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International Congresses.

WHEN is a congress international? Still more, when is it 'truly international', as well as international in name? At first sight the question is one of nomenclature; but it covers one of principle, and of discrepant practices. It has also been brought momentarily into prominence in a special case by a presidential address which, though nominally addressed to one of our 'learned societies', was in a sense encyclical.[1]

Apart from œcumenical councils of—as yet—undivided Christianity, and uniformly unsuccessful attempts to 'get both sides together' in later schisms, international congresses are of recent invention, a product of an 'industrial age', with its facilities for organised study and intercommunication. National conferences, such as the British Association, are meditating their centenary; few international congresses have had a jubilee, though the oldest, that were designed to be periodic, go back into the 'sixties.

Even before the War, there were two grades of such congresses; one, summoned by a government or governments, was composed of official delegations representing nations as such; the other was a privately arranged meeting of fellow-workers in a particular branch of learning, usually convened by a leading society or institution in some one country in the name of colleagues there. Naturally there were hybrids, as when a government either selected or recognised one or more of its nationals, attending a private congress, to express its goodwill, and even to concert practical measures for its own subsequent consideration.

Of the status of a congress convened by invitation of one recognised government to all others, there can be no question; it is 'inter-national', a conference between representatives of nations; if there are absentees or defaulters, "the unworthiness of the minister affecteth not the efficacy of the sacrament". Also, naturally, private conferences have courted the prestige of official patronage, even when it did not bring the substantial encouragement of a subsidy.

Before the War, private international congresses, however periodic by custom, were usually organised by a body of nationals of the country to which the

[1] "Anthropology National and International." Presidential Address of Prof. John L. Myres to the Royal Anthropological Institute of Great Britain: Jan. 28, 1930.

congress was invited, and in which it was to be more or less gratuitously entertained. This had the obvious advantage that the hosts were neighbours accustomed to work together as a team; they knew local conditions, and were the persons most deeply engaged to make the meeting a success. In such meetings effective international co-operation usually began only when the members assembled, and ceased after the 'butter-meeting', leaving the national committee to publish 'proceedings' and pay the bills. In countries where the law of associations is strict, it was necessary to incorporate a joint-stock company to hold and expend subscriptions; but its duration as well as its liability was 'limited', and in due course it went into voluntary liquidation; the doctrine of *cy-près* governing the disposal of assets, if any, either to endow research locally, or to be nest-egg for the next congress. To receive such cash balance, however, some similar body had to come into existence; and accordingly some congresses established a 'permanent committee', either of nationals of the country the invitation of which for next meeting the defunct congress had accepted, or of a few eminent members irrespective of nationality. In the latter event, *de minimis non curabat lex*: outgoing and incoming treasurers were presumably both just and solvent; and pre-War congresses were oftener insolvent than intestate.

What was more difficult was to give effect to the *vœux* or resolutions of such international meetings. It was all very well to refer them to a multi-national committee: but that way the Tower of Babel fell: *quis committeret commissionem?* Again the solution, found slowly and tentatively, was in an inter-congressional executive or 'bureau'.

Now, concurrently with this trend towards continuity between successive congresses, there was perceptible from about 1899 onwards, similar trend towards coherence between the leading 'learned societies' of civilised countries; towards inter-academic correlation of workers, methods, and results. But an adolescent International Association of Academies, complicated by the existence of rather many academies in some countries, and of fewer, or none, in others, was suspended by the War; and the failure to resuscitate it at the Peace left both academies and congresses in chaos aggravated by a tangle.

In October 1918 an 'inter-allied' conference in London called on 'allied and associated' countries to denounce all international scientific associations in which they had participated before the War. It was a "drastic, and perhaps necessary act of sabotage", but it cleared the ground for the International Research Council which was established in 1919. But the International Research Council was not (at the outset) inter-national, but, at best, inter-allied-and-associated. This drawback was, however, remediable, in time. It was a further complication that a permanent body, as the I.R.C. was intended to be, had to have domicile somewhere, and the *siège social* of the I.R.C. was, and is, in Brussels, incorporated under Belgian law. The League of Nations, with domicile in Geneva, had not come into being yet.

Now it was a prime function of the I.R.C. to establish (1) national unions for collaboration in the several sciences; (2) inter-national congresses between the national unions in any science; all deriving sanction and status from the I.R.C. This was no doubt why countries adhering to the I.R.C. were to forswear allegiance to all pre-War congresses. Such unions and congresses have been in due course formed and held in certain sciences, under the sanction of the I.R.C.

What, however, governments or academies adhered to, or forswore, left many nationals—and even fellows of learned societies—unimpressed. In some subjects, where the resumption of collaborated observations, in as many countries as possible, was urgent, national unions, and more or less international congresses, sprang into being forthwith. In others, "time, the great reformer", has been also the great restorer of normality. One series after another of the pre-War congresses has been quietly revived, as soon as people felt like meeting again; and no one has been sent to the Tower for this, or excommunicated from a *siège social* anywhere.

More than this, the League of Nations, through its International Committee for Intellectual Co-operation, has summoned another type of international congress—for example, at Prague in 1928 for 'popular arts', making use of a body, domiciled in Paris, and subsidised by the French Government, the International Institute for Intellectual Co-operation, the precise relations of which to the International Committee of the League at Geneva scarcely concern us here. In this League type of

congress, a general assembly of members at the place of meeting elects a general committee, including many nationalities. The members of this committee domiciled in Paris form a 'permanent bureau' for business between congresses; and the secretariat is supplied by the Paris Institute abovementioned. Hereby the inter-national character of the periodic congresses and their general assembly is assured and maintained; the local arrangements for successive congresses are made by a temporary local committee in the inviting country, as under pre-War conditions; while continuity in administration and collaboration in research are ensured through the liberality of the French Government and the goodwill of members resident in Paris; all under specific sanction from an international committee of the League of Nations.

In anthropology, *fons et origo* of this meditation, an arrangement, superficially similar, presents, on closer examination, divergent features, which appear to have disquieted some of those concerned—not in Great Britain only. Within a few days after the Armistice, an eminent institution for anthropological teaching and research, the 'École d'anthropologie' in Paris, convened a conference, attended by representatives of twelve countries, at which was founded, under the title 'Institut International d'Anthropologie', an association, domiciled in Paris, on the premises of the 'École', for "grouping, coordinating, and centralising the efforts of all persons engaged in anthropological problems, provided that they are accepted by its 'Conseil d'administration'" (or, as one of the speakers put it, "sauf l'exception que vous savez"), which, under French law regulating incorporated bodies, necessarily contains a large proportion of French nationals, and was deliberately so constituted at the first conference. Actually this 'Conseil' includes twenty-six Frenchmen with not more than four representatives of any other country up to a maximum of fifty. Naturally, any country which desires effective representation on a body which meets in Paris most easily secures this if it is represented by Paris residents. The president and treasurer of this 'Institut' must be French subjects, and the secretaries are nominated by the management of the École d'anthropologie.

One, but by no means the only, function of this 'Institut' is the organisation in various countries of congresses *of its members* elected by the 'Conseil' in Paris, paying a subscription, and receiving the periodical *Révue d'anthropologie* published by the teaching staff of the Paris École; this provides the management with a means of publication for proceedings, announcements, and the like. These 'adherents' in some countries have formed 'autonomous offices' rather like the 'national unions' of the I.R.C., except that they are solely composed of individual subscribers or affiliated societies, accepted by the 'Conseil' in Paris. For each congress there is in future to be an 'international' committee, consisting of one member for each country, but its functions are advisory, not executive. Countries which do not 'adhere' to the 'Institut' are nevertheless provided with a representative by the 'Conseil'. Congresses of this series have been held at Liège in 1921, at Prague in 1924, and at Amsterdam in 1927; and it is reported that a similar congress is being arranged at Lisbon in 1930.

At the Amsterdam congress, survivors of the pre-War series of 'Congrès d'anthropologie et d'archéologie préhistoriques' (which dates back to 1867), and representatives of the Royal Anthropological Institute, discussed with colleagues of French and other nationalities the future relations between the old and the new congress organisations, and also between the Paris 'Institut' and the new series of congresses: and in the following years practical fusion has been effected between the old and new series of congresses, so that it would now be possible for a congress organised on the pre-War model to be convened and prepared 'par les soins de l'Institut International d'Anthropologie', without being so wholly governed by that not very international body as the present statutes prescribe.

What the Paris 'Institut' may decide is a matter of immediate interest, for its adherents appear to have been informed that there is to be a congress in Lisbon in September next. Presumably the moment will come when anthropologists, other than subscribing 'adherents' of the 'Institut', will have official intimation of it. Governments of other nations may be invited to send delegates, as some governments did send delegates to Amsterdam. But it would seem an open question whether the resolution carried by the subscribing 'adherents' there, that this congress had a "caractère vraiment international", was, or was not, rather seriously qualified by the aspiration appended to it "que ce caractère international devienne chaque fois plus effectif". If a congress be already 'vraiment international', it cannot become more so by any enhancement or recurrence; except on the Bellman's principle, "What I tell you three times is true". What all anthropologists desire—and probably many persons who are not—is that in friendly fashion this character of internationality may become not only effective but also accepted.

Pioneers of Electrical Progress.

Pioneers of Electrical Communication. By Rollo Appleyard. Pp. ix + 347. (London : Macmillan and Co., Ltd., 1930.) 21*s.* net.

THERE can be little doubt that electrical communication has done much to promote international peace. It promotes a better mutual understanding between different races and prevents false rumours from spreading and warping the judgment of nations. As a help to international commerce it is of the greatest value. The manufacture of the necessary electrical apparatus and operating the communication lines provides work for hundreds of thousands of skilled workmen and engineers all over the world. Yet it was only in June 1837 that Cooke and Wheatstone patented the first primitive electric telegraph. That so little attention has been devoted to the lives of the pioneers who perfected the art is at first sight surprising. But when we remember how rapidly epoch-making developments have succeeded one another we see how the attention of young engineers has been attracted to the present and the future rather than to the past.

In this book, brief and interesting biographies are given of the famous physicists and mathematicians who have laid well and truly the theoretical foundations on which our present systems of communication are based. There are many pioneers of electrical communication who have done invaluable work, and so the author has had to choose those whose work he regards as the most fundamental. Every electrical engineer and workman is continually using the names ohm, ampere, and volt, yet there are many of them who have forgotten or who never knew that they were called after the great physicists, G. S. Ohm, A. M. Ampère, and A. Volta. There are many more who have only the haziest notions about the personality of these great men, of their environment, and the nature of their life work. Mr. Appleyard has therefore rightly included them amongst the ten pioneers he has chosen.

The author begins by giving an excellent biography of Clerk Maxwell. He has taken pains to verify his references and to introduce the right atmosphere into his descriptions. Old students will recognise the picture of the lecture room in the Cavendish Laboratory at Cambridge where Maxwell lectured, but in his time there were no modern electric light fittings and switchboards. The writer remembers it well in Lord Rayleigh's and J. J. Thomson's time. Maxwell, like Kelvin, was much interested in gyroscopes. One of these (p. 19) which he showed at Cambridge so far back as 1857 is of the well-known 'diabolo' pattern.

Maxwell's electromagnetic theory of light and the great part this theory played in the development of radio telegraphy and telephony is well known. Considering the immense amount of highly original work he did, the cutting short of his life at the comparatively early age of forty-eight, when his activities were at their greatest, was an irreparable loss to the scientific world. He left to his successors his equations and his theories, which are of inestimable value in scientific work and in telegraphy and radio communication.

The story of André Marie Ampère is well related. In 1793 his father died on the scaffold, a victim of the 'terreur'. The shock of this tragedy produced a complete nervous breakdown of the son, who was then eighteen years old. The shadow lasted for more than a year, but his love for mathematics and physics was one of the main factors which effected a cure. His great work on the mutual action of two currents, published in 1820, and his wonderful book on electricity and magnetism, published in 1822, led to his election to the professorship of physics in the Collège de France in 1824. He died in 1836. Maxwell well described him as the Newton of electricity, and his name has been universally adopted for the unit of current.

Alessandro Volta was born in 1745 and was educated at Como. His early leanings were towards literature, but when he was twenty-four he was attracted by chemistry and physics. He was a man of affairs and a great traveller, visiting Holland, Germany, England, and France, where he met many of the great men of science. He married in 1794, and during the next five years wrote many valuable memoirs. His home at Como was in the centre of the tempest raging between Austria, France, and Italy at the beginning of last century. In 1801, on the invitation of Napoleon, he visited Paris and gave a demonstration before the French Institute. Napoleon showered gifts and dignities upon him, making him a comte and senator of the realm of Lombardy. He died at the age of eighty-two.

Georg Simon Ohm belonged to a German burgher family. He was born in 1787 and died in 1854. He was an instructor at the Military School in Berlin, then a professor of mathematics at the University of Erlangen, and finally he was appointed in 1849 professor of physics at the University of Munich. His work on electricity was at first neglected, but

the English physicists acknowledged freely their great indebtedness to Ohm.

The other biographies given by the author are those of Wheatstone, Hertz, Oersted, Heaviside, Claude Chappe, and Ronalds. The book is full of attractive pictures, including portraits of the pioneers, and much of the interesting apparatus used in their researches. Visits were made in many cases to the towns where the pioneers dwelt, and photographs taken of the houses in which they lived and of the monuments erected to their memory. A. R.

Nature Unadorned in Tropical Africa.

Zwischen Weissem Nil und Belgisch-Kongo. Von Hugo Adolf Bernatzik. Mit Beiträgen von Prof. Dr. Otto Reche, Prof. Dr. Bernhard Struck und Dr. Hellmut Antonius. Pp. 139+140 Tafeln. (Wien: L. W. Seidel und Sohn, 1929.) 85*s*.

PROBABLY in no part of the world can picturesque dress and fashion without clothing be studied to better advantage than on the Upper Nile. Except perhaps in the Pacific Islands, no people addicted to unabashed nudity are such slaves to fashion as the Shilluks, Dinkas, Nuers, and other Nilotic races. The tall Dinka, though possessing not a stitch of clothing, is a proud and haughty individual, and woe betide the Shilluk or Nuer who omits to make room enough for him on the pathway. Nothing would induce him to appear in public with a faulty garter below one knee or the wrong shaped spear; and farther south, where bead ornamentation is the order of the day, and beads current money, the traveller may find himself, as the writer has done, in serious difficulties as regards ready cash if, before entering the country, he has omitted to obtain correct information as to the precise sorts of beads to take with him. He may buy a choice selection in Houndsditch or in the Birmingham 'trash' markets—green, white, red, or yellow—but when he reaches, say, Northern Kairroudo, he will find that he can do no barter and his camp market soon dwindles. No one will part with chickens, goat, eggs, or flour. Why? Because the traveller has none of the particular blue beads which he notices are worn by all the men, women, and children of the district. His beautiful Brummagem works of art are valueless.

To change a fashion is not possible, but one may sometimes initiate a new one, if not in beads, perhaps in something else. Many years ago, when buying a few barter goods for an African expedition, I discovered in an East End cheapjack's shop an opera hat labelled one shilling, and after a little loitering succeeded in purchasing a box of fifty at the price of sixpence each. Taking them out to railhead on Lake Victoria, I travelled amongst a tall and naked people, making a judicious present of an opera hat to an occasional chief, snapping it open and shut to the huge delight and curiosity of the intended recipient and his retinue. Before a week had gone by the fashion was set. Opera hats were the vogue. Chiefs and Prime Ministers were as thick as bees as soon as camp was formed. Goats, chickens, and everything that could be thought of, were for sale, even ivory. One big chief from afar appeared dressed in a lady's very dirty old blue dressing-gown, without fastenings and split down the back—the only clothed man in the district. How he could have acquired such a possession was difficult to conjecture. He brought a small tusk of ivory and wanted a hat in exchange, which he was given. After trying the opening and shutting trick to the intense interest of the assembled multitude, which laughed in unison with him, he placed it proudly on a head much too large for its covering. It was then the giver's turn to laugh discreetly.

The prevailing present-day fashions amongst Nilotic tribes may be well studied by a perusal of Dr. Hugo Adolf Bernatzik's recent publication. Less than a third of this big volume consists of letterpress, the remainder being a series of enlarged and wonderfully reproduced photographs. As explained in the foreword, it is the outcome of an expedition decided upon originally for the purpose of taking photographs and films of people and animals in those parts of tropical Africa which are at present little known and difficult to reach. He was anxious, the author says, first to visit the hilly country between the Nile and Lake Rudolf, and then to travel westward to the Atlantic through the Belgian Congo, photographing native inhabitants and the animals along the margins of the "mighty Congo forests". He had no success, however, as regards visiting the regions he specially wished to explore. After eighteen months' preparation, the expedition duly arrived at Khartoum in January 1927, with a very extensive outfit consisting of 2 cinema cameras each with 5 objectives, 6 cameras, with 2 telephoto lenses and a flashlight apparatus, etc. A thousand plates and ten thousand metres of film were also provided, and accompanying the author was Bedrich Machulka, of Prague, as safari leader. On reaching Khartoum, great was their disappointment to learn that the regions west of Lake Rudolf were out of bounds, owing to the fact of the turbulent Turkana tribes being still only

partially under administrative control, a well-known fact that should have been ascertained beforehand. In the alternative, the expedition travelled by sailing Ghayassa to the limits of the navigable Nile at Redjaf, making short motor-car and porterage trips to the Nuba Mountains, Rumbeck and Meridi in the Bahr-el-Ghazal, and elsewhere.

Owing mainly, it would seem, to sleeping sickness regulations and the fear of malaria—for he refers to a series of dangerous tropical diseases—Dr. Bernatzik never managed to get far from the river, and did not succeed in taking any animal photographs, or apparently in making any important zoological or ethnological collections, but occupied his time, during one dry season, in the thickly populated regions inhabited by Shilluks and Dinkas, photographing things and people, chiefly scenes depicting village life—dress, occupations, dances, etc. His series of 204 magnificent photographs tell their own tale far better than any description could do. The letterpress of the book contains little new information regarding the fairly well-known life and customs of these tall, nude, cattle-tending and peaceful tribes on the Upper Nile.

