J. C. Philip, of the Imperial College, on "Charcoal and its Activation." These lectures were well attended and much appreciated by audiences who, knowing well enough how easily a science master gets out of touch with modern developments, welcomed such chances of renewing contact with some recent investigations.

A large number of members exhibited apparatus designed by themselves for various uses in connexion with teaching. Among these the most notable collections were those staged by Mr. E. H. Duckworth, of Dean Close School, Cheltenham, and Mr. F. A. Meier, of Rugby School. Lecture demonstrations were given by Mr. C. W. Hansel, Bedford School, in connexion with apparatus of his own design for use in mechanics and optics; by Mr. S. R. Humby, of Winchester, on experiments with high-frequency sound waves, in which he was able to demonstrate effectively most of the familiar phenomena of optics; and by Mr. W. A. D. Rudge, of Rugby School, who demonstrated atomic models. These exhibits and informal lectures by members were a very satisfactory feature of this meeting, in which they occupied a much larger part in the programme than has been the case at most recent meetings. One of the most useful functions of the Association is to enable its members to pick up valuable ideas from one another, and a distinct revival in this particular branch of its activities is therefore to be welcomed.

Among the most popular events at every annual meeting are the expeditions, applications for which commonly exceed the number that can be taken. On this occasion a tour of the London Docks was arranged during the afternoon of Jan. 4; visits to the United Dairies Ltd.; to the Lighting Service Bureau at 15 Savoy Street, Strand; and to the Æolian Hall, New Bond Street, to see the Duo-Art piano-playing reproduction process, filled the programme for the following afternoon. On Friday afternoon nearly 250 members accepted a generous invitation from the Gas Light and Coke Company. After they had been entertained to lunch by the Governor and Court of the Company, a very interesting afternoon was spent in viewing first the gas-producing plant at Fulham, where a large retort house of the latest type has recently been installed, and afterwards the Company's store and training depot at Nine Elms. The Governor, Sir David Milne-Watson, in welcoming his guests at lunch, expressed the view that some people were inclined to suppose that, with the competition of electricity, the gas industry would decline, and he hoped that they would be convinced of the contrary by what they would see during the afternoon. His hope was very fully justified.

It is hoped to meet next year, for the second time, at Cambridge, and Prof. A. C. Seward, Master of Downing College, has been elected president of the Association for the forthcoming year.

The Loutreuil Foundation of the Paris Academy of Sciences.

THE following grants for research have been made from the Loutreuil Foundation:

(*a*) Grants to institutions named by the founder.

(1) National Museum of Natural History. 4000 francs to Désiré Bois, to aid in the publication of the third part of a "Guide aux collections de plantes vivantes du Muséum"; 6000 francs to Paul Chabanaud, to pursue in Austria and Holland work relating to a general study, morphological and systematic, of the heterosome fishes. (2) Collège de France. 3000 francs to Charles Moureu for altering the large cathetometer in his laboratory with the view of the determination of the densities of gases, particularly of pure xenon and krypton. (3) Central Council of Observatories. 3000 francs to the Paris Observatory for the publication of Lalande's catalogue; 3000 francs to the *Journal des Observateurs* to assist this useful publication. (4) Conseil de perfectionnement de l'École polytechnique. 15,000 francs to the library of the École polytechnique, for the purpose of filling up the gaps in a certain number of periodicals. (5) National Veterinary School of Alfort. 11,000 francs to the library, to complete various collections and to purchase important French or foreign books relating to veterinary science. (6) National Veterinary School of Lyons. 5000 francs to the library for completion of collections of periodicals interrupted during the War; 1000 francs to Jean Basset, to carry on his researches against anthrax. (7) National Veterinary School of Toulouse. 3000 francs to Marcel Petit, for the study of the lymaphatics of the foot of the horse, especially those in the keratogen layer. (8) National Agronomic Institute. 2000 francs to Charles Voitellier, for experiments on egg control.

(*b*) Grants to institutions admitted for one year by the president.

Conservatoire national des Arts et Métiers. 5000 francs to Emilio Damour, for pursuing his bibliographical work on glass.

(*c*) Independent bequests.

3000 francs to Norbert Casteret, for continuing his researches and his spæleological work in the region of the central Pyrenees. 6000 francs to the Comité français de géodésie et géophysique, towards the cost of the seventh survey of the new magnetic network of France, and the calculations necessary to the coordination of the observations collected. 5000 francs to Gaston Delépine, for the pursuit of his studies on the carboniferous limestones of the Asturia. 5000 francs to the École supérieure d'aéronautique et de construction mécanique, for acquiring the necessary material for the determination of critical points and for experiments on hardness. 6000 francs to the École technique de photographie et de cinématographie, for

completing the equipment of the research laboratories of the School in view of undertaking a systematic study of photographic preparations. 5000 francs to Gaston Fayet, to ensure the regular publication of the *Bulletin* of the Nice Observatory. 5000 francs to the Fédération française des Sociétés de sciences naturelles as a grant to the "Faune de France." 10,000 francs to the Musée d'histologie de l'hôpital Saint-Louis, for the purchase of instrumental material. 6000 francs to Emmanuel Passemord, to assist the continuation of his researches on the Quaternary period. 2000 francs to Paul Pallary, for assisting his zoological and prehistoric studies in Morocco. 10,000 francs to Pierre Teilhard de Chardin, to aid his geological and palæontological researches in northern China.

University and Educational Intelligence.

DURHAM.—Dr. A. K. Macbeth, reader in chemistry (Durham Division) since 1924, has been appointed to the Angas chair of chemistry in the University of Adelaide. In connexion with the changes following on Dr. Macbeth's departure, Dr. W. A. Waters has joined the staff of the chemical laboratories as a lecturer in chemistry.

EDINBURGH.—The Cameron Prize "awarded to a person who, in the course of the five years immediately preceding, has made any highly important and valuable addition to practical therapeutics," has been awarded to Prof. C. Levaditi, of the Pasteur Institute, Paris, for his work on the chemotherapy of syphilis and his other contributions to our knowledge of microbiology.

IT has been decided to found an institute at Prague for the scientific investigation of coal. It will have the support of the State and of the various coal undertakings in Czechoslovakia.

THE British Federation of University Women, Crosby Hall, Cheyne Walk, S.W.3, directs attention to the fact that applications for the first international junior fellowship offered by the International Federation of University Women and for the Rose Sidgwick memorial fellowship must reach the secretary by, at latest, Feb. 15.

THE annual general meeting of the Association of Women Science Teachers will be held at St. Paul's Girls' School on Feb. 4. In the morning, members of the Association will visit the Royal Institution; in the afternoon the programme will include short discussions on general science as an alternative to the separate sciences in the school certificate course (opened by Miss F. E. M. Morgan), and holiday work in chemistry for girls (opened by Miss C. H. Spencer). In the evening, Sir John Russell will deliver a lecture on "The Growth of Crops—Applications of Botany and Chemistry to Country Life." Further particulars can be obtained from Miss M. E. Birt, 20 Longton Avenue, Sydenham, S.E.26.

NOTICE is given that, subject to candidates of sufficient distinction presenting themselves, the president and Council of the Royal Society of London propose to appoint a second Foulerton research professor, whose duties will be to conduct original researches in medicine or the contributory sciences, calculated to fulfil the objects of the bequest, namely, "The discovery of disease, the causes of it, and the relief therefrom of human suffering." The yearly stipend will be not less than £1400 and the appointment will be made, in the first instance, for five years, renewable for further successive periods of five years up to the age of sixty years. Applications must be received by the assistant secretary of the Royal Society, Burlington House, W.1, not later than May 1.

THE Department of Textile Industries of the University of Leeds has been conducting researches in relation to the colloid character of wool, and these have led to the invention of a device, now being tried out on a large scale, for imposing some of the properties of wool on artificial fibres. Other main lines of research in the department, as reported in Prof. Barker's account of the work of the session 1926–27, related to the chlorination of wool and the physico-chemical properties of wool fat. The work on colour inheritance in animals associated with the institution of a White Wensleydale Flock is, for the time being, discontinued owing to lack of funds. Meanwhile the work already done has led to the Wensleydale-Peruvian Merino cross, with important results. In the Department of Colour Chemistry and Dyeing, satisfactory arrangements for obtaining free samples from manufacturers have made it possible to devote more attention to artificial silk.

THE education of the chemist forms a frequent theme of discussion, and very varied views are held concerning what he should and should not be taught. It has rarely been suggested that legal knowledge should form part of a chemist's equipment, but no one engaged in industrial work will deny that a working knowledge of the numerous Acts of Parliament, and the still more numerous Orders-in-Council and Statutory Regulations governing chemical works, is absolutely essential to anyone holding an appointment of an executive nature. The necessity of this knowledge has been realised by the Sir John Cass Technical Institute, which announces a short course of lectures on Tuesday evenings at 7 P.M. on "English Law as Related to Industrial Chemistry." As the lecturer, Mr. G. S. W. Marlow, is both a chemist and a barrister in practice, the requirements of the industrial chemist will be fully met. At the first lecture, which is to be given on Jan. 24, the chair will be taken by Mr. James Whitehead, K.C.

"ENGINEERING DEGREE SERIES" is the title of a new series of books being issued by Sir Isaac Pitman and Sons, Ltd., intended for students preparing for the national certificate, City and Guilds, associate memberships of the engineering institutions, and B.Sc. (Eng.) examinations. The publishers are to be congratulated on this series of primers, which are all clearly printed, well illustrated, and, what is probably most important, contain many well-chosen examples. The idea of publishing this series in weekly parts should make a wide appeal to part-time students who, although not in a position to purchase the necessary text-books outright, may welcome the opportunity of making weekly contributions towards this end. The scheme of covering the syllabus of the B.Sc. examination in eight to twelve weekly parts of about forty pages each seems rather ambitious, and students preparing for this examination will require to supplement their knowledge by reference to standard text-books. On the other hand, the subject matter of Parts I of "Strength of Materials," by Dr. F. V. Warnock, "Applied Thermodynamics," by Prof. W. Robinson, and "Performance and Design of D. C. Machines," by Dr. A. E. Clayton, seems to be clearly stated and condensed into as short a form as possible. This again will make a special appeal to the part-time student, who may receive at the most only thirty lectures in the subject during a session, and can, therefore, only hope to acquire the basic principles during class instruction. The series should thus meet a definite need, as one of the greatest difficulties of teachers in evening institutes is to recommend a text-book which will adequately cover the syllabus, and at the same time be within the limited purchasing power of the student.

Calendar of Customs and Festivals.

January 24.

ST. PAUL'S EVE.—In Cornwall known as St. Paul's Pitcher Day or Eve of Paul's Tide, the former name derived from a curious custom of tin streamers, the mixed agricultural and mining population of Bodmin and the seafaring population of Padstow. The custom was that a pitcher should be set up at a convenient distance and pelted with stones until demolished. A new pitcher was then bought, with which an adjournment was made to the nearest ale-house, and the pitcher was used in the merry-making which followed. Popularly the custom was explained as a festival to celebrate the discovery of tin-smelting. A variant was observed in Bodmin when boys paraded the town with broken pitchers and threw sherds into any door which had been left open.

In Cornwall popular tradition has assigned super-human powers to its local saints freely. St. Just and St. Keverne hurl boulders at one another which elsewhere, and even in Cornwall, are the missiles of giants. Numerous wells were endowed by them with miraculous powers, such as that at St. Ludgvan, which protected any child baptised with its waters from being hanged. St. Kea floated to Cornwall from Ireland on a rock; and St. Piran was conveyed there on a millstone which had been hung around his neck when he was flung into the sea by the order of an ungrateful Irish king, whose hounds killed in hunting and whose warriors slain in battle he had restored to life. Previously he had fed ten Irish kings and their armies for ten days with three cows. The early connexion between Ireland and Cornwall is indicated by the Irish origin of a number of Cornish saints, and there was a similar link with Wales.