In this attractive picture-book, no less disregard of European conventionalities is shown by the photographer, in his endeavour to portray actual conditions faithfully, than is displayed by the Shilluk and his neighbours in their absolute unconsciousness of nudity. Being within the local fashion, outward contentment reigns amongst them, though inwardly these people are filled with astonishment at the grotesqueness of the white man's clothing, to them quite unnecessary.

CUTHBERT CHRISTY.

Explosion Researches.

Gaseous Combustion at High Pressures: being mainly an Account of the Researches carried out in the High Pressure Gas Research Laboratories of the Imperial College of Science and Technology, London, together with the Equipment and Experimental Methods Employed. By Prof. William A. Bone, Dr. Dudley M. Newitt, and Dr. Donald T. A. Townend. Pp. xiii + 396 + 14 plates. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1929.) 42*s.* net.

IT was at one time a practice as common as it is commendable for the author or instigator of scientific work that mattered to publish a volume of 'collected researches', wherein were reprinted such of his scattered papers, first published in the journal of one or other scientific society, as the author considered most worthy. Prof. Bone, to judge from his recent "Flame and Combustion in Gases" and his still more recent "Gaseous Combustion at High Pressures", rightly believes this to have been a helpful practice—helpful perhaps to himself and his students, in enabling a conspectus of work accomplished readily to be made, and helpful undoubtedly to other scientific workers in the same or adjacent fields.

"Gaseous Combustion at High Pressures" lacks the fascination of the earlier volume, partly because the subject dealt with is more restricted, and largely because there is so little information from other sources with which to make comparison. Organised research on the combustion of gases at high pressures has hitherto been confined to Prof. Bone's laboratories. No one who has had the privilege of working with Prof. Bone, or who has studied carefully the published accounts of his work, can have failed to be impressed by his thoroughness, his attention to detail, and his manifest determination to 'make sure of his facts'. There is therefore a predisposition to take the correctness of his observations (if not his interpretation of them) for granted. But the new observations are so many, and some of them so surprising, that it is disconcerting to have no check on any of them. No doubt one of the objects of the present volume is to encourage others to embark on what is a peculiarly difficult (and potentially dangerous) study. It is to be hoped that it will have that result.

To those who, to quote the authors, "may be induced to enter the field", the most valuable chapters of the book will be the first seven. These describe the apparatus installed at the High-Pressure Gas Research Laboratories at the Imperial College, London, with special emphasis on the precautions necessary to ensure safety in its use. The preparation, storage, and compression of gases; the compressibilities of gases and their mixtures; the character of the explosion-vessels and of the filling system, with its valves and gauges; and the pressure gauges used for recording the development of the explosion pressures, are all described with a wealth of detail which should warn anyone who undertakes similar experiments against the pitfalls that the authors themselves have encountered.

The experimental results, most of which have been published in either the *Proceedings* or the *Transactions* of the Royal Society, deal with, as one of the principal subjects, the rôle of nitrogen in explosions of carbon monoxide and air, and the

effect of replacing nitrogen by other gases. The effect of varying the initial pressure, and of the addition of either hydrogen or steam, on explosions of carbon monoxide and air is also described. The significance of the formation of nitric oxide during such explosions is discussed. It is made clear that nitrogen is far from being an 'inert' diluent, for "it seems probable that in carbonic oxide — air explosions, nitrogen and carbonic oxide can act 'in resonance', the nitrogen intercepting and absorbing the characteristic radiation emitted by the burning carbonic oxide, thereby acquiring increased internal (vibrational) energy and under such 'excitation' becoming chemically more active than normal nitrogen molecules of the same mean kinetic energy" (p. 140).

Explosion experiments are also used to study the effect of initial pressure on the limits of inflammability of gases and to obtain information as to the specific heats and degree of dissociation of gases at high temperatures.

It would be idle to attempt to discuss the several controversial matters to which the authors' interpretation of their results is directed; for, as already stated, there is no basis for comparison of the results themselves. If it were permissible (and it may be) to argue from the innumerable results of explosions at low pressures, it might be suggested that, since the relationship between time and pressure, given by a time-pressure manometer chart, is, unfortunately, influenced by such externals as the characteristics of the pressure-gauge, the shape of the explosion-vessel and the position of the point of ignition, the interpretation of time-pressure records of low-pressure gaseous explosions, and it may be of these high-pressure explosions also, is rendered somewhat uncertain.

The book is remarkable as a record of achievement and of triumph over difficulties. As such, it should make a wide appeal.

R. V. WHEELER.

Our Bookshelf.

Repetitorium der allgemeinen Zoologie (*Morphologie, Physiologie, Ökologie, Abstammungslehre*). Von Prof. Dr. Walter Stempell. Pp. vi + 268. (Berlin: Gebrüder Borntraeger, 1929.) 7·60 gold marks.

"REPETITORIUM" inevitably suggests a cram-book, and in his preface the author humorously describes how he was brought to write this work especially to help the young student of medicine or of agriculture who wants to 'get up' zoology for his examination in the least possible time. But if the published outcome of Prof. Stempell's difficult undertaking is any true index of the extent and diversity of the zoological knowledge required from the German student at this stage in his education, then indeed the English universities should look to some revision of their teaching in the elementary grades.

The first section deals mainly with morphology, and in spirit it is as far removed from the old-fashioned 'type-teaching' still favoured by many of our schools as it is from the specialised 'zoology for medical men' in vogue elsewhere. There follow admirable sections on physiology, embryology, ecology, and evolutionary theories.

The author apologises for the 'mere extract' that is all he can furnish within the limits he has set himself, and he especially directs that it be used as an accompaniment to more detailed works. "An extract", he says, "can never be a really well-flavoured and meaty soup." But the extract he has so skilfully prepared is far from flavourless, and one must only regret that incapacity to read foreign languages with any ease must debar so many English students from tasting this really sound decoction. D. L. M.

Die Tierwelt der Nord- und Ostsee. Begründet von G. Grimpe und E. Wagler. Lieferung 14, Teil 10f: *Amphipoda.* Von K. Stephensen. Pp. 188. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1929.) 15·60 gold marks.

DR. K. STEPHENSEN'S account of the Amphipoda takes an important place in this most useful work. Such a specialist in the subject of course understands how to treat it simply and yet fully, and those who use this monograph will find their work made easy for them in many ways. With this large group it is impossible to figure every species, but every genus is figured, and usually a part or parts of every species. These illustrations are clear and good, and one should be able to identify from them any species in the area. Useful keys are supplied beginning with the sub-orders and tribes, through families and genera, to species. More work than usual is involved in these keys, for in some cases the males and females are so different that they have to be specially separated.

The systematic part of the work occupies 148 pages out of the whole 188. The introduction, besides describing the anatomy clearly, gives a very good account of the bionomics of the Amphipoda. This is specially interesting, for it touches upon such subjects as intersexes, sexual dimorphism, breeding habits, development, life-histories, food and parasites. A large amount of space is given to biogeography and the detailed notes on distribution are of great value. All students of the group will be grateful for this work.

A New School Chemistry. By F. Sherwood Taylor. (Dent's Modern Science Series.) Pp. viii + 508. (London and Toronto: J. M. Dent and Sons, Ltd., 1929.) 5*s*.

ALTHOUGH the subject matter of this elementary text-book is not new, the author's presentation of it is clear and attractive, the chapters being divided into descriptive text, practical exercises,

and examination questions. Short summaries and experiments for demonstration are sometimes appended, and the time required for each exercise is also given. This should be very helpful to the teacher in organising his practical classes. In the section on chemical theory, the combination of the two equations representing the effects of pressure and temperature on the volume of a gas (p. 137) may cause some difficulty, and the reason for introducing the idea of ' molecules ' is not quite clear; otherwise the reasoning which leads up to the determination of atomic weights seems to have been admirably condensed.

The chapter on double decomposition opens well with the statement that acids, alkalis, and salts are all polar compounds, and a hint is given that two types of union may be involved in compounds like copper sulphate and that these two types are due to the sharing of electrons and to electrical attraction respectively. Nevertheless, the chapter on valency is disappointing, no attempt being made to use the terms electrovalence and covalence. Electrolysis and qualitative analysis are also dealt with in an elementary way, but the ionic hypothesis is not used. In the chapter on acidimetry the advantage of calculating the normalities of solutions is clearly explained.

Haliotis. By Doris R. Crofts. (Liverpool Marine Biology Committee: L. M. B. C. Memoirs on Typical British Marine Plants and Animals, 29.) Pp. viii + 174 + 8 plates. (Liverpool: University Press of Liverpool; London: Hodder and Stoughton, Ltd., 1929.) 10*s.* 6*d.*

THE L.M.B.C. Memoirs are indispensable ' apparatus ' in all zoological laboratories, and especially is this true of the little monographs on the Mollusca. All teachers know the difficulty of describing to a class the intricate peculiarities of molluscan structure, and it is not until the student sits down with scalpel and forceps to unravel for himself the intertwisted parts that he begins to appreciate their relations.

Miss Crofts' volume on *Haliotis* is a valuable addition to the series, for this animal is " the only primitive British gastropod which is large enough for satisfactory dissection ", and its general anatomy has never before been given completely by any one author. Clear directions for dissection are set forth; and, in addition to the plates, there are many text-figures that help to elucidate puzzling features in the anatomy. There are some interesting new bionomical notes, and the author strongly recommends the formation of permanent reservation areas off Guernsey to make good the serious depletion of the crop of ' ormers ' that two years' suspension of the fishery there has only partially stayed. D. L. M.

Practical Criticism: a Study of Literary Judgment. By I. A. Richards. Pp. xiii + 375. (London: Kegan Paul and Co., Ltd., 1929.) 12*s.* 6*d.* net.

THIS book has attracted much attention in literary circles, but it deserves notice here also, because it is a good example of the present tendency to bridge the old gulf between the study of the humanities and the study of science. Mr. Richards points out that there are subjects which can be discussed in terms of verifiable facts and precise hypotheses. These are the subjects called the sciences. There are other subjects, such as the concrete affairs of organisation and administration, which can be handled by rules of thumb and accepted conventions. Between these two come ethics, metaphysics, theology, æsthetics, and so forth; the sphere of " random beliefs and hopeful guesses ".

Mr. Richards takes one of these fields of warm disputation, that of literary criticism, and makes it the subject of as scientific an inquiry as the nature of the case permits. By an interesting expedient, devised in the course of teaching duties, he got a large number of people, similar as to age and general culture, to pass unbiased judgments upon certain selected poems of unrevealed authorship. The results seem to have surprised even Mr. Richards, for the same poem was described in terms ranging between " this is a fine poem " and " this is absolute tripe ". Here, then, is the problem. Can nothing be done to improve the technique of criticism? The familiar watchwords of the great critics do not help much, because they are only pointers which may lead different minds to widely different conclusions. Mr. Richards ends his fascinating inquiry by a warning against the abuse of psychology, and some suggestions towards clearing away the fogs of criticism. The better teaching of English is, he thinks, the chief hope.

A Countryman's Day Book: an Anthology of Countryside Lore. Compiled and arranged by C. N. French. Pp. xxvi + 254. (London and Toronto: J. M. Dent and Sons, Ltd., 1929.) 6*s.* net.

THIS collection of weather ' saws ' and countryside lore will interest and amuse many people of very varied interests. Meteorologists, farmers, gardeners, and many others will find in the quotations from old anthologies and in the popular sayings a modicum of truth, but such a preponderance of error as to cause wonder regarding the origin of most of these popular beliefs of bygone times. As the title indicates, a set of ' saws ' and quotations is given for each day of the year. The book is dedicated to cottage gardeners, and contains a number of quaint illustrations copied from ancient sources.

La vie du globe et la science moderne. Par Prof. L. Houllevigue. Pp. xi + 244. (Paris: Armand Colin, 1929.) 14 francs.

IN a number of short essays, the author of this little volume has succeeded in giving a general account of modern ideas bearing on the physics of the globe. There is no attempt at detailed treatment, for the book is written for the general reader and not the specialist, but Prof. Houllevigue has chosen his matter well and has a faculty of lucid exposition without the waste of words. His book should prove of interest to workers in other branches of science who care to know the trend of thought in terrestrial physics.

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.*]

Spectrum of the Sunlit Auroral Rays.

IN a letter in NATURE of Dec. 21, 1929, Prof. Vegard criticised some researches which Moxnes and I had published in the issue of Aug. 17, 1929. In my letter I pointed out that the results obtained were only preliminary, and that the measurements of the

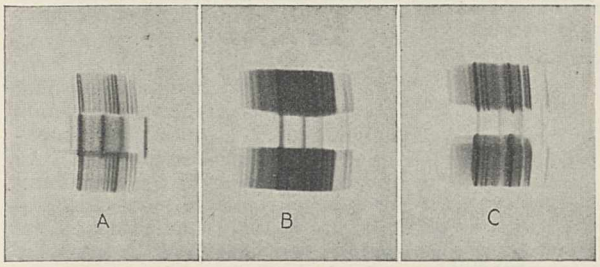


FIG. 1.—Spectrum of sunlit auroral rays (*B*) as compared with spectra of ordinary aurora in the earth's shadow (*A*) and (*C*). Plates *Sonia EW*.

intensities of the spectral lines were to be considered not as quantitative measurements, but only as qualitative indications of relative strength.

Hoping to get more spectra of sunlit auroral rays last autumn, we made an arrangement to obtain spectra of sunlit and non-sunlit auroral rays *on the*

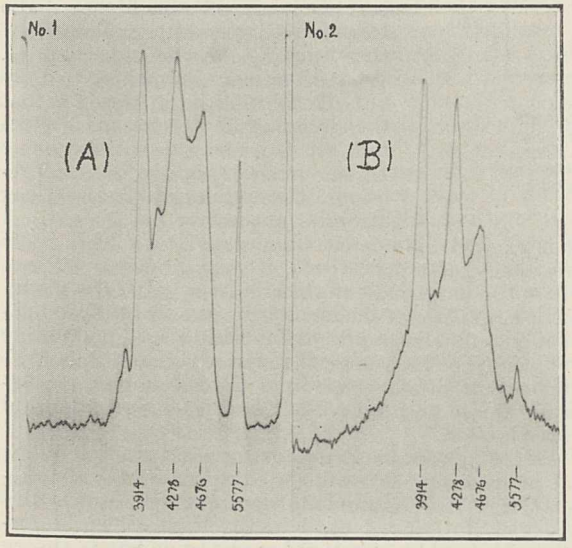


FIG. 2.—Photometric registrations of the spectra (*A*) and (*B*) made by Moxnes.

same plate—but no sunlit aurora rays were observed. We only obtained a spectrum of an ordinary aurora in the earth's shadow; but this spectrum is very interesting as compared with the spectrum already published of the sunlit auroral rays of Mar. 15–16 in so far as the aurora line 5577 A. has about the same strength on both plates. The nitrogen lines 3914 A. and 4278 A., however, are very much stronger on the plate of Mar. 15–16.

As the reproduced figure of the spectra in my letter published on Aug. 17, 1929, was not very convincing, I have had a better one made, where the spectra are reproduced direct from the plates. This is seen in Fig. 1, where *A* is the spectrum of the ordinary aurora of Mar. 15–16 in the earth's shadow, *B* the spectrum of the sunlit auroral rays of the same

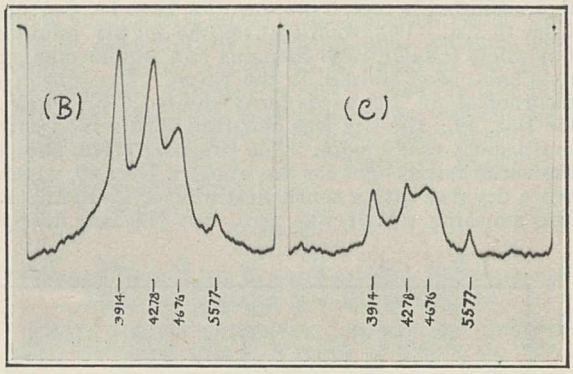


FIG. 3.—Photometric registrations of the spectra (*B*) and (*C*) made by Moxnes.

night, and *C* the spectrum of ordinary non-sunlit aurora from last autumn.

The auroral spectra are in the middle between comparison spectra of helium, and the auroral line 5577 A. is to the right, the nitrogen lines to the left.

In Fig. 2 are shown the photometric registrations of the spectra *A* and *B* made by Moxnes already published in my letter of Aug. 17, 1929. As Fig. 3 we reproduce new registrams made by Moxnes of the spectra *B* and *C*, and from these our previous conclusions seem to be considerably strengthened.

CARL STØRMER.

Oslo.

The Photo-electric Recording of Daylight.

AT the Conference of Empire Meteorologists in London last August we exhibited apparatus intended for use in the photo-electric recording of daylight. This has now been placed in position, the photometer being on the parapet of the flat roof of the Marine Biological Laboratory at Plymouth and the recorder in the laboratory.

The photometer contains a Burt vacuum sodium photo-electric cell mounted in a heavy gun-metal case, designed primarily for use in measuring submarine illumination. There is a stout glass window, above which is a sheet of double surface-flashed opal glass. This acts as an efficient diffusing surface and is set horizontally so as to measure vertical illumination. From the photometer case two rubber-insulated high-tension ignition cables, each 100 yards long, lead to the laboratory on the ground floor, being passed through cork discs—such as are used as floats for nets—to protect them from chafing. They are there connected to a 60-volt 'Exide' storage battery (five 10 v. type WJ plus one 10 v. type WJG) and to a Cambridge Instrument Co. 'thread recorder'. The accumulators maintain a steady 60-volt pressure as the photo-electric current is very small, and the batteries are mounted on paraffin wax.

The recorder has a scale with fifty divisions, corresponding in all to 5 micro-amperes, which happens to be close to the maximum current given by this particular photometer used in mid-winter noon sunlight. For more intense light the current is shunted to one-half or to one-fifth.