In view of the peculiarly localised character of Cornish saints, it might be expected that a distinctively local industry like tin mining, which goes back to a remote past, would be associated with a local saint rather than St. Paul; in fact, St. Piran and St. Chiwidden are credited with the discovery and working of tin. If the destruction of the pitcher represented a sacrifice, human or other, it might be simply a survival of a 'Celtic' rite; but the very fact that it is associated with an observance of tin-workers, and its restricted but peculiar distribution, which extends to the fishing as well as the mining population, suggests that the festival of St. Paul may have overshadowed a rite belonging to another culture, such as might be associated with the so-called "Cornish fisher type," found at Padstow among other places, which, distinct in physique and often in custom, still to some extent holds aloof from the rest of Cornwall.

January 25.

ST. PAUL'S DAY.—Strype records that on this day —the day of the conversion of St. Paul—a solemn procession, in which the civil dignitaries and representatives of all the parishes took part, was made through the City of London to St. Paul's. The court, on one occasion at least, was also present. At night bells were rung and bonfires were lit.

There are some curious features in an old custom connected with the tenure of lands in Essex from the Dean and Chapter of St. Paul's. The lands were held by the Le Baud family from 1274 on payment annually of a buck on the day of St. Paul's conversion and a doe on the Commemoration of St. Paul. The buck was brought to the steps of the altar, where it was received by the Dean and Chapter in full canonicals with garlands of roses on their heads. The head and horns of the buck were then placed on a pole and carried in front of the cross around the church until the procession came out of the west door, when the huntsman sounded the death of the buck and the city horns replied. Among the gifts to the huntsman from the Dean was a loaf bearing the image of St. Paul. This custom was discontinued in the reign of Elizabeth. There is no evidence to show whether the custom of carrying the horns in procession arose out of the terms of the tenure or whether, as is not improbable, the tenure was instituted to ensure the continuance of a custom which had grown out of a tradition connected with the previous use of the site for a pagan temple of great sanctity.

In popular belief St. Paul's Day is one of several days in the calendar connected with prognostication of the weather in the coming year. If the sun shines, it betokens a good year; if rain or snow, indifferent; if misty it predicts a great dearth; if it thunders, great winds and death. Another form of the belief holds that a cloudy day will be followed by pestilence. A number of forms of the prognostication are recorded. The belief is evidently of some antiquity and widespread. It is recorded by Hospinian. It is also recorded that in many parts of Germany, if it were cloudy on this day it was the custom to drag the images of St. Paul and St. Urban to the river—a familiar method of treating the images of saints popularly connected with the weather, but more usually to secure rain rather than avert it, as it seems in the present instances. In an ancient calendar of the church of Rome, this day is marked as one on which husbands do not lie with their wives.

ST. DWYNWEN'S DAY.—Formerly celebrated in Wales on Jan. 25 with many festivities, the trying of love spells, and the exchange of love tokens. The saint was the patron of lovers and of all between whom ties of affection prevailed. According to the legend, Dwynwen was loved by Prince Maelon Dafodrill, but a marriage had already been arranged for her by her father. Dwynwen prayed to be cured of her love, and dreamed that an angel administered a potion to her which effected her wish, but that a similar potion turned her lover to ice. The angel asked her to express three wishes. She wished her lover to be unfrozen, that all true lovers should either obtain the object of their affections or be cured of their love, and thirdly that they should never wish to be married. Her wishes were granted, and she then devoted herself to a religious life. Her symbol is the crescent moon, her girdle had the same attributes as the cestus of Venus, and she carried the bow of destiny, which on her last visit to earth she left at Tresillian Cave, Glamorgan, in the form of a natural arch of stone. This is used as a means of divination in connexion with marriage. If a pebble is thrown over the arch at the first attempt, it indicates a marriage within the current year. Each failure indicates a year to wait.

The similarity between the popular cults of St. Agnes and St. Dwynwen in connexion with marriage is apparent. The legend of St. Dwynwen, it may be conjectured, represents a working over and Christianising of a cult of a Celtic goddess, while in the case of St. Agnes the cult has been absorbed by the legend of a saint of which the central feature was a love episode. In both cases the desired end was not attained, and yet two virgin saints are associated with the forecast of a love affair with a successful issue, which clearly points to an imperfect assimilation of pagan-Christian elements. The Welsh legend attempts a logical solution by illogically granting the *faithful* lover forgetfulness.

Societies and Academies.

LONDON.

Linnean Society, Jan. 5.—**Suzanne Leclercq** and **M. Bélliére**: *Psygmophyllum Gilkineti*, nov. sp., from the Middle Devonian (with Old Red Sandstone facies) of Malonne, Belgium. *P. Gilkineti* is an arborescent or at least suffrutescent plant. Axis woody, smooth, ramified, furnished with numerous distant, non-sheathing leaves, spirally arranged. Leaves large, coriaceous, and with long petioles. The whole extent of the principal specimen is about 1 ft. 10 in. in height by 3 ft. 2 in. in width, with leaves reaching to 18 in. in length, including the long and rigid petiole.—**S. H. Williams**: A naturalist in the Guiana jungles. Prof. Williams was in charge of the University of Pittsburg Investigations in British Guiana. The tropical research station, acquired from the New York Zoological Society, is situated at the junction of the Mazaruni and Cuyuni Rivers, in the heart of the largest and least-known jungle area in the world. Prof. Williams also travelled into the highlands in the interior, beyond Kaieteur Falls, in order to make a study of zonal distribution of Coleopterous insects.

GENEVA.

Society of Physics and Natural History, Dec. 1.—**G. Tiercy**: The variations of the radial velocities of η-Aquilæ, Y Ophiuchi and X Cygni. The author has proved a remarkable parallelism between the curve of radial velocities and the light curve of these three variable stars.—**P. Ferrero** and **R. Wunenburger**: Researches on the chlorination of naphthalene. The chlorination has been carried out in the gaseous state; the maximum yield of chlornaphthalene compared with the theoretical yield based on the naphthalene (60 per cent.) is realised at 350° C. with a ratio of 1·5 molecules of chlorine for one of naphthalene.—**A. Van der Wijk**: The formation of ammonia by the silent electric discharge in the presence of mercury. The author establishes that the velocity of the reaction varies according to the formula

$$V = -\left(\frac{\partial x}{\partial t}\right) = K[H_2][N_2]^{\frac{1}{2}},$$

which, for a maximum of V, requires a mixture of 67 per cent. hydrogen and 33 per cent. nitrogen.—**P. Balavoine**: A seasonal variation of the composition of butter fat. A diminution of the volatile acids is produced in August and September (23·5 against an average figure of 28) with a refractive index of 46 against 43·5 (measured with the Zeiss butryo-refractometer).—**R. Chodat** and **W. H. Schopfer**: Carotine and sexuality. The authors prove, by various reactions, that in the Mucorineæ the (+) progamete contains the carotine dissolved in a fat whilst this is not the case for the (-) progamete.—**E. Cherbuliez** and **P. Rosenberg**: Researches on the silicates. The increase of conductivity of orthose at constant temperature above 900° C. is explained by a dissociation, which leads to the final nepheline stage passing through the leucite stage. The variation mentioned exists for leucite but not for nepheline. This phenomenon does not take place with augite.

SYDNEY.

Royal Society of New South Wales, Dec. 7.—**H. B. Taylor**: The determination of minute quantities of metals in biological material (Part 1). The determination of lead. The lead present in urine is separated directly by adsorption on calcium oxalate formed by the addition to the urine of ammonium oxalate. The calcium oxalate precipitate is heated to convert it into carbonate, treated with hydrochloric acid, evaporated to dryness, taken up in water, made slightly alkaline, and filtered. The lead is left on the filter, together with a small amount of calcium phosphate. The lead is determined by dissolving the precipitate in hydrochloric acid, neutralising with sodium hydrate, and adding a freshly prepared solution of sodium-bisulphite. The amount of lead present is proportional to the opalescence produced. The method is capable of determining 0·005 mgm. of lead per litre of urine.—**A. R. Penfold**: The essential oil from the timber of rosewood (*Dysoxylon Fraseranum*). This excellent furniture timber suffers from the drawback of 'sweating,' due to the high content of oil and its peculiar nature. Although the wood is red in colour, the oil is viscous, with a pronounced bacon odour, and is intensely blue in colour, due to the presence of about 0·75 per cent. of azulene. The principal constituents were found to be cadinene, probably copaene, two new sesquiterpenes yielding azulene on dehydrogenation with sulphur, and a further sesquiterpene which has been named 'dysoxylonene.'—**Sir George H. Knibbs**: Proof of the laws of twin-births. Earlier analyses based upon means have shown that the ratios of the total number of twins born to mothers of any age, of cases of two males, of a male and a female, and of two females, were different functions of their age; the uniovular cases among them were always 0·00300 of the cases of maternity, whatever the age. Taking the masculinity into account, the numbers of uniovular and diovular cases for each year of age from 13 to 49, of *MM*, *MF*, and *FF* twins, agree very closely with the numbers actually observed in Australia in the six years 1920 to 1925. The formulæ were:

Ages.	Ratio.	Uniovular Cases.	Diovular Cases.
Up to age 37	t =	0·00300	$+0{\cdot}00058(x-15)$
Beyond age 37	t =	0·00300	$+0{\cdot}01276-0{\cdot}00128(x-37)$

The masculinity of the uniovular cases was 0·020, and of the *MM* and *FF* of the diovular cases, 0·040; t denotes the ratio of the cases of twins to the cases of maternity for mothers of age x.—**M. B. Welch**: Some mechanical properties of Australian grown *Pinus insignis* (*P. radiata*) with notes on the wood structure. The effect of rate of growth under different conditions has been studied in comparison with the mechanical properties of the wood. In general, slow growth results in a stronger wood. Impact tests indicate that the wood possesses remarkable toughness, especially material of fairly high density.—**W. R. Browne**: Petrological notes on some New South Wales basic alkaline rocks. Brief notes are given on a number of Tertiary basic alkaline rock-types, mostly from localities hitherto unrecorded; they comprise analcite and nepheline-bearing olivine-dolerites, a nepheline-basalt, and a texhenitic aplite containing barkevikite, recently collected from the Prospect intrusion.—**E. Cheel**: Descriptions of four new species of Boronia, with notes on certain other species. The new species described are: *B. subulifolia*, an 'awl-shaped leaved' species found on Mount Currockbilly near Braidwood which had previously been confused with *B. pilosa*, a Tasmanian species. *B. hispida*, a small plant covered with stiff hairs from the Grampian Mountains and head of the Turos River in N.S.W.; *B. Ruppii*, named after Rev. H. M. R. Rupp, who collected it near Barraba; and *B. Whitei*, which seems to be confined to the New England district, chiefly in the neighbourhood of Torrington. Five distinct species have previously been confused with the 'Lodum-leaved Boronia.' They are: *B. ledifolia* (Ledum-leaved Boronia); *B. rosmarinifolia* (Rosemary-leaved Boronia); *B. repandra* (Repand-leaved Boronia); *B. glabra* (Smooth-leaved Boronia); *B. triphylla* (Three-leaved Boronia), and *B. rubiginosa* (Rust-coloured Boronia).

Official Publications Received.

BRITISH.

Malayan Forest Records. No. 3: Commercial Timber Trees of the Malay Peninsula. By F. W. Foxworthy. Pp. 195+140 plates. (Kuala Lumpur: Forest Department.) 5 dollars; 12s.

Agricultural Research Institute, Pusa. Bulletin No. 168: List of Publications on Indian Entomology, 1926. Pp. 48. (Calcutta: Government of India Central Publication Branch.) 10 annas; 1s.