The sodium cell is sensitive mainly to blue light,

but gives a good idea of the fluctuations in daylight. One of the General Electric Co.'s new red-sensitive cells might be used instead, as it is sensitive throughout the visible spectrum, and gives a suitable current. Its infra-red sensitivity would, however, constitute a drawback.

The smooth graph marked A on the accompanying figure shows the record obtained for Dec. 19, starting from 10 A.M. The recorder gives one dot per minute, but where the light was changing in a regular manner dots have been omitted in the figure. The sunshine recorder about 100 yards away showed 7 hr. 0 min. for Dec. 19; the sky was cloudless with a moderate south-south-east breeze. The irregular graph shows the variations in light for the whole of Dec. 20, which was a dry day with a south-west wind of 10-15 m.p.h. The sunshine record was zero, but the sun nearly

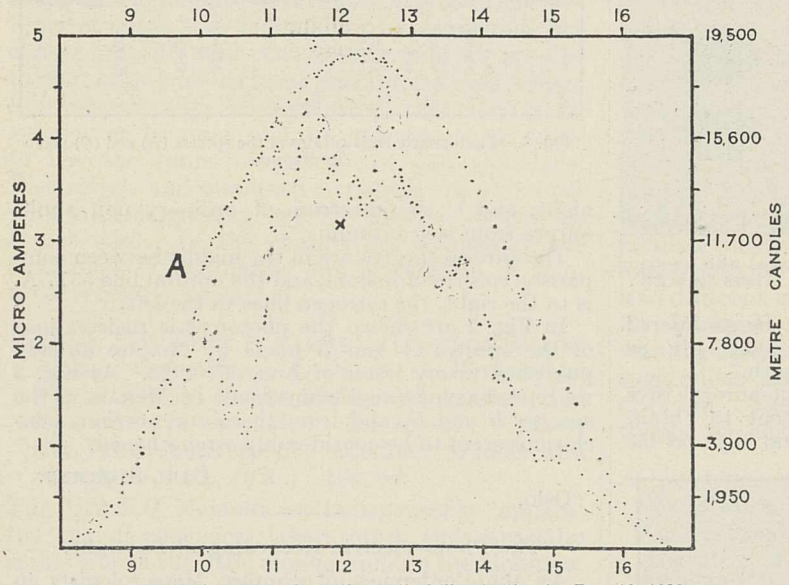


FIG. 1.—The regular curve shows the vertical illumination for Dec. 19, 1929, starting from 10 A.M., marked *A*. The irregular curve is the record for Dec. 20. For cross see text. The left-hand ordinates are micro-amperes, the right-hand are metre candles, while the abscissæ are hours. The charts are marked in quarter hours and tenths of a micro-ampere.

broke through at 11.40 A.M., and the vertical illumination then exceeded that of Dec. 19 with clear sun. The cross at noon denotes the dot obtained on Dec. 19 by shading the photometer from the direct rays of the sun and is a measure of the diffuse light. The ratio of total vertical to vertical diffuse light was thus found to be 1·49. At noon in midsummer this ratio, β, measured in the same position with a similar and similarly mounted sodium cell was, as a maximum, 4·28, a more usual value being about 3·3.

The ordinates on the right-hand side of the figure show metre candles, the photometer having been standardised against an open carbon arc—selected as being the source most nearly akin to daylight and easily reproducible.

We hope by means of these records to be able to correlate plant growth with daily illumination in metre-candle hours. The cost of the thread recorder was defrayed by the Government Grant Committee of the Royal Society.

W. R. G. ATKINS.
H. H. POOLE.

Marine Biological Laboratory,
Plymouth, and
Royal Dublin Society,
Jan. 22.

The 'Wave Band' Theory of Wireless Transmission.

Two obvious objections can be made to Sir Ambrose Fleming's lucid analysis of the wave band theory in NATURE of Jan. 18.

The first is theoretical. To deny the reality of the wave band method of regarding a modulated carrier-wave is at bottom much the same as to deny that a point on the rim of a rolling bicycle wheel 'hops along' in a series of cycloids. In both examples the two alternative points of view have equal rights to the name 'real'.

The second is practical, and so may justify this letter. Two stations operating on frequencies, say, of 500 and 520 kilocycles, will not give a noticeable heterodyne note, as their beat-frequency of 10,000 is too high for the average loud-speaker to reproduce effectively. But if one of them modulates its carrier-wave by a soprano solo, bad heterodyning results every time the soprano emits a high note. The fluctuating-amplitude formulation does not lead us to expect this off-hand; the wave band formulation does. In practice, therefore, the latter is likely to hold its own.

E. H. LINFOOT.
Graduate College,
Princeton University,
New Jersey, Feb. 2.

SIR AMBROSE FLEMING does not give us in his very able article any alternative explanation of the fundamental problem of the tuned circuit, namely, that the really selective circuit *does* cut off the higher audio frequencies, generally explained by the 'cutting of the side bands'. What is actually happening? Does not the solution lie in the fact that the damping of a resonant system falls off as its selectivity increases? In our modern lightly damped receiver, the oscillation persists long after its excitation has ceased. If it is excited by a carrier modulated by a high audio frequency, the persistence of its vibrations will not allow the amplitude of these to vary with the modulated amplitude of the incoming wave and the modulation gets flattened out, whilst with a low modulating frequency, or bass note, the slower rise and fall of the carrier amplitude gives time for the circuit oscillations to rise and fall with it and thus give a faithful reproduction.

So the lightly damped circuit gives a gradual falling off in intensity as we go up the scale of audio frequencies; the lighter the damping the earlier this becomes noticeable, until in the limit all audio frequencies would be 'cut off' as the 'side band' theory has it. Either theory explains this, the cause of all the trouble in the ether, but, whereas the latter suggests that the defect is inherent however real selectivity is attained—that is, response only to the carrier vicinity—the former suggests that if some other means of selectivity than the lightly damped circuit could be found—even with response to the carrier alone—there is no reason why the modulation should not be faithfully reproduced. The 'side band' theory puts the onus on the wave itself, the amplitude idea on the receiver; the former closes and bolts the door, while the latter leaves it open for exploration

and fresh ideas. It does not then seem to be "merely a matter of a choice of points of view", as Prof. Fortescue suggests.

Sir Ambrose states that we do not have to alter the tuning of our condensers to receive high notes. Now it is an experimental fact that if we have a receiver of several stages—say three tuned circuits, each lightly damped—the high notes will be cut down very effectively, but we can restore them by tuning one circuit to the carrier and the other two slightly above and below respectively. This at first sight suggests that the side bands exist and tuning to them restores the high notes. However, it admits of as good an explanation on the other theory, for it is observed that the effect of 'detuning' thus is to reduce the overall damping of the circuits—as evidenced by a reduction in intensity and a drop in the maximum amplitude—while the resonance curve becomes a steeper-sided one with more flattened top. Thus more selectivity is achieved without loss of damping by three detuned circuits.

A. A. NEWBOLD.

"Meadway", Cheltenham Road,
Evesham, Feb. 13.

ALTHOUGH the letters recently published in NATURE on the above theory have indicated that some of the contentions in my article of Jan. 18 last are not generally supported by scientific opinion, yet some service has perhaps been done by it if only in eliciting the interesting letters from Sir Oliver Lodge, Sir Richard Glazebrook, Prof. Fortescue, Mr. Bedford, and others.

In addition to noting the importance of the remarks by Sir Oliver Lodge, I find the letter of Sir Richard Glazebrook very valuable, because he gives the proof that a receiver tuned to frequencies of $n+m$ or $n-m$ can be set in oscillation by a carrier wave of frequency n modulated by an acoustic frequency m. Now here we touch the very pith of the discussion. When a carrier wave modulated as above is sent out from a transmitter, can we say it travels through the space to the receiver as two distinct waves of frequencies $n+m$ and $n-m$ respectively? Or is it simply a single modulated wave which can actuate a receiver tuned to the two or more frequencies?

Since we can only detect any wave by a receiver, we have the same difficulty that we have in deciding the nature of a ray of white light and how it is the prism resolves it into an infinity of rays of various wave-length in the spectrum. That the prism itself has a good deal to do with the effect is indicated by the phenomenon of anomalous dispersion.

So it is also with the wireless receiver. We have difficulty in disentangling the pure space phenomena from those produced by the receiver itself. I am unable to see that those who object to my views on the wave band theory have given proof that the side waves exist in space and are not an effect due to the nature and operation of the receiver.

Apart, however, from philosophical questions on which differences of opinion may exist, there is the very practical question: What kind of receiver should anyone buy to obtain the best results in receiving broadcast music? An eminent scientific friend tells me in a letter that a wireless dealer told him he ought not to have a very selective receiver to get the best results. Prof. Fortescue seems to agree to some extent with this statement. On the other hand, my experience is that the most selective receiver gives the best results, and many would agree. It is, then, very important to ascertain whether good musicians with normal hearing using highly selective receivers and listening to music of a wide range of pitch detect any enfeeblement of high notes relatively to low notes and if this effect is absent in not very selective receivers. I hope some evidence on this point may be gathered in.

In the present state of jam in the ether with wave-lengths between 200 metres and 600 metres the wireless receiver makers require some guidance from scientific opinion as to the type of receiver they should make and advise their customers to buy. The reception from 5GB, 2LO, and the Brookman's Park short wave, of broadcast music in anything like satisfactory tone is becoming very difficult and demands some remedy. Is that remedy to be found in the use of hyperselective receivers or not? That is the question, and the answer to it given by experiment bears closely on the validity of the wave-band theory.

AMBROSE FLEMING.

Manor Road, Sidmouth,
Feb. 18.

Crossed Connexion of the Cerebral Hemispheres with the Muscles and Sense Organs.

PROF. ROAF'S interesting speculation published under the above title in NATURE of Feb. 8, (p. 203) is based on the assumption that the two eyes possessed by most vertebrate animals have arisen in the course of evolution from a single median eye such as is found in the free-swimming larva of an Ascidian. He argues (if I understand him rightly) that when the image of an object falls on the left half of the retina of an animal of this type, the appropriate response is a contraction of the muscles of the right side of the creature's body and tail, and that the efferent nerve paths from the brain will therefore be simplified if the afferent fibres involved end in the right half of the central nervous system. Such a view may be held to account for the central projection of the retina of each of the two eyes of a mammal in such a way that fibres from its upper half are connected with the superior lip of the calcarine fissure; and that fibres from its right margin are connected with cerebral points situated to the left of those with which areas of retina lying farther to the left are connected. (This may legitimately be inferred from the work of Gordon Holmes and others on cortical projection in man.) But Prof. Roaf goes further and suggests that it may also account for the fact that in most vertebrates the right eye is directly connected only with the left side of the brain, and the paths from the two eyes undergo complete decussation. At this point the argument seems to me to become less convincing.

Even if comparative anatomists were to assure us that a single median eye was indeed the direct ancestor of our two eyes (and, so far as I am aware, such an ancestry has not previously been suggested), we should need also to be told that the evolutionary development took the form of a bisection of this eye so that the right half of its retina became the retina of the resulting right eye. Alternatively we should have to assume that, in the most primitive vertebrates possessing two eyes, the left eye received images of objects lying to the right of those seen by the right eye.

Now it is usual in all vertebrates, other than a few birds and higher mammals, to find the two eyes placed laterally in the head, with the right eye forming images only of objects situated on the animal's right, and with little overlap between the two visual fields. Impulses from the right eye are carried to the left side of the brain, and are then relayed back to the right side in order (presumably) that contraction of muscles on this side of the animal's body may direct its movements towards the seen object. If Prof. Roaf accepts the rather improbable suggestions contained in the last paragraph as an explanation of the

sensory decussation, I imagine he would say that this further development of laterally placed eyes necessitated the motor decussations.

Surely, however, this double decussation is an incredibly clumsy arrangement if he is right in suggesting that "By repeated correlation between stimulation due to an object and the movement to bring the image of it on the centre of the retina, a relationship [can] be established in the same way that a conditioned reflex is developed". A much simpler arrangement, and one which would avoid the double decussation, would be that found in certain cephalopods, where each eye is connected with its own side of the brain. Moreover, if the fabric of the central nervous system is as plastic in the hands of evolution as Prof. Roaf postulates, would it not be more probable that, early in the development of two laterally placed eyes from a single median eye, the previously crossed optic paths should become uncrossed, rather than that the whole motor system should be reshuffled and new crossed motor paths added?

Arguments like mine, based on human estimates of the unerring wisdom of providence or Nature, are notoriously fallacious, but unless some evidence is forthcoming in support of the evolutionary history outlined in my second paragraph, I find it difficult to take Prof. Roaf's suggestion seriously. Certainly the "crossed relationship is suggestive of an optical effect", but until more assistance is obtained from comparative anatomy the problem cannot be satisfactorily solved. Ramón y Cajal's theory (1898) was also inspired by optical projection, and all that he could say in its favour in 1911 was that it "n'a pu être . . . remplacée par un autre qui fût aussi plausible" ("Histologie du Système nerveux". Paris, II. p. 380). Modern knowledge of cortical projection from the retina seems to negative the fundamental assumption on which his psycho-anatomical view was based. Sensori-motor relations like those postulated by Prof. Roaf would seem to offer a more hopeful clue (cf. Sherrington, "The Integrative Action of the Nervous System", London, 1906, pp. 384-386), and I hope that the question will not be allowed to drop.

R. S. CREED.

New College,
Oxford, Feb. 10.

Stellar Absorption Lines.

CONSIDERABLE attention has been recently devoted by various investigators to the explanation of the observed contours of stellar absorption lines. There are many physical factors that contribute to the formation of the contour. The most important are: (1) the abundance of the absorbing atoms in the gas, (2) the Stark effect, and (3) Doppler effects due to the rotation of the stars. We are here concerned with the first of these, which is usually designated as 'natural widening' of spectral lines. H. N. Russell and others have shown that this type of broadening is particularly important in the stars because of the large number of absorbing atoms present in a stellar reversing layer. It is responsible for the enormous widths of the H and K lines of Ca^+ in the later spectral types.

The 'natural widening' of spectral lines has been exhaustively studied by physicists. The scattering coefficient can be expressed by

$$\sigma = c \cdot \frac{N \cdot f}{(\lambda - \lambda_0)^2},$$

where c depends upon atomic constants only, N is the number of absorbing atoms per cm.^{3}, and f is the 'oscillator strength'. According to Unsöld, the contour of a stellar absorption line is then given by

$$\frac{I}{I_0} = \frac{1}{1 + \sigma \cdot H},$$

where I is the intensity in the line, I_0 is the intensity of the continuous spectrum, and H is the thickness of the absorbing layer. Near the centre of the line the intensity should be vanishingly small. While his expression for the scattering coefficient is not strictly applicable to the centre of the line itself, Unsöld has pointed out that in practice all absorption lines in which natural widening is paramount should be black in the centre. That the theory is correct has been shown by R. Minkowski (*Zeits. für Physik*, **36**, 839; 1926), who found that lines produced in the laboratory actually appear black in the centre.

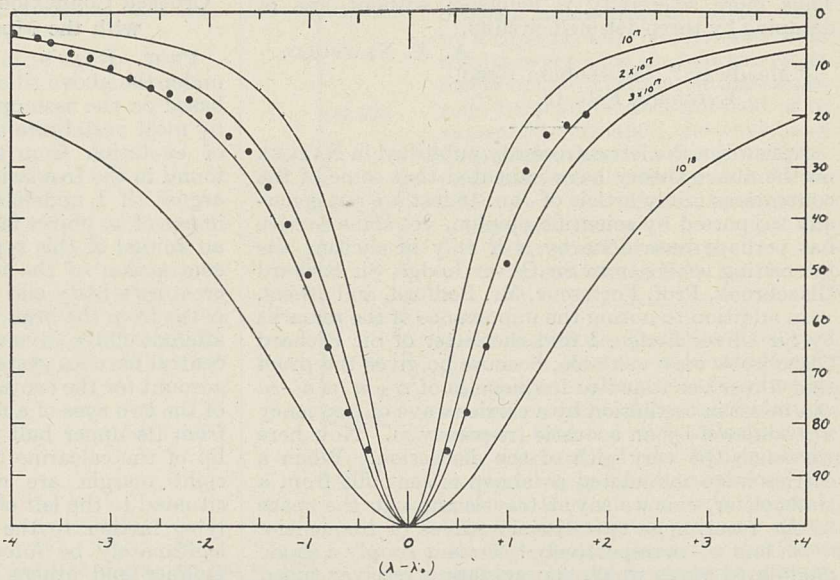


FIG. 1.—The contour of $H\beta$ in the spectrum of 7 ϵ Aurigæ, the ordinates being percentages of absorption of the continuous spectrum, and the abscissæ, Ångström units. The dots are the mean observations from five spectrograms, and the curves are theoretical contours given by Unsöld's formula, the figures representing the values of NHf.

In the stars, on the other hand, the absorption lines do not, as a rule, appear black. Even the broad calcium lines H and K show appreciable residual intensities. It has been believed by many that a stellar line is never black in the centre and that the observed contour is thus in disagreement with Unsöld's theory.

Our observations show that stellar absorption lines do occasionally appear black in the centre. In the accompanying diagram (Fig. 1) we have reproduced the contour of the $H\beta$ line in ϵ Aurigæ. It will be seen that the observations agree very well with Unsöld's curve for $NHf = 2{\cdot}5 \times 10^{17}$. The middle of the line is perfectly transparent on our negatives: there is no trace of residual intensity even on our longest exposures. Extrapolation of the observations toward the centre would bring the residual intensity to zero, in full agreement with the theory.

ϵ Aurigæ is known to be a supergiant star. Its atmospheric density must consequently be very low. This seems to support the idea, expressed first by Unsöld, that the observed residual intensities in the lines of other stars are due to some process depending upon collisions between the atoms. The fact that the hydrogen line in ϵ Aurigæ is free from the wide wings which are characteristic for other stars and are apparently produced by intra-molecular Stark effect, is itself a good indication that the pressure is very low.

O. STRUVE.
C. T. ELVEY.

Yerkes Observatory of the
University of Chicago,
Jan. 7.

Zygospore Formation in Mucors.

SINCE the discovery of heterothallism, or separate sexes, in Mucors by Blakeslee some twenty-five years ago, the conception has been widely extended in the fungi and has recently been applied to the green algæ. But in recent years the facts regarding multiple sexes in fungi have become so complex as to strain credulity, and new views, such as Dame Helen Gwynne-Vaughan's conception of nutritive heterothallism, have been coming in to relieve the tension on the earlier rigid hypothesis of fixed + and − strains corresponding respectively to the female and the male sex.

Finding peculiar results from certain strains of *Mucor hiemalis* which we have had for some years in this laboratory, it was decided to make an analytical study of the process of zygospore formation in this species in relation to various media. Several other genera of Mucorineæ have also been investigated at the same time. Subcultures were made from the original stocks, and subsequent monospore cultures from these. Experiments were made, not only varying the environmental conditions such as temperature, humidity, and light, but also to show the effects of adding various substances to the agar culture medium. A few only of these experiments can be summarised here.

In the heterothallic *Mucor hiemalis*, zygospore formation is most favoured when the moisture content of the medium is at a minimum, and the humidity can be regulated by varying the percentage of agar used in making up the medium. The addition of zinc nitrate, on the contrary, appears to increase the development of mycelium and sporangia. Most of the species thrive best on an alkaline medium (pH 7·2). When + and − strains of *Mucor hiemalis* are grown together in a Petrie dish on potato agar at a temperature of about 15° C., zygospore formation appears to be completely inhibited; but identical cultures grown at 25° C. produce large numbers of zygospores. At low temperature also the two strains will not intermingle, but a line of repulsion or aversion remains between them, which appears to be due to the fact that the medium has been rendered toxic. When such cultures are placed in an incubator at higher temperature they produce zygospores.

Small doses of oxalic, formic, malic, citric, or hydrochloric acids added to the medium so as to change the pH from 7·2 to 6·8 have a toxic effect on the fungus, causing repulsion in every case; that is, with + and +, or − and −, or + and −. However, like strains grown on a medium containing starch (2 per cent), agar (1·5 per cent), and diastase (0·04 per cent) will show no signs of repulsion, but no zygospores are formed except between + and − strains. Different media produce striking effects on the morphological characters of the mycelium. Media having sugars or traces of acids produce enormous oil inclusions in the hyphæ, which are cylindrical, thick, and heavy in appearance, while on a medium without sugar or acid the hyphæ are flat, hyaline, and much less branched. In starch diastase medium the hyphæ become septate and the protoplasm highly granular.

It is found that the mycelia of + and − *Mucor*, *Rhizopus*, *Sporodinia*, and other Mucorineæ all produce two kinds of sporangia, namely, large and small, the large sporangia emitting large spores and the small sporangia small ones.

Perhaps the most striking result has been the production of imperfect zygospores from the − strain of *M. hiemalis* alone when grown on a medium composed of 1 per cent fructose, 1·2 per cent agar and a few drops of acetic acid bringing the pH to 6·8. These zygospores ceased development after fusion of the progametes had taken place, and the wall had begun to thicken. The process resembles the 'imperfect hybridisation' obtained by Blakeslee by bringing together + and − strains from different genera. In no case has zygospore formation been obtained between + strains. Chlamydospores are frequently produced in all the strains, and under certain conditions azygospores are formed.

By fixing the mycelium in 3-5 per cent formalin and staining in Ehrlich's hæmatoxylin, the nuclei in zygospore formation can be followed under an immersion lens. The pronuclei remain separate, although in close contact, so far as their history has yet been followed. Several zygospores have been germinated in hanging drop cultures by a method to be described later, and it is hoped to follow the later history of the nuclei.

This work is being extended in various directions and a full account will be published later.

R. RUGGLES GATES.
D. V. DARAN.

King's College, London,
Jan. 31.

The Viscosity of Liquids.

THE viscosity of liquids is a subject which, so far as I know, has hitherto been without any general theoretical basis. No physical mechanism, for example, has ever been brought forward to account even for so simple and general a fact as the decrease of liquid viscosity with temperature, in contrast to the familiar and well explained increase of gaseous viscosity with temperature. As a result, the study has hitherto consisted largely of a collection of more or less well established empirical relations, mostly of limited scope.

In consequence of certain general theoretical considerations, shortly to be published, which I have been applying to the problem of liquid viscosity, I have not only been able to give a general account of the influence of temperature on liquid viscosity, but also I have arrived at a formula of great simplicity which fits the experimental facts very well. There is, of course, a whole collection of empirical formulæ (due to Poiseuille, Koch, Meyer, Slotte, and others—see, for example, Hatschek's "The Viscosity of Liquids" (1928)) connecting viscosity with temperature, but they have all at least three arbitrary constants, and a very limited range of validity. Different types of formula have been employed for different liquids. My formula has only two constants, so that the agreement between it and the experiment emboldens me to believe that it has some fundamental significance, as indicated by my theory. The formula is

$$\eta = Ae^{b/T}$$

where η is the viscosity, T the absolute temperature, and A and b the constants. It holds over practically

the whole temperature range with a great variety of substances. The following are two examples, chosen not because of exceptional agreement, but because of the wide range of temperature and viscosity which they cover:

Temp.	Butyl Alcohol.		Octane.	
	$\eta_{calc.}$	$\eta_{obs.}$	$\eta_{calc.}$	$\eta_{obs.}$
0° C.	0·0523	0·0519	0·00706	0·00706
10	0·0388	0·0387	0·00616	0·00616
20	0·0293	0·0295	0·00543	0·00542
30	0·0226	0·0227	0·00482	0·00483
40	0·0177	0·0178	0·00432	0·00433
50	0·0141	0·0141	0·00390	0·00391
60	0·01135	0·01139	0·00354	0·00355
70	0·00926	0·00929	0·00323	0·00324
80	0·00765	0·00766	0·00296	0·00297
90	0·00638	0·00638	0·00273	0·00273
100	0·00538	0·00539	0·00252	0·00252
110	0·00458	0·00460	0·00234	0·00234
120	..	..	0·00219	0·00216

$\eta_{obs.}$ is taken from Landolt-Börnstein. It is doubtful if the experimental error is less than the very slight divergence between calculation and experiment.

The only general viscosity relation which I have found to provide a test for the formula is one due to A. W. Porter. This empirical relation is as follows: If two liquids be examined throughout a sufficient range of temperature, a number of temperatures T_1 can generally be found for one liquid I, at which the viscosity is the same as it is for the other liquid II at a number of temperatures T_2. If T_1/T_2 is plotted against T_1 a straight line results. This relation follows at once from the formula given above. For if A_1, b_1 and A_2, b_2 are the constants for liquids I and II, then

$$A_1 e^{b_1/T_1} = A_2 e^{b_2/T_2}$$

$$\therefore \log A_1/A_2 = \text{constant for the two liquids concerned} = b_2/T_2 - b_1/T_1$$

or $$T_1/T_2 = \alpha + \beta T_1$$

where α and β are constants, which is the experimental relation.

Water, as would be expected, and other associating liquids, demand a further constant for complete representation, but the application of the formula in the region within which it is valid, namely at high temperature, has led to interesting results, to be detailed in a forthcoming publication.

E. N. DA C. ANDRADE.

University College,
London, W.C.1.

Botanical Nomenclature.

THE letter from Mr. R. A. Inglis in NATURE of Feb. 8, p. 204, calls for a reply, and the following is sent on behalf of the British Sub-Committee on Nomenclature, which has since 1923 been engaged in examining proposals for the revision of the International Rules of Botanical Nomenclature. Mr. Inglis is mistaken in supposing that Art. 57 is concerned with anything other than spelling. The only Article which bears, even indirectly, on gender is Article 7, which states—albeit erroneously—that "Scientific names are in Latin for all groups". It follows that they are subject to the rules of Latin grammar, and that adjectival specific epithets necessarily agree in gender with the generic names to which they are attached. The only problem is the correct gender of certain generic names. The real difficulty lies in the fact that Latin as used in botany has changed *continuously* from classical times down to the present, and that the same name, for example, *Atriplex*, may have had more than one gender even in ancient Rome. It seemed to the Sub-Committee that an Article dealing specifically with the gender of generic names was required, and the following new Article has been submitted by them, along with other proposals, for the consideration of the International Botanical Congress (1930).

"The gender of generic names is governed by the following regulations:

"I. A Greek or Latin word adopted as a generic name normally retains its classical or medieval gender, even if the author who published it gave it a different gender. Where, however, the classical or medieval gender varies, or is in dispute, or where it differs from the gender usually ascribed to the generic name, the gender of the latter shall be fixed by the Advisory Committee.

"II. Generic names which are modern compounds formed from two or more Greek or Latin words take the gender of the last. If the termination is altered, however, the gender will follow it.

"III. Arbitrarily-formed generic names, or vernacular names used as generic names, take the gender assigned to them by their authors. Where the original author has failed to indicate the gender, the next subsequent author has the right of choice."

Under II, *Airosperma* is neuter, as urged by Mr. Inglis, but *Polygala*, being feminine to Pliny as well as to Linnæus, should, we think, remain feminine (under I).

T. A. SPRAGUE
(Convener, British Sub-Committee on Nomenclature).

Royal Botanic Gardens,
Kew, Feb. 14.

Research and the State.

I HAVE read with great interest in NATURE of Nov. 23, 1929, Sir Walter Fletcher's lecture on medical research and on the inadequate rewards for such essential activities. There are apparently three kinds of activities to be considered.

1. The research worker who, if he is one of the best type, has the spirit of inquiry in him. He is often quite indifferent to practical results. Such people are not too numerous and should be given a free hand.

2. The educated publicity agent who makes knowledge available. The late Prof. Huxley probably represented the greatest man of this type the world has seen.

3. The practitioners who adapt their methods to the knowledge gained.

All these groups seem to me to be equally important from the social point of view.

In common with many associates I regard research conducted by permanent officials as apt to become relatively sterile. Skeleton organisations and institutions for research are a necessity. The ideal, however, is surely to have a fund available, and when a research worker presents a proposal really worth investigating he can be treated generously until the work is finished.

Research as a profession will, I am afraid, tend to end in mediocrity and useful compilations. I am writing, however, chiefly to ask Sir Walter Fletcher how he proposes to influence the public, which, after all, find the money. It is certain that the Anglo-Saxon will not act until he understands the objective. It is no use presenting to him pages of mathematical formulæ and the like, interesting and useful as they are to a limited circle.

In some of the American universities an official editor makes it his business to let each part of the university know what the other departments are doing, and to let all the citizens of the State obtain the

available knowledge which is furnished in clear and simple terms. The University of Melbourne is contemplating something of the kind at present.

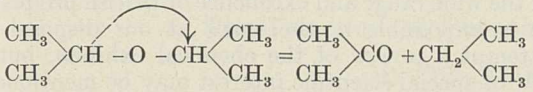
To me, systematic popular education is requisite if the ideals voiced by Sir Walter Fletcher are to be translated into practical action. Perhaps the end can be achieved in some other way, but ultimately the public-spirited citizen and the elector must be pleasantly instructed in the necessity for adequate support. Lecturing him for his neglect will not advance matters.

JAMES W. BARRETT.

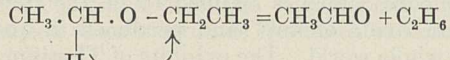
105 Collins Street,
Melbourne, C.1, Jan. 2.

Homogeneous Catalysis of Gaseous Reactions.

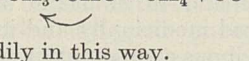
A SHORT time ago it was shown that the decomposition of di-isopropyl ether in the gaseous state is subject to a remarkable catalytic influence of iodine. The course of this reaction, which is homogeneous, and quite distinct from that of the uncatalysed reaction taking place at higher temperatures, can be represented by the equation



We now find: (*a*) That the same reaction takes place under the catalytic influence not only of iodine, but also of various alkyl iodides and, to a smaller extent, of bromides (*iso*PrI, EtI, MeI, *iso*PrBr, EtBr, $C_2H_4Br_2$, HBr); chlorides have little influence; (*b*) that this catalytic mechanism, involving the transfer of a hydrogen atom within the molecule, is a general one. Thus the changes



and



both occur readily in this way.

The decomposition of ethyl ether is quite different from the normal homogeneous decomposition (conditioned by the collision of two ether molecules).

It is to be noted that the hydrogen atom, the transfer of which is catalysed, is in each case attached to the carbon atom adjacent to the oxygen.

Kinetic studies of these and similar reactions are being published shortly.

It is interesting to note that this phenomenon, where the hydrogen atom is loosened and transferred under the influence of an electronegative atom, is in a sense complementary to the fundamental process of acid and basic catalysis in solution, which according to Brönsted always involves the giving or accepting of a proton by the catalyst.

K. CLUSIUS.
C. N. HINSHELWOOD.

Physical Chemistry Laboratory,
Balliol College and Trinity College,
Oxford, Jan. 29.

Do Glass Tubes or Rods Bend under their own Weight?

ABOUT seven years ago, in discussion with some scientific friends, I heard the opinion expressed that glass tubes if stored upright tend to bend permanently under their own weight. The same idea is to be found in print. Thus, in Ostwald's "Physico-Chemical Measurements" (English Translation, 1894, p. 66), we read that glass tubing "must be kept lying flat, otherwise it will become permanently curved".

It seems difficult to reconcile this with the known fact that the annealing temperature of soft glass is somewhere about 500° C.; but it was thought worth while to test the point directly. A glass rod 4·9 mm. in diameter was laid across two nails about 1 metre apart on a brick wall, and loaded at the middle with 300 grams, which was judged to be near the limit of what it would safely bear. (In fact, after the experiment was concluded, it broke under test at 1060 grams.) The height of the mid-point was read on a mirror glass scale; the initial loading produced a depression of 2·8 cm. After that, for seven years there was no further movement large enough to be considered significant. Slight changes of reading were observed from time to time, but they were not systematic, and probably due to internal movements in the wall. The final reading was 1 millimetre lower than the initial one. If we have regard to the last four years alone, the net change of reading has been too small to measure.

The stress applied in this experiment is very great compared with any that can be caused by the weight of the rod itself. It is therefore quite certain that glass of mature age does not bend in the way suspected. It is perhaps just possible that newly drawn glass may do so.

RAYLEIGH.

Terling Place, Chelmsford,
Feb. 18.

"Encyclopædia Britannica."

THE version of the article "Tides" in the 14th edition of the "Encyclopædia Britannica", to which Prof. Proudman refers in his letter published in NATURE of Feb. 15, has appeared only in five per cent of the sets we expect to distribute. That it appeared at all was due solely to an accident at the printers, which we much regret.

The publishers have spared neither trouble nor expense to satisfy their distinguished contributor over this article; many thousands of sheets containing the first version have been destroyed, and new pages containing the revised article printed to replace them.

Moreover, in fairness to our subscribers, we think it should be added that Prof. Proudman has conceded to two of our representatives that there is no error or misstatement of fact in the first version of the article, and has founded his objection to it on the ground that space was not given for a fuller elaboration of his views.

The Encyclopædia Britannica Co., Ltd.,
W. H. FRANKS
(Manager).

Imperial House,
80-86 Regent Street,
London, W.1, Feb. 17.

The Classification of the Primates.

IN his letter on "The Classification of the Primates" in NATURE of Jan. 25, Dr. Tate Regan twice refers to "the Mascarene Lemurs". The term "Mascarene" is usually restricted to the Islands of Bourbon, Mauritius, and Rodrigues, of which the first two were discovered by Mascarenhas at the beginning of the sixteenth century. Is there any authority for extending it, as Dr. Tate Regan does, to Madagascar?

The direct evolution of the Platyrrhines from a Lemuroid ancestor, independently of the Catarrhines, was suggested by W. D. Matthew (*Am. N.Y. Acad. Sci.*, 24, pp. 215-16), but he offered no valid evidence.

HENRY BURY.

The Gate House,
Bournemouth West, Feb. 1.

British Industries Fair.

THE British Industries Fair, 1930, which was held in two sections, one in London and the other in Birmingham, on Feb. 17-28, has, from all accounts, been the most successful Fair of the series organised by the Department of Overseas Trade and held annually since 1915. In particular, it has had a greater success than ever before in fulfilling its primary object of attracting important overseas buyers and bringing them into touch with the British producer. It is a commonplace of talk in high industrial circles that Great Britain is far behind many other countries—especially those with which it is brought into keenest competition—in the art of salesmanship. The steady growth of this Fair is encouraging evidence that we are learning and mastering at least one of our lessons in this vital business art.

This year the London section of the Fair was held at Olympia instead of, as formerly, at the White City, and the change has been a great gain to the appearance, compactness, and efficiency of the Fair as a business exhibition designed to do business. Moreover, no visitor making a circuit of the exhibits could fail to be impressed with the variety and, in many cases—perhaps, in general—with the high quality of the goods that are being manufactured in Great Britain in these days; notwithstanding the impression created by the unemployment figures and by those journalistic jeremiads, justifiable and unjustifiable, as to the condition of British industry, that disturb the equanimity of many a British citizen's breakfast table. Indeed, the psychological impression produced on the visitor by an observant tour of the exhibits is not the least of the valuable results achieved. The Britisher, in particular, may well exclaim: If we are doing so much so well, may we not do more even better?

The process of what is generally termed rationalisation in industry aims comprehensively at doing better this more. As was pointed out in a recent article in NATURE, rationalisation implies essentially the application of scientific knowledge, methods, and research to all the factors of industry—materials and processes, the human elements, salesmanship, and the financial and administrative organisation. Just as Goethe's dying cry was for "more light", so the living cry of British industry to-day must be for "more science". If that be so, the condition of those British industries which are predominantly and essentially scientific is of vital importance to Great Britain. The great chemical industry, in regard to both heavy and fine chemicals, obviously enters so largely into nearly all other industries that there is no need to stress its importance. But neither the application of scientific research to the problems of industry, nor continuous scientific control, regulation, and testing of the processes and products, is possible without the aid of scientific instruments of all sorts. The impression made, therefore, at the British Industries Fair by these two broad categories of scientific industries—chemicals and scientific instruments—is one that must be taken into account in any assessment of the Fair as an indicator of the scope and character of British industry. In any case, the exhibits of these products are those in which readers of NATURE are most likely to be generally interested.