Memoirs of the Department of Agriculture, Trinidad and Tobago. No. 4: The Useful and Ornamental Plants of Trinidad and Tobago. By W. G. Freeman and R. O. Williams. Pp. iii+198. (Trinidad: Government Printing Office, Port-of-Spain.) 2s. 6d.

South Australia: Department of Mines. Mining Review for the Half-Year ended June 30th, 1927. (No. 46.) Pp. 70+7 plates. (Adelaide: Harrison Weir.)

South Australia. Annual Report of the Director of Mines and Government Geologist for 1926. Pp. 8. (Adelaide: Harrison Weir.)

Proceedings of the Prehistoric Society of East Anglia for 1926. Vol. 5, Part 2. Edited by G. Maynard. Pp. xii+91-255. (Ipswich: W. E. Harrison; London: H. K. Lewis and Co., Ltd.) 10s. net.

The Scientific Proceedings of the Royal Dublin Society. Vol. 18 (N.S.), No. 45: *Catenaria anguillulae* as a Parasite of the Ova of *Fasciola hepatica*. By Prof. J. Bayley Butler and J. J. C. Buckley. Pp. 497-512+plates 23-26. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.) 3s.

Transactions of the Institute of Marine Engineers, Incorporated. December. Pp. 627-710. (London.)

Journal of the Chemical Society: containing Papers communicated to the Society. December. Pp. x+iv+2901-3205. (London: Gurney and Jackson.)

Madras Agricultural Department. Year Book, 1926. Pp. ii+123. (Madras: Government Press.) 1.8 rupees.

Department of Agriculture, Madras. Bulletin No. 88: Statement giving the History of certain Important Crops from Sowing to Harvest and describing their Vicissitudes under Adverse Seasonal Conditions. Pp. 16. (Madras: Government Press.) 2 annas.

Report on the Operations of the Department of Agriculture, Madras Presidency, for the Year 1926–27. Pp. ii+93+6 plates. (Madras: Government Press.)

Malta. Annual Report on the Working of the Museum Department during 1926–27. Pp. xv. (Malta: Government Printing Office.)

The Indian Forest Records. Entomology Series, Vol. 13, Part 2: Part i. Identification of Immature Stages of Indian Cerambycidae, II.; Part ii. Descriptions of three Indian Beetle Larvæ (Carabidæ, Col.). By J. C. M. Gardner. Pp. 37+5 plates. (Calcutta: Government of India Central Publication Branch.) 1.4 rupees; 2s. 3d.

Memoirs of the Department of Agriculture in India. Veterinary Series, Vol. 4, No. 2: Studies in Bovine Lymphangitis. By Prof. V. Krishnamurti Ayyar. Pp. 103-127+8 plates. 1.3 rupees; 2s. Botanical Series, Vol. 14, No. 7: The Kolamba Rice of the North Konkan and its Improvement by Selection. By R. K. Bhide and S. G. Bhalerao. Pp. 197-245+7 plates. 1.4 rupees; 2s. (Calcutta: Government of India Central Publication Branch.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 38, Part 4. Pp. 405-567+vii+plates 14-22. (London: Edward Stanford, Ltd.) 5s.

South-Eastern Agricultural College, Wye: (University of London), County Councils of Kent and Surrey. The Downy Mildew of the Hop. By Prof. E. S. Salmon and W. M. Ware. Pp. 28+4 plates. (Wye.) 6d.

Proceedings of the Royal Irish Academy. Vol. 37, Section B, No. 26: Seasonal Changes in Conifer Leaves, with special reference to Enzymes and Starch Formation. By Prof. Joseph Doyle and Phyllis Clinch. Pp. 373-414. 1s. Vol. 37, Section B, No. 27: The Relative Food Values of Brown and White Wheaten Flour, and their Comparative Potency for the Prevention of Xerophthalmia in Guinea-Pigs. By E. J. Sheehy. Pp. 415-425. 6d. (Dublin: Hodges, Figgis and Co.; London: Williams and Norgate, Ltd.)

City and County of Bristol: The Bristol Museum and Art Gallery. Report of the Museum and Art Gallery Committee for the Year ending 30th September 1927. Pp. 20+8 plates. (Bristol.)

Department of Scientific and Industrial Research. Report of the Building Research Board, with the Report of the Director of Building Research, for the Period ended 31st December 1926. Pp. v+118+6 plates. (London: H.M. Stationery Office.) 2s. net.

Board of Trade. Catalogue of the British Industries Fair, 1928, The White City, Shepherds Bush, London, W.12, February 20th–March 2nd. Organised by the Department of Overseas Trade. Special Overseas Advance edition. Pp. xvi+364+Ad.220. (London: Department of Overseas Trade.) 1s.

FOREIGN.

Department of the Interior: Bureau of Education. Bulletin, 1927, No. 13: Statistics of State School Systems, 1924–1925. Pp. 54. 10 cents. Bulletin, 1927, No. 16: The Reading of Modern Foreign Languages; Extent to which those who have pursued French, German or Spanish in High School or in College or in both read these Languages after Graduation. By Prof. M. V. O'Shea. Pp. vii+78. 15 cents. Bulletin, 1927, No. 17: Typical Child Care and Parenthood Education in Home Economics Departments. By Emeline S. Whitcomb. Pp. v+62. 20 cents. Bulletin, 1927, No. 18: Public Education of Adults in the Years 1924–1926. By L. R. Alderman. Pp. 26. 5 cents. Bulletin, 1927, No. 21: Public Evening Schools for Adults. By L. R. Alderman. Pp. 22. 5 cents. Bulletin, 1927, No. 25: Record of Current Educational Publications, comprising Publications received by the Bureau of Education during April–June 1927. Pp. 54. 10 cents. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Bulletin 792-C: The Toklat-Tonzona Region, by Stephen R. Capps: Geologic Investigations in Northern Alaska, by Philip S. Smith. (Mineral Resources of Alaska, 1925–C.) Pp. ii+73-122+plates 2-4. (Washington, D.C.: Government Printing Office.)