The first point to be noticed is that in these two industries—or groups of industries—great advantage was gained by having the exhibits organised wholly or largely under the auspices of the organisations representative of the respective industries. The arrangements for the Chemical Section were made under the auspices of the Association of British Chemical Manufacturers, and the exhibits in this section constituted one of the most imposing and convincing testimonies that the Fair provided of the wide range and excellence of British products. It is impossible in the space at our disposal to attempt a review of the chemical exhibits, but a few of special scientific interest may be mentioned. The British Drug Houses, Ltd., showed specimens of the following new products among their medical specialities: acetylcholine, iodised tincture of guaiacol, and the vitamin products, radiostol, radiostoleum, and radio-malt. Hopkin and Williams (Travancore), Ltd., showed a collection of rare-earth minerals, including monazite sand from Travancore, which is claimed to be the richest in thorium oxide of any sand produced in quantity in the whole world. The exhibits of Thorium, Ltd., included mesothorium (a by-product of the thorium industry and found in monazite sand), which is largely employed medicinally and in the manufacture of self-luminous compounds in place of radium. The very impressive stand of the Imperial Chemical Industries, Ltd., included a small cinema where films were shown exhibiting the manufacture of explosives and of other products of constituent firms of that organisation.

The exhibits of scientific and optical instruments gained enormously this year by being organised, for the most part, under the auspices of the British Optical Instrument Manufacturers' Association. The large stand on which the exhibits of the constituent members of this Association were shown was one of the most striking features of the exhibition. Other stalls of scientific and optical firms not within the membership of the Association were grouped near to this exhibit. The total impression produced by the exhibits of scientific and optical instruments, as well as of optical glass, was most encouraging to the visitor desirous of being reassured that the products of these British industries need not fear comparison with the most renowned foreign products of like categories. The developments in the highest types of binoculars were, in particular, striking. On the stand of Messrs. Ross, Ltd., for example, there was a stereo prism binocular of extra wide field and magnification of 7 diameters, specially designed for use at dusk and for observation at night. The light transmitting

power of this instrument is remarkable, the central illumination being, it is claimed, fully 20 per cent and the illumination at margins of field 137 per cent greater than that obtained with other binoculars of the same power and aperture. Messrs. Barr and Stroud, Ltd., have introduced a novel element in the design of their binoculars by the use of bakelite for the usual enamelled metal parts, which has enabled the weight to be reduced. We have not space to mention more of the many other excellent and novel exhibits of this section, but one general observation should be emphasised.

We have already said that the scientific and optical instrument exhibits gained greatly this year by being, in great part, organised on a fairly representative single stand. But while this method of exhibition has its great and obvious advantages, it can yield its greatest benefits only if it receives the whole-hearted co-operation of all, or nearly all, the firms in these important industries. We talk of mass action in chemical reactions; there is such a thing as mass mental effect, both as to quantity and quality, in exhibitions; and it is of great importance to realise that a visitor to the British Industries Fair, and more particularly, perhaps, a foreign visitor, cannot help getting from the exhibits of scientific and optical instruments a general net impression of what these British industries as a whole are like. For this reason it is important that, at least, all the leading firms in the industry should realise the opportunities the Fair offers for creating an impression of the scope and quality of British scientific and optical instruments, quite apart from any direct benefits that may accrue to individual firms.

The Function of Phosphate in Alcoholic Fermentation.[1]

By Prof. ARTHUR HARDEN, F.R.S.

NATURE AND FUNCTION OF THE PHOSPHORIC ESTERS PRODUCED.

IF we next consider the exact nature of these phosphoric esters and the relation of their formation and hydrolysis to the decomposition of the sugar molecule, we are met with a singularly complex condition of affairs, which cannot yet be interpreted satisfactorily. The main facts seem to be as follows.

When fermentation of sugar by yeast preparations is carried out under suitable conditions in the presence of added inorganic phosphate, a rapid production of carbon dioxide and alcohol occurs and a phosphoric ester of a sugar accumulates, the amount of phosphate found in this form being approximately proportional in the ratio (CO_2/PO_4) to the increased production of carbon dioxide and alcohol caused by the addition of the phosphate (Kluyver and Struyk, it is true, have found lower ratios than this, but there is no doubt that high ratios, 0·8-1, are often observed).

The phosphoric ester produced, however, may consist mainly of the hexosediphosphate originally described by Young and myself or of the hexosemonophosphate described by Robison and myself and afterwards studied by Robison, or it may be a mixture of these in any proportions. In the case of fermentation by dried yeast (and possibly of other preparations), a further complication is afforded by the fact that a disaccharide-phosphoric ester (trehalosemonophosphate) may also be present.

This conclusion is founded in the first place on a large amount of experience which has been gained at the Lister Institute in preparing hexose-mono- and di-phosphate. These preparations are as a rule carried out by making repeated additions of phosphate and sugar to a fermenting mixture of yeast juice or dried yeast and fructose (or glucose). With dried yeast a large proportion of the diphosphate is usually obtained, and the relatively small amount of monophosphate produced contains a considerable proportion of trehalosemonophosphate. With yeast juice the results are very variable and no trehalosemonophosphate has so far been detected among the products. More precise experiments have been made by Lord Henley and myself in which the gas evolved after a single addition of phosphate was carefully measured and the proportions in which mono- and di-phosphates were produced were determined as accurately as possible. Unfortunately, the available methods are not very good as they rest on the solubilities of the different compounds in 10 per cent alcohol, and these are to some extent mutually affected in the presence of both compounds. Further, yeast, like Africa, is always yielding something new, and the recently discovered fact that pyrophosphates exist in yeast and by their formation from, or hydrolysis to, orthophosphates may cause disappearance or appearance of 'inorganic phosphate', adds another source of inaccuracy to the many previously known.

Allowance has, of course, to be made for the phosphorus compounds existing in the mixture at the moment of addition of inorganic phosphate and for the normal evolution of carbon dioxide which occurs throughout the experimental period in addition to the enhanced evolution due to the esterification.

In spite of these minor uncertainties, the somewhat surprising fact emerges, that whatever the nature of the phosphoric ester which accumulates, the carbon dioxide produced is approximately equivalent in the ratio $CO_2 : PO_4$ to the amount of phosphate which undergoes esterification. The full results are given in two papers published recently by Lord Henley and myself in the *Biochemical Journal*, and need not be quoted here in detail. These experiments indicate the wide variation which may occur in the nature of the hexosephosphate produced, whilst the ratio $CO_2 : PO_4$-esterified remains

[1] Continued from p. 279.

constant and approximately equal to unity. Two extreme cases may be quoted, in one of which 13·5 per cent of the phosphate (PO_4) esterified was present as hexosediphosphate and 86·5 per cent as monophosphate and, in the other, 97 per cent as diphosphate and only 3 per cent as monophosphate; the CO_2/PO_4-esterified ratios were 0·98 and 0·86 respectively.

I do not propose to discuss in any great detail the various theories which have been proposed to explain these complicated relationships. It would be natural to assume that the introduction of the phosphoric acid group into the sugar molecule forming a hexosemonophosphate might render this more accessible to decomposition into the compound (or compounds) containing three carbon atoms which are now accepted as an intermediate stage in the production of carbon dioxide and alcohol. The phosphate radical from one of these groups might then serve to convert another molecule of the monophosphate into the stable diphosphate (Meyerhof)

$$2C_6H_{11}O_5PO_4H_2 = C_6H_{10}O_4(PO_4H_2)_2 + 2CO_2 + 2C_2H_6O,$$

or two of the three-carbon groups containing each one phosphate group might unite with each other forming the stable diphosphate (Kluyver and Struyk)

$$2C_6H_{11}O_5(PO_4H_2) = 2C_3H_6O_3 + 2C_3H_5O_2(PO_4H_2) = 2CO_2 + 2C_2H_6O + C_6H_{10}O_4(PO_4H_2)_2.$$

Any monophosphate escaping these reactions would be found as a constituent of the mixed hexosephosphates resulting from the fermentation.

To add further to the difficulty of unravelling this complex tangle, it must be remembered that, whether glucose or fructose be fermented, the hexosediphosphate produced is probably a derivative of fructose, or at least yields fructose on hydrolysis, whilst the monophosphate is with equal probability a mixture of about 80 per cent of a glucosemonophosphate and 20 per cent of a fructosemonophosphate. It is obvious from this that whatever changes occur are not limited to the simple introduction or removal of a phosphoric acid group; fundamental changes occur in the constitution of the molecule of the sugar itself.

Attractive as is the theory of the intermediate character of any one of the hexosephosphates, it seems to me impossible at the moment to bring it into agreement with some of the facts which have just been related. The production of 70-80 per cent of the monophosphate, with an unaltered degree of formation of alcohol and carbon dioxide, renders it impossible that this ester should be "obviously nothing but a part of the intermediate product which has escaped the coupled decomposition—esterification reaction" (Meyerhof and Lohmann, *Biochem. Z.*, **185**, 155; 1927).

It appears to me that the fundamental idea expressed in the original equation of Harden and Young is nearer the truth than any alternative that has as yet been suggested. A coupled reaction of some kind occurs, as the result of which the introduction of two phosphate groups into certain sugar molecules—either into the same molecule or one each into two different ones—induces the decomposition of another molecule. The introduction of these phosphate groups in the presence of muscle extract, and presumably in both muscle itself and yeast, is actually accompanied by a small evolution of heat (Meyerhof and Suranyi, *Biochem. Z.*, **191**, 106; 1927), and it is possible that this may have some significance for the occurrence of the coupled reaction. What are the conditions for the preferential formation of the mono- or di-ester we do not yet certainly know, although the work of Kluyver and Struyk suggests that dilution of the enzyme may be one factor in this.

The mechanism of the fermentation of the monoester has not yet been worked out in sufficient detail to afford valid evidence either for or against the theory, but Dr. Robison and I have made experiments (about to be published) which show that the monophosphate itself reacts with a further quantity of phosphate and that this reaction is accompanied by an enhanced production of carbon dioxide and alcohol.

The lack of exact chemical equivalence among the products (ester on one hand, carbon dioxide and alcohol on the other) is probably more easily explicable on this view than on any other.

Sugar Metabolism in Vegetable and Animal Organisms.

After the establishment of the important part played by phosphates and phosphoric esters in alcoholic fermentation, it was soon found by various workers that these compounds provided the clue to many other biological phenomena. The cozymase of alcoholic fermentation was found by Meyerhof to exert an equally important part in the respiration of yeast, and the important observation was made also by Meyerhof, that it occurred in muscle and was an essential factor in the carbohydrate metabolism of muscle, in which the intervention of a hexosephosphate had been proved by Embden. This phenomenon was shown to take place on lines quite similar to those of the respiration and fermentation of yeast, and in 1924, before the riddle of lactic acid formation had been completely solved, Meyerhof wrote ("Chemical Dynamics of Life Phenomena"): "It may indeed be considered a success of general physiology and its mode of experimenting, that the chemical dynamics of a highly-differentiated organ like the muscle could be partly revealed by the study of alcoholic fermentation of yeast".

A still greater success was to follow. An astonishing degree of similarity was shown to exist between almost every detail of the production of lactic acid by the muscle enzymes and of alcohol by the yeast enzymes, which extended to the identity of the phosphoric esters concerned, the accumulation of ester under similar conditions and even to the effect of arsenate on the process. After the publication of Meyerhof's preliminary papers in which these observations were recorded, I wrote

(*Continued on p.* 323.)

Supplement to NATURE

No. 3148 MARCH 1, 1930

Cellulose in the Light of the X-Rays.[1]

By Sir WILLIAM BRAGG, K.B.E., F.R.S.

ONE of the most fascinating features that emerge during the closer study of natural constructions is surely the extended use of certain atoms, certain molecules, and certain ways of combining molecules; while other atoms, molcules, and combinations are but seldom employed. Thus, for example, half the world of which we have knowledge is made of oxygen: silicon is used to the extent of 27 per cent, aluminum 8 per cent, iron and a few others make up most of the remainder, and some eighty or more of the 92 kinds of atoms cannot muster 2 per cent between them. The seas that cover the larger part of the earth's surface give to the water molecule H_2O easy precedence over all others. In the rocks, the oxygen atoms govern the structure: the recent work on the silicates by W. L. Bragg and his collaborators shows us that we may regard the great bulk of the earth's crust as a piling together of bulky oxygen atoms cemented by atoms of other kinds such as silicon, aluminium, iron, or magnesium. Sometimes the piling is of the simplest character, and seems to depend for the most part on considerations of space to be occupied. Sometimes, as in quartz, more complicated structures are framed in order to satisfy the directional qualities of the mutual attractions of silicon and oxygen.

If we take special note of the elements of living structure, the extraordinary predominance of the carbon atom at once attracts attention. Though the mass of the carbon in the world is only about a fortieth of one per cent of the whole, its importance to life is extreme. Two forms of molecular constitution are outstanding: the long chain of carbon atoms which is the basis of so many substances, fats, oils, paraffins, and so on, and the benzene ring in which six carbon atoms are tied together strongly into hexagonal form. A very large proportion of organic chemistry deals with the properties of these two forms of molecules and of their derivatives; they are of the greatest importance in regard both to biochemistry and to the chemistry of industry.

[1] Discourse delivered at the Royal Institution on Friday, Jan. 24.

CELLULOSE AND FIBRES.

Cellulose is the fundamental molecular combination occurring in vegetable growth. One has but to remember that forests and shrubs and grasses and plants of all kinds are mainly composed of cellulose to realise the strangeness of such a particular selection. What is there in the cellulose molecule or combination of molecules that its responsibility should be so great? It is pre-eminently the molecule of growth in the vegetable world. It is found in the animal world also. It must be a molecule by the aid of which purpose and direction can be worked out. A mass of cellulose as it occurs in a plant cannot be of equal properties in all directions, for growth has to take place along definite lines. With one or two stray exceptions, such as asbestos, the bulk of inorganic substances do not display that curious feature which we describe in a word as 'fibre'.

Cellulose is a fibrous material, and its molecule or its molecular combination must somehow give it this fundamental character. The fibrous character of the stem and leaves of plants is their most obvious characteristic: the marked quality of direction is at the basis of their manner of growth and their constructional possibilities. These qualities, moreover, we use for our own purposes. We spin the natural fibres of cotton and hemp, ramie, jute, and the like, forming threads and ropes which have the special quality of standing strain in one direction. We weave cotton goods; and we use the comminuted cellulose to make paper. In these cases the fibres are distributed in one plane in more than one direction and so form sheets that stand two-dimensional strain. Of late years the cellulose, specially treated in various ways, is drawn out into threads of artificial silk, or rayon. This fibrous quality is therefore essential not only to Nature's employment of cellulose, but also to the use that we make of it. We should like to know exactly what cellulose is, and what there is in the curious structure that justifies this extensive use.

Chemistry of Cellulose.

The main attack upon the question has been made by the chemists, who have found it a simple matter to analyse cellulose into its constituent atoms: it may be described as a multiple of $C_6H_{10}O_5$. But of course this description is quite insufficient to explain its properties: there are, in fact, several other substances of the same composition, such as starch, glycogen, dextrin. The distinctive properties of cellulose must depend on

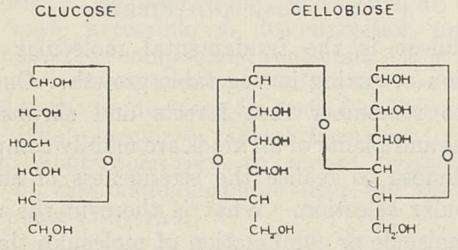


Fig. 1.

how these twenty-one atoms are arranged with respect to one another. We must therefore endeavour to discover the design. It would be quite out of place to attempt a description here of the chemist's attack upon the problem of position. We have already heard, at the Royal Institution, a general account of the atomic positions in the sugar molecule from Sir James Irvine, who has himself been a pioneer in this field. Cellulose is closely allied to the sugars; indeed their basic features are the same. A brief description of some of the chemical results will be quite sufficient for our purpose.

It is certain that the six carbon atoms are connected in a chain. But the chain is not to be thought of as drawn out in a straight line. The chemist writes a formula of a straight line character, when he wishes merely to show which atom is attached to which, but his meaning goes no further. Fig. 1 shows the usual method of writing the formula for glucose, of which the $C_6H_{10}O_5$ group is the anhydrous form.

Each carbon atom is attached to four other atoms: the positions of the hydrogens and the OH groups, right or left of the carbons, have a meaning in that if any pair is inverted the character of the substance changes. The most curious feature of the diagram is the connexion of the first and the fifth carbon atoms through an oxygen. Possibly the diagram is wrong in that it should be the fourth that is joined to the first. The latter view was favoured for many years, but later researches, especially by Haworth, make the 1 : 5 junction the more probable, and we will adopt it provisionally.

Clearly, when we come to think of this set of atoms as a group in space, we must make arrangements for the oxygen at the side of the diagram to get into contact with the two atoms to which the formula attaches it. Getting into contact means that the centre to centre distance between two atoms is a quantity which under similar conditions may be considered to be fairly constant. It would be impossible to think of an oxygen touching the first and last of five carbons in a straight line. The chain must be bent round until contact is possible, and at once we have the idea of a six-atom ring, five carbons and one oxygen.

There is no doubt that this ring is the basic element of all living plants and of numbers of those substances which can be derived or made from plant materials. The fact stirs the imagination and the desire to investigate the remarkable structure by every means at our command. A similar urge comes from the many industrial enterprises that use cellulose, from the cotton workers of every kind, from the huge concerns that make artificial silk, from the paper makers, from those concerned with celluloid, explosives, certain varnishes, and a host of other things.

It has not been possible so far to go by chemical means much beyond the point already described.