Department of the Interior: U.S. Geological Survey. Water-Supply Paper 566: Surface Water Supply of the United States, 1923. Part 6: Missouri River Basin. Pp. viii+395. 50 cents. Water-Supply Paper 570: Surface Water Supply of the United States, 1923. Part 10: The Great Basin. Pp. v+183. 25 cents. Water-Supply Paper 596-C: Ground Water in the Ordovician Rocks near Woodstock, Virginia. By George M. Hall. (Contributions to the Hydrology of the United States, 1927.) Pp. ii+45-66+plates 7-8. Water-Supply Paper 596-D: Quality of Water of Pecos River in Texas. By W. D. Collins and H. B. Riffenburg. (Contributions to the Hydrology of the United States, 1927.) Pp. ii+67-88+plate 9. (Washington, D.C.: Government Printing Office.)

Publikace Pražské Státní Hvezdárny. No. 4: Recherches sur les mouvements propres de 3802 étoiles. Par V. Nechvíle. (Mémoire paru dans le Bulletin Astronomique, Tome 5, Fascicule 3.) Pp. 97. (Paris: Gauthier Villars et Cie.)

Spisy vydávané Přírodovědeckou Fakultou Masarykovy University: Publications de la Faculté des Sciences de l'Université Masaryk. Čis. 82: Náčrtek geologických poměrů v okolí Luhačovic se zřetelem na vznik jejich minerálních pramenů (Sur la situation géologique des environs de Luhačovice et l'origine de leurs sources minérales). Napsali J. Woldřich a J. Augusta. Pp. 17. Čis. 83: Příspěvek k analytickému studiu kyseliny dusité (Contribution à l'étude analytique de l'acide azoteux). Napsali J. V. Dubský a Arn. Okáč. Pp. 84. Čis. 84: On the Occurrence of Syphilis and Tuberculosis amongst Eskimos and Mixed Breeds of the North Coast of Labrador (A Contribution to the Question of the Extermination of Aboriginal Races). By Prof. V. Suk. Pp. 18. Čis. 85: Sur les correspondances analytiques entre deux plans projectifs (Deuxième partie). Par Otakar Borůvka. Pp. 34. Čis. 86: Zobecnění pojmu variety (Sur une généralisation de la notion de variété). Napsal Zdeněk Horák. Pp. 20. Čis. 87: Čopský ohyb Tisy (Le détour de la Theiss près le Čop). Napsal Viktor Šauer. Pp. 18. Čis. 88: Příspěvek ke studiu tukového tělesa Chironomid I (Contribution à l'étude du corps adipeux des Chironomides I). Napsal O. Kriebel. Pp. 15. Čis. 89: Měření modulu pružnosti v tahu metodou dynamickou (Determination of the Elasticity Modulus of a Rod as Cantilever or with Loads by Dynamical Methods). Napsal Josef Zahradníček. Pp. 12. (Brno: A. Píša.)

Sborník Vysoké Školy Zemědělské v Brné, ČSR: Bulletin de l'École supérieure d'Agronomie, Brno, RČS. Sign. C10: Hltanové žlázy včely medonosné (Apis mellifica L.) (The Pharyngeal Glands of the Honeybee (Apis mellifica L.).) Napsal Štěpán Soudek. Pp. 63+3 tabulkami. Sign. C11: Měření poorchového napětí biologických tekutin v systému s látkou obdobnou protoplasmatu (The Measure of the Surface-Tension of the Biological Liquids in a System with Substance analogous to the Protoplasm). Napsali Jaroslav Krizenecky a Olga Dubska. Pp. 42. Sign. D6: Půdoznalecký prozkum lesního velkostatku Adamova vysoké školy zemědělské v Brné. Část prvá, pedogenetická (Examinations of Soils of Adamov, the Forest-Estate of the College of Forestry at Brno). Napsali Václav Novák a Ivan Zvorykin. Pp. 94. Sign. D7: Addenda ad floram Čechoslovakiae mycologicam III. Napsal Richard Picbauer. Pp. 25. (Brno: A. Píša.)

CATALOGUES.

Reichert, 1876–1926. List E7. Pp. 138. (Wien: C. Reichert.)

Mr. Murray's Quarterly List. January 1928. Pp. 32. (London: John Murray.)

A Catalogue of Important and Rare Books on Astronomy, Chemistry, Physics, Engineering, Electricity, Mathematics and Navigation. (No. 413.) Pp. 68. (London: Bernard Quaritch, Ltd.)

Catalogue of Interesting Works on Flowers, Shells, Insects and General Literature (including early editions of Bacon, Black, Byron, Johnson, Lamb, Masefield and others). Pp. 8. (London: John H. Knowles, 92 Solon Road, S.W.2.)

Catalogue of Interesting Items on Art, including an Original Drawing by Guilio Romano, circa 1510; useful Colour Prints and New Books; Birds, Insects and other Branches of Animated Nature; Botany and Horticulture, Voyages, Travels and General Literature. Pp. 16. (London: John H. Knowles, 92 Solon Road, S.W.2.)

Catalogue of Fine Chemical Products for Laboratory Use: including Organic and Inorganic Chemicals, Analytical Reagents, Standard Stains, Indicators. Pp. 130. (London: The British Drug Houses, Ltd.)

A Catalogue of Books published by the Syndics of the Cambridge University Press, 1928. Pp. xv+284. (London: Cambridge University Press.)

A Catalogue of General Literature, including History and Biography. (No. 440.) Pp. 20. (Cambridge: Bowes and Bowes.)

The Work Meter. Pp. 12. (London: Lewenz and Wilkinson, Ltd.)

Hints on Gas Welding (Oxy-Acetylene Process). (Booklet No. 1.) Pp. 64. Hints on Oxygen Metal Cutting. (Booklet No. 2.) Pp. 64. 6d. Gas Welding and its Applications. (Booklet No. 4.) Pp. 36. (London: The British Oxygen Co., Ltd.)