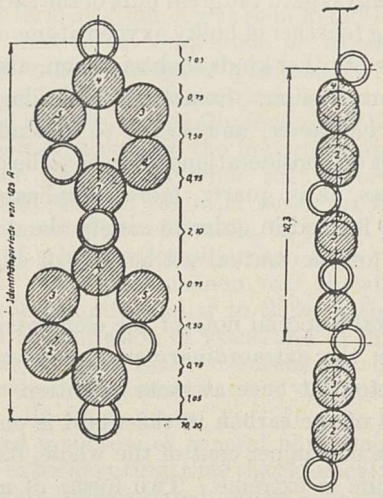


Fig. 2.—Model of cellobiose. Shaded circles represent carbon atoms; oxygen atoms are drawn as double rings to show the limits between which their diameters probably lie. This model, due to Mark, shows two glucose rings, stripped of atoms unessential for the purpose of showing the method of combination, and joined together by an oxygen to form the kernel of the cellobiose molecule. Two views of the model are shown. It should be compared with Fig. 1.

The indications become hazy, and the chemists are divided as to their meaning. The most important step is the statement of the formula of the substance called cellobiose which has been derived from cellulose. Cellulose, it will be remembered, is a multiple product of the element $C_6H_{10}O_5$; it is some compound made up of the rings just described,

generally known as glucose rings. Cellobiose contains two rings, and the chemical evidence is in favour of combination in the manner indicated, according to chemical conventions, by the right-hand formula of Fig. 1. The first carbon of one glucose ring is joined to the fourth carbon of a second ring. In the process, one oxygen and two hydrogens, the constituents of a water molecule, have disappeared from the combination. It is further held that by tacking on a third ring with a similar oxygen linkage, cellobiose may be extended to form cellotriose, which consists of three rings; and that, finally, by the continued addition of rings, up to an indefinite number, we have the essential structure of cellulose. The actual arrangement in space is probably as represented in Fig. 2, but this diagram contains some information which only X-rays could supply. We had therefore better leave the construction at this point and consider the X-ray evidence.

Evidence of X-ray Methods.

Let us remember that the new method of X-ray analysis derives its power from its capacity to detect any regularity of arrangement of atoms or molecules. To such dispositions it is very sensitive: it can record a perfect array of a few hundred molecules or so, or an imperfect array if the number is greater.

We have seen that there must be in cellulose some directed quality, if it is to play so important a part in growth as it appears to do. Of course, it may be said that direction is possibly attached as a property to some other constituent of the plant, the identity of which is yet unknown. But, on one hand, cellulose is common to all plants, and their most prominent content; on the other, it turns out, as will appear, that it is easy to understand how cellulose can have the quality that we look for. Now we cannot imagine how direction is to be obtained without regularity of arrangement. There must be a pattern, involving the constant repetition of some form of grouping, which we might expect to be related to the line of growth. We might then look at once for some such effect, when an X-ray is sent through a fibre of cotton or ramie or hemp, as we have become accustomed to find when X-rays act on a photographic plate after traversing a crystal. A crystal is merely a crowd of atoms in regular array.

When the experiment is made, the effect is found at once. Moreover, it is a kind that we recognise as indicative of fibrous nature. Let us look at this point a little more closely.

When a pencil of homogeneous X-rays passes through a crystal which is made to revolve about an axis, one set of crystal planes after another comes to its proper angle for reflection, and the reflected ray leaves the crystal in a direction inclined to the primary pencil at twice the reflecting angle. We must remember that all the lattice points in the crystal, that is to say, points representing all the units of pattern, can be looked on in an infinite number of ways as lying on sets of parallel, equidistant planes. The proper angle for reflection θ

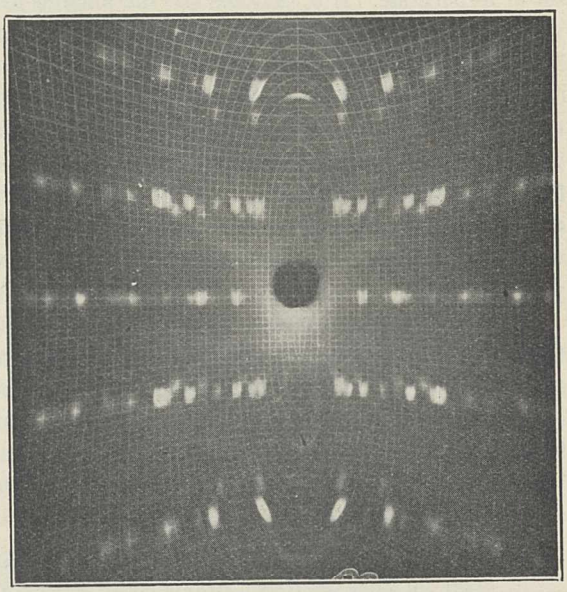


Fig. 3.—Asparagine. X-ray diagram, obtained by W. H. George using the 'rotation' method. The X-rays are monochromatic, and the crystal is rotated during the exposure. The network at the back of this diagram is placed there for convenience of interpretation.

is connected with the wave-length (λ) of the rays and the spacing (d) of the planes by the law $n\lambda = 2d \sin\theta$, n being any integer.

A photographic plate may be placed to receive the various reflected rays; and if both rotation axis and plate are perpendicular to the primary pencil, a symmetrical figure is formed on the plate. An example is given in Fig. 3. The crystal was in this case asparagine, which is a derivative of one of the constituents of wool. The weight of the crystal was of the order of a milligram.

From the positions of the spots and their intensities, the X-ray methods draw information respecting the crystal structure. This is clearly a matter of calculation, based partly on geometry and partly on physical theories as to the reflection process. We do not stop to consider the details. The work of interpretation is by no means easy at all points: but some results can be obtained at once and accurately, others are more difficult and less certain.

The clear separation of the spots on the asparagine photograph and their arrangement on a few well-marked lines show that the axis of rotation has coincided with an important direction in the crystal; that is to say, a line which passes through many lattice points to the unit of length, and is the intersection of a number of important sets of planes. The lattice points lying on the axis are of necessity equally spaced along it; this must be so in a crystal. The magnitude of this spacing is readily obtained from the photograph. The spots obviously lie on a set of hyperbolæ. If v_n denotes the distance of the vertex of the nth hyperbola from the horizontal line, which is called the equator, and if D is the distance from the crystal to the photographic plate, the spacing in question is equal to $(\lambda \operatorname{cosec} \theta)/n$ where $\tan \theta = v_n/D$. The proof of this rule is to be found in books on the subject. Unless the spots are very hazy, this determination can be made with, at the very least, an accuracy of one or two per cent.

Obviously, if a crystal were made to revolve about three different axes (not coplanar), we should in a similar way find the periodicities in three corresponding directions in space and so determine the form of the crystal lattice.

X-ray Diagram of Cellulose.

Now if we take some cellulose fibre, such as ramie, and place it so that a fine pencil of homogeneous rays passes through it, afterwards falling on a photographic plate as in the experiment just described, we find that a spot design appears on the plate of a character exactly the same as that of the asparagine photograph. It is clear, therefore, that the fibre is in some respects crystalline. There is, however, one significant peculiarity in the manner of obtaining the ramie photograph. It is not necessary to rotate the substance as in the case of the asparagine. The explanation is that the ramie contains not one crystal but many crystals which have in common one important direction; it must be important because the photograph has clear lines. Otherwise the crystals may have any disposition about this line as axis, so that the diagram is like that which a single crystal gives when it is made to rotate.

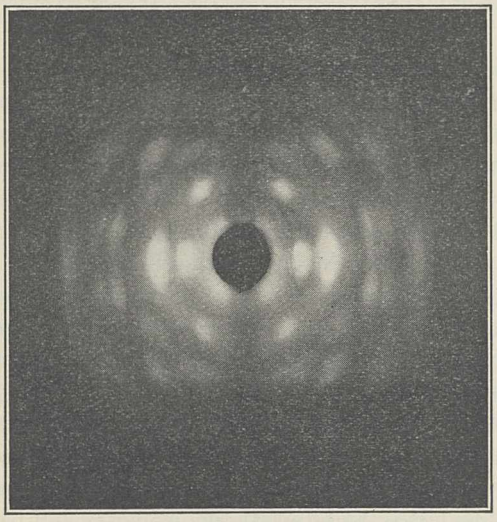


Fig. 4.—X-ray photograph of ramie fibre.

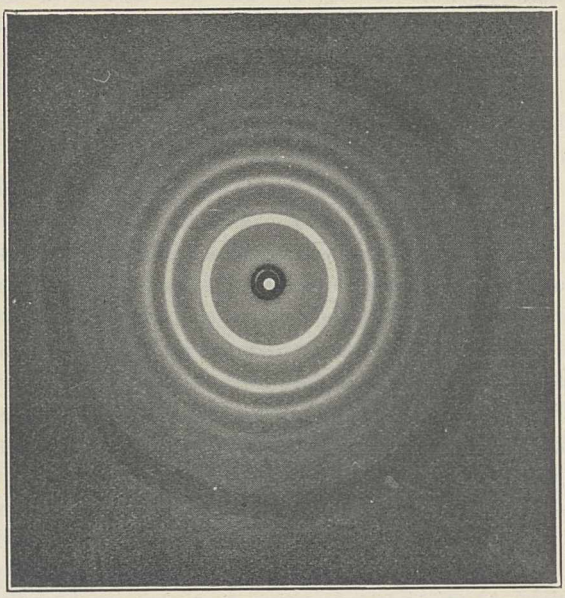


Fig. 5.—Cystine. This kind of diagram, due to W. T. Astbury, is typical of a substance consisting of a multitude of very small crystals, not arranged with respect to each other.

It will be observed that the ramie photograph (Fig. 4) is not so clear as the other. That is mainly due to the incompleteness of the array of the crystals with respect to each other.

Suppose that the disarray were complete, as it would be if the fibrous material were so pounded or otherwise treated that the crystals pointed all ways. There could then be no particular directions on the photograph; no vertical or horizontal lines of symmetry. There could only be a set of rings, as if the fibre photograph were spun rapidly in its own plane about its centre. An example of such a photograph is given in Fig. 5; the material is cystine, one of the constituents of wool. It is due to W. T. Astbury of the Textile Research Department at the University of Leeds.

When the spots in the photograph are sharp, we conclude that the crystals are well oriented in respect to one direction, the fibre direction. When there is no orientation at all, the result is as in

Fig. 5. Every stage between is possible; with a small departure from orientation, the spots merely begin to spread along the circles on which they lie.

Some of the blurring is due, however, to the smallness of the crystals. The X-ray action is of the nature of a diffraction, and it is well known that sharp images denote the combined action of many regularly arranged objects and vice versa. It is even possible to estimate roughly the number of the diffracting centres in the crystal from the spreading of the spot. This has been done by H. Mark, whose work on the whole subject is of first importance.

If now we measure the distances of the vertices of the hyperbolæ from the equator in this ramie photograph, we can, as already explained, find the length of the periodicity along the rotation axis. It comes out to be 10·3 A. (1 A. $= 10^{-8}$ cm.).

Summing up, we now know that:

(1) Cellulose contains crystals which may be invisible in the microscope but are clearly indicated by the X-rays: they are usually termed crystallites.

(2) These crystallites are partly oriented, having one direction in common, more or less.

(3) In each crystallite there is a periodicity in this special direction of 10·3 A. This is often called the 'identity period'.

It may not be safe to say that the whole of the cellulose is composed of crystallites, but there is a strong temptation to assume that this is so. Cellulose is a multiple, as regards content, of the unit $C_6H_{10}O_5$, as we have seen reason to suppose that this unit forms a ring which is the basis of the structure. The X-rays do not suggest the presence of a second structure, having any real difference from the first: and we suppose, therefore, that the ring structure pervades the mass. When the X-ray methods become more reliable in the matter of measuring the intensities of the reflection due to a given weight of the substance, in comparison with other substances of similar and known structure, we shall be able no doubt to answer this question conclusively.

Comparison of the Chemical and X-ray Analyses.

We now return to the results of the chemical examination of cellulose and ask how our new results harmonise therewith. As regards the first two deductions stated above, there can of course be no contradiction: we have simply obtained some additional information on the matter of structure. But the third deduction is of rather a different nature. If chemistry has suggested a special arrangement of the atoms, it must show a reason for the periodicity that has been discovered. Now the X-rays have shown us that atoms of carbon and oxygen, when built into the regular structure of crystals, can be said to have dimensions. They do not behave so simply as to warrant our thinking of them as hard spheres. But when the state of combination of two atoms is known, the distance apart of their centres can be stated within limits so close as to give a determining value to estimates of structure.

We know that two carbon atoms bound together in that strong fashion, which is sometimes described as due to the exercise of principle valencies, and is found in diamond, graphite, benzene, hydrocarbons, and the like, are at a distance of very nearly 1·5 A. from one another, centre to centre. We are not quite so sure of the value of the similar distance in the case of oxygen and carbon. But from parallel cases in calcite and elsewhere we can safely assume that it is about 1·2 A. In Fig. 2, due to Mark, an attempt is made to apply these known distances to the determination of the dimensions of the cellobiose double ring. There is naturally some uncertainty about it because the form of the ring is not yet known accurately. Moreover, the way in which the oxygen bridge is fitted in, while by no means devised *ad hoc*, can only be assumed from analogy with somewhat similar cases in other crystals.

The length of the double ring comes out at 10·3 A, agreeing with the X-ray results. Notwithstanding all its possibilites of error, such a coincidence is most striking. It certainly supports excellently the idea that cellulose is essentially a long chain compound in which the glucose rings form the successive links, being attached to one another by oxygen bridges as shown in Fig. 2. According to Haworth ("Sugars", p. 84) the unit that is constantly repeated is formed of two rings or links, not of one, which means that the links differ from one another alternately. A difference of this kind is shown in Mark's figure: the oxygen bridges lie, it will be observed, alternately on one side and on the other of the principal plane of the molecule. There is an imperfect repetition of the pattern at each link, and a perfect repetition at each second link. It is known that such a condition should manifest itself in the X-ray diagram by the weakness of the spots in the first, third, and odd numbered hyperbolæ as compared with the strength of the spots in the even numbered. The effect may wear off in the hyperbolæ of high number. The weakness of the first cellulose

hyperbola as compared with the second is very obvious.

Thus the X-ray evidence is certainly, so far, in favour of the conception of cellulose as formed of chains of glucose rings. Throughout the whole length of the chain the bonds are of the strong type such as are found in diamond. The conception has been put forward before (Herzog, *Zeit. ang. Chem.*, **34**, 385; 1921. Polanyi, *Naturwiss.*, 288, 1921), though by no means accepted. It is described, for example, in Haworth's "Sugars". The American botanist Sponsler, who has also used X-ray methods, has maintained it ("Colloid Symposium Monograph", 1926). In particular, H. Mark has argued strongly in favour of it, and has supported his views by much experimental research. Nevertheless, there are cellulose chemists to whom the idea does not appeal: Trogus and Hess, for example, have argued against it quite recently.

If we try to estimate the value of such evidence as this, and of much more that will presently be considered, we must recognise that it is not fully decisive. On one hand, there are many factors which are not fully understood; on the other, the X-ray analysis is clearly far from its full development and does not yet handle its problems with the assurance of long experience. But even now the X-ray evidence has a distinct value: it may be expected to be worth much more in the future. In this particular case, it is satisfactory to prove a periodicity which a very interesting and promising theory of cellulose would lead us to expect.

The Unit of Pattern of Cellulose.

The diagram has obviously more to tell us than the value of the one periodicity we have been considering. The positions of the separate spots have information to give which goes far to determine the form and dimensions of the unit of pattern. Suppose the unit to be represented by the rhomboidal cell in Fig. 6. The implication of the 'cell' is that if we moved our point of view in the crystal from *O* to *A* or to *B* or to *C*, we should not be able to detect the change. Suppose that *OB* is the periodicity we have found, which we distinguish by writing 10·3 alongside. All the other dimensions of the cell have yet to be found.

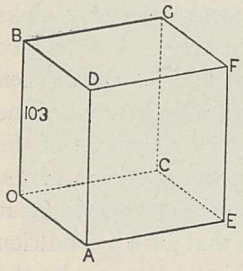


Fig. 6.

Every spot on the equator is made by a set of planes to which *OB* is parallel. For example, the set of planes of which the planes *OBDA* and *CGFE* are consecutive members, contribute one spot to the equator row, and the position of the spot on the diagram gives us the perpendicular distance between the two faces mentioned. So also for the pair *OBGC* and *ADFE*. We may pick out two spots on the equator and decide, as we can with certain limitations which need not be discussed here, that we will make the planes to which these spots belong the faces of the unit cell. But the diagram does not tell us directly what angle these faces make with each other. If we had a single crystal instead of a multitude we should have no difficulty, because we should make a variety of diagrams by revolving the crystal about at least two other directions, such as *OA* and *OC*. It is this lack of the single crystal that most contributes to the difficulty of our task.

Nevertheless, we are not without means which will guide us indirectly if less certainly to a conclusion. To begin with, the general appearance of the diagram considered in comparison with others of like origin suggests strongly that the crystal is nearly if not quite monoclinic. In other words, the direction of periodicity *OA* and *OC* are nearly if not quite perpendicular to *OB*. We may safely assume for the present that they are so. For brevity's sake I do not argue this out in full. If this is assumed, we have but one unknown left, namely, the angle between *OA* and *OC*. To find it we have the perpendiculars from *A* on *OC* and from *C* on *OA*. Also a definite assumption will carry with it the positions of all the other spots on the diagram, and though this is not so liberal in fresh information as it sounds, yet on the whole the determination of the angle is restricted to one or two very distinct possibilities.

Much argument has been spent on the final choice. It appears that all the details of the diagram are well satisfied if it is assumed that $OA = 8{\cdot}35$ A., $OC = 7{\cdot}9$ A., and the angle $COA = 84°$ nearly. We have already determined *OB* to be 10·3 (Mark and Meyer, *Zeit. Phys. Chem.*, **2**, 115; Andress, *Zeit. Phys. Chem.*, **2**, 380).

An approximate knowledge of the specific gravity of cellulose is enough to show that this cell contains four of the $(C_6H_{10}O_5)$ groups.

Our picture is now taking shape. We picture these long chains as arranged parallel to *OB* (Fig. 6). If the axis of one chain lies along *OB*, the axes of exactly similar chains lie along *AD*, *EF*, and *CG*. Such an arrangement places the matter of two glucose rings within the six walls of the cell,

thus accounting for two out of the four rings. Here calculations based on the relative intensities of various spots come to our aid, and in a manner which can be found in accounts of X-rays methods, tell us that there is a chain in the middle of the cell, passing approximately through the centres of the faces *OAEC* and *BDFG*. This accounts for the other two rings.

The Crystallites.

We must think, therefore, of the crystallite as composed of these long chains laid side by side like a bundle of sticks. This prompts us to consider next the manner in which the sticks are held together.

Now there is an obvious difference between the forces that bind together the links in each chain, and those that bind together the chains themselves. The former are relatively very strong, all of them being of the nature of those that are found in diamond. But the latter are due to the mutual action of carbon atoms the primary valencies of which are satisfied by attachments of hydrogens and of hydroxyl groups. They are more of the nature of the forces that bind molecule to molecule in organic crystals like naphthalene. When naphthalene melts or sublimes, its molecules are separated and these secondary valencies are snapped. But the work to be done is very small in comparison with that which is required to snap the primary valencies in the molecule itself. There are no hydroxyl groups in naphthalene, so that the secondary forces are not so large as those we may expect to find in our present case. But still there must be a very great difference between the forces within the chain and those from chain to chain.

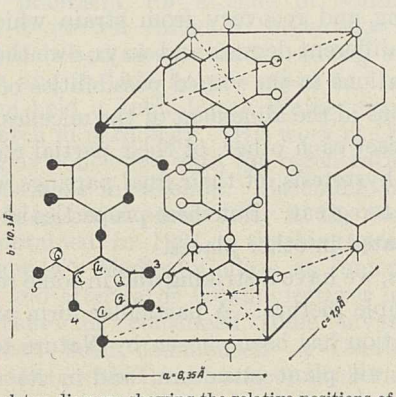


Fig. 7.—Skeleton diagram showing the relative positions of the chains. (From Mark and Meyer, *Zeit. phys. Chem.*, **2**, 122; 1929.)

We find internal evidence in the structure of our model which is entirely in sympathy with this view. While the centre to centre distance of carbon atoms bound by primary valencies is nearly 1·5 A., the distance of closest approach of carbon atoms belonging to different molecules is about 3·5 A. In graphite, for example, the layers are separated by a distance of 3·41 A. In naphthalene, the corresponding distance is about 3·5 A.; in the fatty acids it is the same. If we consider the cellulose model, we see that some such distance must be assumed here also. Otherwise, the chains would not come into contact with each other; they would not fill up the volume. For example,

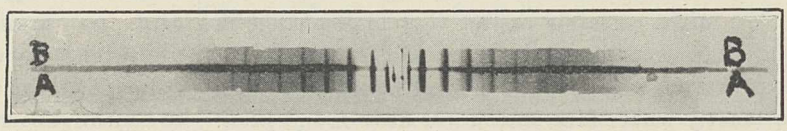


Fig. 8.—X-ray photographs of a paraffin, $C_{19}H_{40}$, at the ordinary temperature (*A*), and at the temperature of liquid air (*B*). (Dr. A. Müller.) The lines in the centre are due to the various orders of reflection by the long spacing, which is actually the length of the carbon chain. These are in the same positions in the two photographs. But certain lines farther out are due to the sideways spacings of the chains, and these are considerably shifted by the change in temperature.

the model shows the planes of the ring lying mainly in the *ab* and parallel planes, as in Fig. 7, due to Mark and Meyer (*Zeit. phys. Chem.*, **2**, 122; 1929). The reflection from this set of planes is by far the strongest on the diagram, which is indeed a very important guide to the construction of the model. The distance from plane to plane is 3·95 A., which fits in very well with hypothesis.

Temperature Effects.

A certain measure of confirmation comes from a different quarter. The coefficient of expansion of diamond with temperature is exceedingly small. In the case of graphite it is very small in the plane of the sheets, but many times greater at right angles thereto (Backhurst, *Proc. Roy. Soc.*, **102**, 340; 1922). In other words, the sheets do not stretch as the temperature rises, but draw apart from each other.

It is to be remembered that a comparison of X-ray diagrams at different temperatures shows the expansion coefficients in every direction in a crystal. This is possible even when the crystal is microscopically invisible, though the accuracy is not so great as when we have a single perfect crystal that can be handled.

The observations on diamond and graphite suggest strongly that the strong carbon bonds in diamond and graphite stretch or contract very little with changes of temperature, while in the case of the weak bond in graphite there is a very

appreciable alteration in the centre to centre distance.

The point is further illustrated by an effective experiment due to Dr. Müller. A comparison of the two photographs in Fig. 8 shows that temperature affects the length of a carbon chain far less than the distance that separates the chains from one another.

No doubt the changes in form which a crystal experiences when the temperature is varied are often complicated and are difficult to interpret. But in these simple cases it seems clear that we are observing a difference in the reaction of primary and secondary valencies.

We might certainly expect very little change in the dimensions along the cellulose chain when the temperature is lowered to that of liquid air. This is exactly what Mark and Meyer have found (*Zeit. phys. Chem.*, **2**, 127). But there is a considerable change in other directions.

Mercerisation.

The process known as mercerisation, so very interesting from the scientific point of view, and so important industrially, produces notable changes in the X-ray diagram. Yet so many of the original features remain that the new structure is obviously to be regarded as a modification of the old. Most important is the fact that there is no change in the dimensions of the separate links of the chain. Andress (*Zeit. phys. Chem.* **4**, 190) has shown that the new diagram can be fully explained if the sideways relations of the chains with respect to each other are somewhat varied, in the manner depicted in Figs. 9 and 10. The new arrangement is regarded as that of the stable form of the crystal, the older as the metastable.

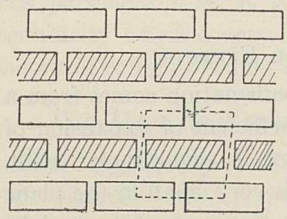


Fig. 9.—General disposition of the cellulose chains, looking along the *c* axis.

The permanence of the identity period along the chain, and therefore of the chain itself, survives not only a physical alteration such as mercerisation, but also various chemical changes. For example, there are forms of trimethylcellulose, of acetyl-cellulose, and of nitrocellulose, which are crystalline, are of the same general form as cellulose itself, and have the same periodicity of 10·3 in the fibre direction. In other directions there are great changes; clearly the introduction of new atomic groups between the chains must push them apart, though there may be no change in the chains lengthways. When by chemical means the stranger atoms have been taken away again, the original X-ray diagram of cellulose is restored; except that in some cases, depending on the nature of the treatment, the diagram of the recovered material is that of mercerised cellulose.

There are, however, other examples of cellulose derivatives which show a more radical change as the result of chemical action. Another form of nitrocellulose shows, according to Mark, an identity period of 25 A.; and 15 A. has been found in an acetylcellulose and a cuproamine cellulose.

So, in general, the chain seems to retain its nature even when subjected to wide changes of temperature and to many chemical processes. All this is in entire accord with the conception of the chain of glucose rings tied together through its whole length by strong bonds resembling those of diamond: a conception encouraged by the studies of the sugar chemists and now supported by the X-ray evidence. By sideways bonds the chains are tied together into bundles or micelles, and when the chains are long enough these sideways bonds, though individually far weaker than the others and more susceptible to physical and chemical action, will be strong enough to hold the bundle together as a definite element in the structure of the cellulose. The process of the stretching and recovery from strain which fibres show in different degrees and ways, owe their many complications to the varied possibilities of gradual alterations in the alinement of the micelles, of their sliding past each other, of their partial recoveries, of their hysteresis, of their final partings when the strain is too great. But these properties of fibre are fully treated in other places.

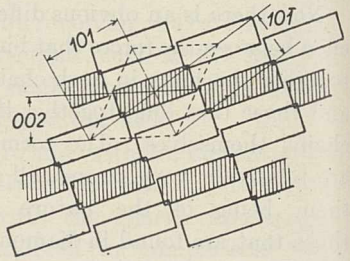


Fig. 10.—General disposition of the chains in mercerised cellulose, looking along the *c* axis.

In fine, we have a striking and in some respects a very simple picture. A particular form of atomic combination has been chosen by Nature to be the basis of all plant structure, and in its essential structure it already embodies the fibre principle. The X-ray analysis at least supports and gives some precision to views as to structure which have already been suggested. There are great possibilities of improvement in the X-ray methods; and it may well be that before long their pronouncements will be much more definite.

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the following passage in concluding a short review of the work (NATURE, Dec. 18, 1926): "The striking similarity established by Meyerhof between the changes of carbohydrates in muscle and in the yeast cell is seen to be much closer than has been believed. The remarkable phenomena accompanying alcoholic fermentation are now duplicated in the case of lactic acid production, and it may reasonably be expected that most of the fermentative decompositions of the sugars will be found to be initiated in a similar manner."

Direct proof is still wanting in many cases, but some instances are known among bacteria (Virtanen), moulds (Euler and Kullberg), and higher plants (Ivanoff, Bodnar). It is not too much to say that the fundamental biological mode of attack on carbohydrates is that revealed by the study of alcoholic fermentation.

OSSIFICATION.

Another biochemical function of the hexose-phosphates which is shared by other hydrolysable phosphoric esters is that of a potential source of phosphate ions. I am happy to say that one of the most beautiful and important developments of this idea has been worked out quite independently at the Lister Institute by Dr. Robison as a direct consequence of his work on the hexosemonophosphate of yeast juice. "During my investigation of the hexosemonophosphoric acid isolated from the products of fermentation", he said (*Biochem. J.*, **17**, 286; 1923), "the hydrolysis of the ester by enzymes was studied. In some experiments in which the readily soluble calcium and barium salts were used as substrates, the progress of the hydrolysis was shown by the formation of a precipitate of sparingly soluble calcium or barium phosphate $C_6H_{11}O_5PO_4Ca + H_2O \rightarrow C_6H_{12}O_6 + CaHPO_4$.

The formation of this precipitate suggested to me the query whether some such reaction might conceivably be concerned in the deposition of calcium phosphate during the formation of bone in the animal body. In the first place I sought for an enzyme capable of effecting hydrolysis in the bones of growing animals."

The search was successful, a 'bone phosphatase' was found in the ossifying cartilage of young animals and a series of interesting and important investigations has followed, as a result of which I have little doubt that their author is on the high-way to the biochemical explanation of the process of ossification—a good instance of the far-reaching and unexpected results flowing from observations made for quite a different purpose.

Obituary.

PROF. J. M. DUNCAN SCOTT.

DR. JAMES MATTHEWS DUNCAN SCOTT, professor of physiology in the University of Saskatchewan, died at Saskatoon on Jan. 28 last. Prof. Duncan Scott's career as a physiologist was a relatively short one. After taking an arts degree at St. Andrews, and qualifying in medicine with honours at Edinburgh, he joined the forces during the War and served in Egypt. At the conclusion of the War he suffered ill health for some years, owing to a troublesome frontal sinus infection which necessitated surgical intervention.

After practising for a time in South Africa, Duncan Scott felt called to undertake scientific work, which had always had a strong attraction for him, and in 1921 he proceeded to Cambridge, where he held a John Lucas Walker Studentship for research in pathology. His work at Cambridge was largely concerned with the regeneration of the red blood cells in anæmia. Becoming interested in physiology, and particularly in the teaching of it, he obtained in 1924 a teaching post at St. Bartholomew's Medical College as junior demonstrator, and afterwards became lecturer in physiology. There he continued some investigations which had been commenced at Cambridge in collaboration with Dr. Ffrangcon Roberts, on the situation and connexions of vagal and vasomotor centres in the medulla. This work he prosecuted with great assiduity and considerable skill, as a research scholar of the British Medical Association. As an outcome of his teaching work he also became interested in the physical chemistry of colloids, and held highly original, though not generally acceptable, views on that subject.

In 1926, Duncan Scott was invited to the University of Saskatchewan to occupy the newly created chair of physiology. This was an opportunity for the display of those fine qualities of orderliness and strict classification which had always characterised Duncan Scott. Before leaving England and proceeding to found and equip a physiological laboratory under conditions of relative isolation, he prepared a list, accurately classified down to the smallest detail, of every article which would be required in such a laboratory. He regarded his work there in a pioneering spirit, and as a field of high endeavour; he was, on the whole, well gratified with the results which came out of it so far as the organisation of the department was concerned. The duties of organisation and teaching naturally distracted him temporarily from his research work, though he never entirely lost touch with this, and when at the annual Physiological Congress at Boston in 1929, at which he gave two demonstrations, he expressed the opinion that the first labours of organisation had now been definitely completed, and would, he hoped, leave him free to continue his research work.

The passing of so courteous a colleague and of so keen a teacher and investigator will leave a gap among the physiologists of two continents. Dr. Duncan Scott leaves behind him a widow and three sons, to whom all his friends will extend their warmest sympathy.

MR. F. W. DOOTSON.

MR. FREDERICK WILLIAM DOOTSON, who died in Cambridge on Dec. 12, 1929, after a very short illness, was born in Manchester on Aug. 10, 1863.

His long connexion with the University Chemical Laboratory at Cambridge dates from 1891, when he entered the University as an undergraduate at Fitzwilliam Hall. After graduating in the Natural Sciences Tripos, he attached himself to Trinity Hall, and for many years was a successful private tutor. He was also engaged in the teaching work of the Chemical Department, first as demonstrator and in later years as a University lecturer.

In conjunction with the late W. J. Sell, Dootson published a paper on citrazinic acid, which was followed by a systematic series of investigations on the chlorine derivatives of pyridine. He also published papers on derivatives of acetone dicarboxylic esters, in one of which he demonstrated a very simple method for transforming an aliphatic into a benzenoid compound. His last paper, published jointly with Dr. S. Chapman, was entitled "A Note on Thermal Diffusion".

In later years, the gradual increase in his administrative duties drew Dootson away from research. During the period of the War, however, he was occupied with experimental preparative work on various substances of national importance. His success as a teacher continued to the end; indeed many generations of Cambridge students will remember with gratitude his kindly and unsparing help, and his friends among the teaching staff will mourn the loss of a congenial and gifted colleague. A. J. BERRY.

DR. DONALD H. A. HUTCHINSON.

DR. DONALD H. A. HUTCHINSON, a master of the art of photomicrography, died of cancer on Feb. 1, at the age of fifty-six years. An ardent naturalist all his life, he concerned himself latterly with the photography of living microscopic animals by means of both still and moving pictures. Many will remember the remarkable films of protozoan life which he exhibited at the Zoological Society of London in 1924 and at the British Association meeting at Oxford in 1926; but only his intimate friends will know of the amount of his work and of the patience and ingenuity with which it was achieved. It was work carried out in the spare moments of a busy general practice. He never sought publicity, but hoped eventually to produce an atlas of photographs of as many kinds of protozoa as possible. He was always trying to get better and still better results.

A few of Dr. Hutchinson's photographs have recently been published in "The Science of Life", but there remain a large number of magnificent studies which have been seen by only a few. The writer of this brief notice, who, during a few years at Lowestoft, spent many wonderful evenings in Dr. Hutchinson's laboratory, intends to publish a volume of his photographs and some of the more interesting sections of his films; he believes that they will be of great value to students of animal life, and in addition a source of inspiration to workers in the field of photomicrography.

A. C. H.

WE regret to announce the following deaths:

Dr. F. Arnall, head of the Department of Pure and Applied Chemistry at the Cardiff Technical College, whose interest was mainly in organic chemistry, on Feb. 7, aged thirty-four years.

Sir William Atkinson, I.S.O., formerly Divisional Inspector of Mines, Home Office, a past-president and honorary member of the North Staffordshire Institute of Mining Engineers, on Feb. 15, aged seventy-nine years.

Dr. G. G. Chisholm, formerly reader in geography in the University of Edinburgh and secretary of the Royal Scottish Geographical Society from 1910 until 1925, on Feb. 9, aged seventy-nine years.

Prof. Felix M. Exner, director of the Zentralanstalt für Meteorologie und Geodynamik and professor of terrestrial physics in the University of Vienna, who was an honorary member of the Royal Meteorological Society, on Feb. 7, aged fifty-three years.

Mr. A. A. Campbell Swinton, F.R.S., known for his pioneer work on X-rays and radio communication, on Feb. 19, aged sixty-six years.

News and Views.

THE problem of the structure of cellulose is one which has not only a fascination for the organic chemist but is also of the greatest importance in many industrial processes. The method of X-ray crystal analysis has been applied to supplement the older chemical methods, and the results of this work were set out by Sir William Bragg in a recent discourse at the Royal Institution which we are glad to be able to print as a supplement to this issue of NATURE. X-rays have gone far to confirm modern views of the structure of cellulose and have succeeded in shedding new light on some aspects of the problem. It has been shown, for example, that cellulose contains large numbers of small crystals which tend so to arrange themselves that they have one direction in common. The outward sign of this selective orientation is the fibrous nature of the material. In the direction of length of the fibre it is found that the atomic pattern repeats itself every 10·3 A. The other dimensions of the crystal cell are less certain, but the evidence is consistent with the values of 7·9 A. and 8·35 A. at 84° to each other and perpendicular to the fibre axis. Such a cell contains the substance of four $C_6H_{10}O_5$ groups. Along the fibre direction there are chains of glucose rings (five carbons and one oxygen) linked together by oxygen atoms, the pattern repeating itself identically after every two rings, the length of which is 10·3 A. One such chain starts from each corner and one from the centre of the base of the crystal cell.