Patents for Inventions: including some Useful Information on Trade Marks, Designs and Copyright. By Benj. T. King. Seventeenth edition. Pp. 16. (London: Kings Patent Agency, Ltd.)

Diary of Societies.

SATURDAY, JANUARY 21.

BRITISH MYCOLOGICAL SOCIETY (at University College), at 11 A.M.—Dr. E. J. Butler: Morphology of Catenaria in the Eggs of the Liver Fluke.—Miss M. M. Duke: The Genera Vermicularia and Colletotrichum.—N. C. Preston: A Cercospora Leaf Spot of Turnip.—J. Ramsbottom: Mycological Nomenclature.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Southern District Meeting) (at Town Hall, Devizes), at 12 noon.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire District) (at Town Hall, Sheffield), at 2.—W. J. Hadfield: Report of the Royal Commission on Land Drainage.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (1).

PHYSIOLOGICAL SOCIETY (in Department of Physiology, King's College), at 4.—Prof. J. Mellanby: The Preparation and Properties of Secretin.—

D. T. Barry: Cardio-inhibitor Threshold of Vagus in Relation to Perfusion Pressure.—H. Dunlop: The Duration of the Action of Pituitary Extract on the Circulation.—Prof. R. J. S. McDowall: The Production of High Blood Pressure by Small Doses of Histamine.—Prof. J. Barcroft: Effect of Pregnancy on the Size of the Spleen.—Demonstrations:—(*a*) The Recording of the Velocity of the Pulse Wave in Animals, (*b*) The Automatically Developing Camera, (*c*) A Simple Fluid Circulator, (*d*) A Convenient Anæsthetic Spray, by Prof. R. J. S. McDowall and R. A. Collier.—The Effect of the Circulation on the Electrical Resistance of the Skin, by H. B. A. R. Densham and H. M. Wills.—Specimens Illustrating the Comparative Physiology of the Epiglottis, by V. E. Negus.—The Estimation of Chlorides in Biological Fluids, by R. K. Christy and W. Robson.—Chromosome Linkage in Œnothera, by Prof. R. Ruggles Gates.—The Effect of Temperature Gradients on the Early Development of the Frog and Chick, by M. A. Tazalaar and M. E. Shaw.—Stromuhr, by H. Barcroft.—Section of Exterised Intestine, by Prof. J. Barcroft.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—L. C. Perkin: Gyroscopic Aids to Navigation.

MONDAY, JANUARY 23.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Influence Exerted by the Thyroid and Parathyroid Glands on the Growth of the Body.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section, London), at 6.30.—C. G. Bainbridge: Cutting Steel and Iron with Oxygen.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. W. Dorey and C. S. Buyers: Discussion on Power Factor Correction.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.—A. H. Law and J. P. Chittenden: Higher Steam Pressures and their Application to the Steam Turbine.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (at Armstrong College, Newcastle-upon-Tyne), at 7.—W. Ellerd-Styles: Large Electric Baking Ovens.

INSTITUTION OF WELDING ENGINEERS (at Caxton Hall, Westminster), at 7.30.—A. E. Plumstead: Electric Welding Repairs to Inflated Gasholders.

ROYAL SOCIETY OF ARTS, at 8.—Dr. A. E. Dunstan: The Scientific Foundation of the Refining of Petroleum (Cantor Lectures) (2).

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—A. Bulleid: On Apical Infection.—H. P. Baylis: Case of Necrosis of the Mandible.—W. Rushton: An Abnormally Small Premolar.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—President's Address and Presentation of Prizes.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—Capt. C. J. Morris: Some Valleys and Glaciers of Hunza.

TUESDAY, JANUARY 24.

ROYAL DUBLIN SOCIETY (in Science Room, Ball's Bridge, Dublin), at 4.15.—Dr. J. H. J. Poole: Atomic Mechanics.

INSTITUTE OF CHEMISTRY (Bristol Section) (jointly with Bristol University Chemical Society), at 5.—Prof. A. Smithells: What has become of Inorganic Chemistry?

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—P. R. Coursey: The Development of Dielectrics for Electrical Condensers (2).

INSTITUTION OF CIVIL ENGINEERS, at 6.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Leeds University), at 7.—Dr. S. Z. de Ferranti: Electricity in the Service of Man (Faraday Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (jointly with Institution of Post Office Electrical Engineers) (at Milton Hall, Manchester), at 7.—H. C. Gunton: Recent Applications of Power in the Post Office.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—Capt. G. I. Finch: Mountaineering Photography.

QUEKETT MICROSCOPICAL CLUB, at 7.30.—Exhibition of Opaque Objects under Various Methods of Illumination.

ROYAL ANTHROPOLOGICAL INSTITUTE (Anniversary Meeting), at 8.30.—H. J. E. Peake: Presidential Address.

ILLUMINATING ENGINEERING SOCIETY.—Discussion on Various Problems in Illuminating Engineering.

WEDNESDAY, JANUARY 25.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.30.—Dr. G. Carter: Tests for Drunkenness, particularly in Relation to Motor Accidents.

ROYAL SOCIETY OF MEDICINE (Tropical Diseases, Dermatology, and Comparative Medicine Sections), at 5.—Special Discussion on Cutaneous Mycoses in the Tropics. Opener: J. Ramsbottom (for the Section of Tropical Diseases).

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: The Present Position of Knowledge Regarding the Manner in which Sex Glands Exert their Influence on the Growth of the Body as a Whole and on its Special Parts and Organs.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Prof. J. K. Charlesworth: The Glacial Retreat from Central and Southern Ireland.

GLASGOW UNIVERSITY ALCHEMISTS' CLUB (at Glasgow), at 7.30.—Prof. A. Findlay: The Appeal of Science.

SOCIETY OF DYERS AND COLOURISTS (Midlands Section) (jointly with Foreman Dyers' Guild) (at Globe Hotel, Leicester), at 7.45.—G. H. Ellis: Dyeing Hosiery containing Celanese.

ROYAL SOCIETY OF ARTS, at 8.—H. de Koningh: Enamels.

EUGENICS SOCIETY (at Linnean Society), at 8.—R. B. Kerr, Dr. F. C. S. Schiller, and others: Super-men and Sub-men.

BRITISH PSYCHOLOGICAL SOCIETY (Medical Section) (at Medical Society of London, 11 Chandos Street, W.), at 8.30.—Dr. D. N. Hardcastle: A Physiological Approach to the Problem of the Unconscious.

THURSDAY, JANUARY 26.

ROYAL SOCIETY, at 4.30.—Prof. F. Horton, Dr. A. C. Davies, and U. Andrewes: Critical Potentials for Soft X-Ray Excitation.—H. Gough: The Behaviour of a Single Crystal of α-Iron Subjected to Alternating Torsional Stresses.—R. W. James, I. Waller, and D. R. Hartree: An Investigation into the Existence of Zero Point Energy in the Rock Salt Lattice by an X-Ray Diffraction Method.—*To be read by title only:*—Dr. H. T. Flint and J. W. Fisher: The Fundamental Equation of Wave Mechanics and the Metrics of Space.—B. Swirles: The Internal Conversion of γ-Rays.—A. Muller: On the Input Limit of an X-Ray Tube with a Circular Focus.—J. E. Sears, W. H. Johnson, and H. L. P. Jolly: A New Determination of the Imperial Standard Yard to the International Prototype Metre.—Dr. L. F. Bates: The Specific Heats of Ferromagnetic Substances.—Dr. W. Jevons: The Ultra-Violet Band System of Carbon Monosulphide, and its Relation to those of Carbon Monoxide (the 4th Positive Bands) and Silicon Monoxide.—Dr. H. T. Flint: Relativity and the Quantum Theory.—N. K. Adam: Note on the Explanation of a so-called Intertraction Phenomenon.—B. F. J. Schonland: (*a*) The Polarity of Thunderstorms; (*b*) The Interchange of Electricity between Thunderclouds and the Earth.—Prof. E. V. Appleton and J. A. Ratcliffe: On a Method of Determining the State of Polarity of Downcoming Wireless Waves.—H. Glauert: The Effect of Compressibility on the Lift of an Aerofoil.—Dr. A. T. Doodson: The Analysis of Tidal Observations.—H. R. Lang: On the Measurement of the Specific Heat of Aniline with Temperature, using the Continuous Flow Electric Method.—Prof. T. H. Havelock: Wave Resistance.—K. Yardley: An X-Ray Study of some Simple Derivatives of Ethane. Parts I. and II.

ROYAL SOCIETY OF MEDICINE (Balneology Section), at 5.—Dr. A. Schott: Carbon Dioxide Thermo-saline Springs in the Light of Modern Research.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. F. Thorpe: The Significance of Unsaturation in Carbon Compounds (2).

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—R. J. Mitchell P. A. Ralli, and Capt. G. S. Wilkinson: Schneider Trophy Machine Design.

C.B.C. SOCIETY FOR CONSTRUCTIVE BIRTH CONTROL AND RACIAL PROGRESS (at Town Hall, Bethnal Green, E.2), at 8.—Dr. Marie Stopes: The Ideals and Practice of Constructive Birth Control.

BRITISH PSYCHOLOGICAL SOCIETY (General Section and Education Section) (at 32 Upper Bedford Place, W.C.1), at 8.30.—Dr. O. Decroly: La Globalisation dans l'Écriture et la Lecture (Lecture).

INSTITUTION OF THE RUBBER INDUSTRY (Manchester Section).—Dr. W. J. S. Naunton: The Proper Use of Organic Colours in Soft and Hard Rubber.

FRIDAY, JANUARY 27.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: A Review of the Evidence for Including the Suprarenal and Pineal Glands among the Controllers of Growth.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Newcastle-on-Tyne), at 6.—J. L. Taylor: Ship Vibration Periods.

SOCIETY OF DYERS AND COLOURISTS (jointly with Society of Chemical Industry) (Chemical Engineering Group) (at Dyers' Hall, E.C.), at 6.45.—A. I. Hatfield: Dry Cleaning and Finishing Machinery.

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemical Section), at 7.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—C. H. Faris: Applications of Electro-Chemical Deposits of Metals to Engineering Purposes.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—R. H. Allen: Powdered Fuel for Boiler Firing.

INSTITUTE OF METALS (Sheffield Local Section) (at Sheffield University), at 7.30.—J. C. Buchanan: The Metal Aeroplane.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Dr. J. E. McCartney: Some Observations on Diphtheria Carriers.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Miss D. A. E. Garrod: Prehistoric Cave Art.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at St. Thomas' Cafe, Swansea).—S. Robson: Paper.

SOCIETY OF DYERS AND COLOURISTS.

SATURDAY, JANUARY 28.

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (Associates and Students Section) (at Neville Hall, Newcastle-upon-Tyne), at 3.—D. W. Baron: Machine Mining at Ashington Colliery.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. W. Chambers: Some Tudor Biographers (2).

PUBLIC LECTURES.

SATURDAY, JANUARY 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Stone-working in Ancient Egypt.

MONDAY, JANUARY 23.

GRESHAM COLLEGE, at 6.—G. P. Bailey: Modern Science and Daily Life: Coal and Coal Tar.

EAST ANGLIAN INSTITUTE OF AGRICULTURE (Chelmsford), at 7.—Prof. J. B. Buxton: Some Diseases of Pigs.

TUESDAY, JANUARY 24.

KING'S COLLEGE, at 5.30.—R. P. Wallis: Steam Boiler Plant. (Succeeding Lectures on Jan. 31 and Feb. 7.)

GRESHAM COLLEGE (Basinghall Street), at 6.—Sir Robert Armstrong-Jones: Physic. (Succeeding Lectures on Jan. 25, 26, and 27.)

UNIVERSITY OF LEEDS, at 8.—Prof. E. H. Davies: Australian Aboriginal Songs.

SATURDAY, JANUARY 28.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Proofs of Evolution in Animals and Man.