THE structure of cellulose suggested by the X-ray examination throws light on its physical and chemical behaviour. The atoms forming the chains of glucose rings along the fibres are very tightly linked together, while the chains are joined sideways by much weaker bonds due to the hydroxyl groups attached to the ring atoms. The cellulose micelle resembles a bundle of sticks, each stick strong in itself but loosely at-

tached to its neighbours. The atomic arrangements and dimensions of the cell can be altered by physical and chemical means, but there is a strong tendency for the chains which lie along the axis of the fibre to remain unchanged. The length of 10·3 A. in this direction is affected by temperature much less than are the other dimensions. Such a process as mercerisation leaves the periodicity of 10·3 unaltered, and the change accompanying this process can be explained as due to a slewing round of the chains about the fibre axis. Many chemical derivatives such as nitrocellulose and acetyl cellulose show also this characteristic 10·3 A. dimension, and the additional atoms introduced by the chemical actions result in an increase in the distance between adjacent chains. It is interesting to note that when such atoms are removed, the structure reverts sometimes to that of the original cellulose and sometimes to that characteristic of the mercerised material.

THE Council of the Royal Society, at its meeting on Feb. 20, recommended for election into the Society the following fifteen candidates: Herbert Stanley Allen, professor of natural philosophy, University of St. Andrews; Edward Battersby Bailey, professor of geology in the University of Glasgow; Frederick T. Brooks, University lecturer in botany, Cambridge; Paul Adrien Maurice Dirac, University lecturer in mathematics, Cambridge; Harold Ward Dudley, chemist, National Institute for Medical Research, Hampstead; Charles Alfred Edwards, principal and professor of metallurgy, University College, Swansea; Harry Eltringham, entomologist, Hope Collections, University of Oxford; Charles Edward Inglis, professor of mechanism and applied mechanics, University of Cambridge; Harold Spencer Jones, H.M. Astronomer at the Cape of Good Hope; Eric Keightley Rideal, lecturer in physical chemistry, University of Cambridge; Robert Robison, assistant chemist, Department of Biochemistry, Lister Institute; John Stephenson, formerly lecturer in zoology, University of Edinburgh; George Paget Thomson, professor of natural philosophy, University of Aberdeen; Charles Todd, Department of Experimental Pathology, National Institute for Medical Research; William Whiteman Carlton Topley, professor of bacteriology and immunology, London School of Hygiene and Tropical Medicine.

ON Feb. 19 an interesting lecture was delivered to the Royal Aeronautical Society by Prof. Walter Georgii of Darmstadt and Mr. Fritz Stamer on "Ten Years' Gliding and Soaring in Germany", and on "The Flying School at Wasserkuppe". The post-War restrictions on the use of power units for aircraft in Germany turned the attention of the younger generation in 1920 towards gliding as a substitute. Since this form of flight depends on the use of slowly rising currents in the air, a practical glider is chiefly characterised by its small vertical component of velocity. This is effected by reducing the total resistance, and the wing loading. Thus a large span of good aspect ratio is adopted in order to give a small induced resistance. The body is closed and cantilever construction is used in order that there shall be no external bracing. Launching is done by the usual method with a rubber cable, and the starting carriage is dropped. In practice, in designing for low resistance, the structural weight is increased to a restricted degree and the result is to produce a medium heavy glider, with a margin of strength for high performance and for flying in gusty weather. The additional weight gives greater air speed required for progress against strong winds and for passing rapidly through unfavourable belts of down winds. For long distance soaring flight, a light compass and a Pitot tube are carried; but in research flights pressure gauges, inclinometers, and meteorographs are carried for recording air conditions.

THE first impetus to gliding in Germany was given by W. Klemperer in 1920, when he attained a glide of 2 minutes 22 seconds duration, traversing a distance of 1830 metres. Progress came rapidly. By 1922 gliding flights lasting more than one hour were attained. Hentzen actually reached an altitude of 350 metres, remaining aloft for 3 hours 10 minutes. Schultz, at Rossitten in 1924, recorded a flight lasting 8 hours 24 minutes; and in 1925, 14 hours 7 minutes. This record was beaten in 1929 by Dinort with 14 hours 43 minutes. It is characteristic of these flights that the best course between any two points is not necessarily the straightest, but may involve long detours in reaching up-wind areas and lengthy soaring over a particular region to gain sufficient height. The pilot, in fact, must fly on sound topographical and meteorological information.

THE Essex Field Club commemorated the fiftieth anniversary of its foundation by a gathering on Feb. 22, held in the Great Hall of the Municipal College, Stratford. Among those who were present at the function were Lieut.-Col. Sir David Prain (president-elect of the Club), Sir Arthur Smith Woodward, Sir William Lister, Sir Henry Miers, Sir R. Armstrong-Jones, Prof. J. W. Gregory, Prof. E. J. Salisbury, Prof. A. G. Green, Mr. Reginald Smith, Mr. J. Ramsbottom, and Mr. Arthur Cotton. The Mayor of West Ham and the president of the Club, Mr. D. J. Scourfield, jointly received the guests and in turn welcomed them to the function. Speeches were made by the Right Hon. Frances, Countess of Warwick, who made an eloquent appeal that the modern desecration of the countryside by petrol-pumps and the like should be stopped by legislation; by Brigadier-General Colvin, Lord Lieutenant of Essex, by Sir Henry Miers, by Sir Arthur Smith Woodward, and by Sir David Prain, each referring to those aspects of the Club's activities with which he was personally acquainted. During the evening a conversazione was held, when there were many interesting exhibits of natural history objects and prehistoric relics, and an extensive series of topographical photographs and prints of Essex localities. Lantern lectures were given by Mr. William Glegg on "Some Features of Essex Bird-Life", and by Mr. S. Hazzledine Warren on "The Land of Lyonesse in Essex", which were well attended. Music was provided by a trio of ladies. The Club's Museum, which adjoins the College, was closed to the general public on the occasion, and was inspected by the guests during the evening.

THE latest discoveries in the Antarctic reported in the *Times* are the result of the Norwegian expedition in the *Norvegia*. Working westward from their discoveries of land adjoining Enderby Land, the Norwegians discovered a shallow bank, named after the ship, in about lat. 67° S., long. 32° E. Bad weather and heavy ice made it impossible to find land which certainly must exist to the south. The *Norvegia* therefore stood south-west, and in lat. 71° S., long. 12° 29′ W., sighted a long chain of icebergs aground, and to the south of them shallow water extending to new land. The north-west point of this land is in lat. 71° 26′ S., long. 11° 31′ W. From an aeroplane Capt. Riiser Larsen and Capt. Luetzow Holm charted this land for a few miles and saw it extending to the south-west. Part of the coast appears to be free from ice and part is faced by an ice cliff. No peaks showed above the ice of the interior. This new land is clearly an extension of Coats Land, which Dr. W. S. Bruce discovered a little farther to the south-west in 1904. There is little doubt that it is continuous with Enderby Land in the east.

AT a meeting of the Royal Society of Edinburgh on Feb. 17, Prof. Carl Størmer, of Oslo, delivered an address entitled "Do the Wireless Echoes of Long Delay come from Space outside the Moon's Orbit?" Prof. Størmer mentioned first his mathematical researches on the aurora made in 1904, which gave among other things the result that streams of electrons sent out from the sun towards the earth could not penetrate into a certain definite region. This region has the form of a tore or anchor-ring which may be obtained by rotating an oval, which touches the earth's magnetic axis in its centre, round this axis. This will be familiar to the readers of NATURE from two letters published in November 1928 and January 1929. Prof. Størmer then gave an account of the observations of long-delayed wireless echoes made in Norway, England, and Scotland, and especially by a French expedition to observe the solar eclipse in Indo-China in May 1929, where about two thousand echoes were observed, some of them coming 30 seconds after the signal with one-third of its strength. These echoes are explained by reflection of the wireless waves from currents and surfaces of electrons at the boundary or outside the above-mentioned toroidal region, and corresponding to distances from the earth several times as great as the moon's distance. Prof. P. O. Pedersen's reasons for adopting this explanation were also referred to.

IN his Friday evening discourse, delivered at The Royal Institution on Feb. 21 on "Principles of Plant Breeding", Mr. J. B. S. Haldane said that the very numerous types of *Primula sinensis* in cultivation, including the new giant species or subspecies which is practically sterile with the ancestral form, have all arisen in cultivation in the last century. They are determined by combinations of Mendelian genes, of which about thirty are known. These have varied suddenly and spontaneously. The laws governing their assortment in the progeny of hybrids are simple, but the result of new combinations is often unexpected. Thus, on dark-stemmed plants, flowers which were expected to be a uniform blue proved to be mottled. By the application of Mendelism the establishment of new races is greatly simplified, but, for the production of a first-rate horticultural variety, selection is still needed. The laws of inheritance in the giant subspecies, which has twice the original chromosome number, are more complicated than those enunciated by Mendel, and lead to quite different practical consequences. A failure to realise these consequences has handicapped the practical breeder. The application of these principles to other plants was briefly considered.

A NOVEL use of the mobility of radio communication will shortly be put into operation by the Egyptian State Telegraph Department. Six radio sets mounted on three motor lorries have been ordered from the Marconi Company. These sets are to be used as stations in areas not supplied by the land telegraph and telephone system. This enables any place in a wide range of country on both sides of the Nile to be linked up at very short notice with the main telegraph system. The motor lorries are of the six wheel type fitted with caterpillar attachments so that they will be equally mobile on hard or soft sand. Each lorry will carry a medium-wave half kilowatt telephone transmitter and a small portable short-wave transmitter the power of which is a hundred watts. The aerials are suspended from 70 ft. portable masts. Medium waves having lengths ranging from 600 metres to 2150 metres will be used, and also short waves having lengths ranging from 20 metres to 50 metres. Egypt is a country in which, apart from the Delta, the towns and cities with their connecting railway and telegraph communications lie along a narrow strip of land bordering the Nile, with large areas of thinly populated or desert country on either side. In these circumstances, these mobile radio stations should prove of value in providing extensions of the system either periodically as a regular service or in times of emergency.

ENGINEER REAR-ADMIRAL W. S. HILL read a paper on powdered coal for ship propulsion to the North-East Coast Institution of Engineers and Shipbuilders on Feb. 21, giving a review of the general position regarding the introduction of the use of pulverised coal afloat. Particulars were given of some sixteen British and foreign vessels in which the boilers have been converted from hand firing to pulverised coal firing, or in which the boilers were originally fitted for burning pulverised coal. The advantages claimed for pulverised coal are that it leads to a saving of labour approaching that saved by oil-firing, that it improves the steaming of ships, and that there is a gain in overall efficiency. Much depends on the actual power used for pulverising. Two years ago, 25 h.p. per ton of coal milled was common; this figure, however, has been reduced to 14, and in a new mill about to be fitted afloat to 8. The burners have now taken a secondary place to the mill. The general question of pulverised fuel burning, it may be added, is among the subjects now being investigated by the Fuel Research Board.

THE Medical Research Council has appointed the following committee to advise upon the further investigation of pulmonary silicosis and of other pulmonary conditions associated with the inhalation of dusts arising from industrial processes: Prof. Arthur J. Hall (Chairman); Dr. A. E. Barclay; Mr. J. C. Bridge; Prof. S. L. Cummins; Prof. E. H. Kettle; Dr. E. L. Middleton (Secretary); Prof. M. J. Stewart; Dr. Cecil Wall. The Committee will survey the present state of knowledge, will advise the Council upon new lines of inquiry that may be profitably pursued, and will assist in the supervision of such investigations as it may be decided to initiate or support. The work will be directed particularly towards obtaining, in co-operation with the Factory Department of the Home Office, more accurate knowledge of the causes and diagnosis of silicosis and of other industrial pulmonary disorders. The need for better knowledge of these subjects has been emphasised by the recent Report of the Silicosis (Medical Arrangements) Committee, the recommendations of which to the Secretary of State for extended research work have been referred to the Council by the Home Office.

THE second volume of the *Transactions* of the Seventh Congress of the Far Eastern Association of Tropical Medicine, held in British India in December 1927, of which the first volume was referred to in our issue of June 22, 1929 (p. 954), has been issued (Calcutta: Thacker's Press and Directories). It consists of 871 large pages, and comprises the proceedings of Sections III. and IV. Nearly a hundred papers, with the discussions to which they gave rise, are recorded in full; those of Section III. deal with plague, cholera, dysentery, sprue and intestinal infections, bacteriophage, leprosy, tuberculosis, and bacteriology; while Section IV. was concerned with typhus-like diseases and leptospiræ, etc., protozoology, and malaria in all its aspects. Malaria forms the subject of no fewer than thirty papers; leprosy takes ten; and five are concerned with the bacteriophage, an ultra-virus parasitic on bacteria and provoking in them an extremely infectious disease which results in their destruction and solution. The whole volume is important for all who are concerned with the cure, and especially the prevention, of disease in the tropics, and much of it is of high interest to scientific workers on more general lines. The volume is well printed and the general get-up excellent; it is illustrated by numerous maps and charts, as well as by twenty-six plates, mostly in half-tone, the reproductions of photographs which show the character of certain areas in Lower Bengal in relation to the prevalence of malaria being extremely good. The editor, Lieut.-Col. J. Cunningham, is to be congratulated on the result of his labours.

IN the past, submarine cables have played an invaluable part in submarine communications. Until, however, the advent of 'loaded' cables, their use for telephone communication was very restricted. Nowadays the distances which submarine telephone cables span are continually extending, and in a few years it seems probable that all the continents will be interconnected by a submarine telephone network. We have received from Messrs. Siemens Brothers and Co., Ltd., of Woolwich, a volume giving interesting particulars of some of the loaded submarine telephone and telegraph cables which they have put down. In the early types of loaded cable the insulating material employed was gutta-percha, but the development of submarine telephony led to the replacement of this material by paper, the resistivity of which is much greater. A study of Heaviside's theories led to the adoption of the continuously loaded cable. Commercial iron or silicon iron was used at first for the loading, but, as only low magnetising forces were obtainable, the increase in the speed was not great. The discovery of permalloy, one of the nickel iron group of alloys which after appropriate heat treatment develops a very high permeability at a very low magnetising force and shows practically no hysteresis loss, greatly improved the quality of the loading. It showed that submarine telephony over long distances was possible and greatly accelerated the speed at which submarine telegraph messages can be sent. For example, in the Fanning-Suva section of the Pacific cable, the speed has been increased to seven times that of the unloaded cable. Particulars are given of the Isle of Man, Anglo-French, Anglo-Belgian, and Anglo-Dutch submarine telephone cables.

IN connexion with the Shannon hydro-electric power station, it has been feared that the factories which will probably be built in the neighbourhood of Limerick will detract from the beauty of the west coast of Ireland. At present the station helps to supply electric power to Dublin, but without the steam stations in Dublin the hydro-electric power would be quite inadequate. To supply power to Dublin from the station 120 miles away is not economical. In our opinion, the water power available on the Liffey will sooner or later have to be harnessed for the benefit of Dublin, and possibly also the huge amount of peat available in the Bog of Allen will have to be utilised. The natural place to utilise the Shannon power is along the west coast. As the population increases, it is necessary to provide houses and factories for them, and many of the beauty spots will suffer. In *Distribution*, the journal of Henley's Telegraph Works, for February, an account is given of the Cadbury-Fry-Pascall Ltd. factory which was built seven years ago at Claremont, Tasmania. The factory is built near the sea and is surrounded by picturesque mountains, including Mount Wellington. The buildings are lighted by more than 800 windows and the floor space is 120,000 square feet. A model garden village has been laid out for the workers, the cottages each containing two or three bedrooms and two sitting-rooms. Tennis courts, golf-links, and everything that human ingenuity can do has been done to make the workers contented. The 85 motors and 12,000 lights are supplied with power purchased from the hydro-electric system. Special shower baths and dressing-rooms are provided for the workers, and electric lifts transport passengers and materials to the upper floors. Whenever possible, Australian raw material and machinery are used. There are many suitable

sites for similar factories within fifty miles of Limerick.

IN the second Rickman Godlee lecture delivered at University College, London, on Nov. 7 last and recently published by the College, Viscount Grey of Fallodon gave a charming account of "Natural History, the Pleasure and Purpose of Observation". In simple language, more expressive than technicalities could ever be, and with many touches of humour, he pointed out the need for accuracy and caution in observation, and at the same time the danger of sterility which lies in over-caution. His speech itself expressed his own pleasure in the study of Nature, and this he visualised as having four aspects: the pleasure in common things; the pleasure in observing changes caused by the change of the seasons and the variety of light; the pleasure of noting the recurrence of things which come round regularly, for which we have learned to care; and last, the interest in seeing something rare. The address (which has been published by the College at 1*s*.) should become a text for the teacher of nature study in schools, for if nature study could but open the eyes and minds of youth to these beauties of sense and thought, it would fulfil its main purpose of adding to the fullness and happiness of life.

AMONG recent accessions to the British Museum (Natural History) are six photographs of East African elephants taken by Mr. Marcuswell Maxwell and presented by the proprietors of the *Times*. Of the collection of birds purchased for the Museum, some 300 of them, of about eighty different species, were collected by Mr. G. L. Bates during a trip in 1928 in a part of the interior of West Africa through which no ornithologist has previously travelled. The Entomological Department has received a collection of 1362 tiger-beetles from all parts of the world, presented by Mr. H. E. Andrewes, and a collection of Coleoptera and Hymenoptera from the Algerian Sahara, numbering 1224 specimens and including the types of several new species, from Dr. Ernst Hartert. The most interesting acquisitions to the Department of Geology are a complete *Ichthyosaurus* on a slab of Lower Lias limestone from Street, Somersetshire; and a large collection of Permian echinoderms and brachiopods, Triassic ammonites, and Tertiary gastropods and lamellibranchs from the island of Timor. The collection of minerals has received gifts of three new species: bismutstantalite, from Uganda, from the Director of the Geological Survey of Uganda; probertite, a borate mineral from California, from Prof. F. H. Probert; and larnite, from Larne, Co. Antrim, from Dr. C. E. Tilley. Recent acquisitions for the general library include Carlo Ruini's "Anatomia and Medicina Equorum nova", 2 volumes, Franckfurt am Mayn, 1603; the astronomer Olof Peter Hiorter's "Almanach för skott-ahret . . . 1744", an official Swedish almanack, about three inches square, with an article by Linnæus on Swedish plants, one of the only two copies known; and a copy of the anonymous skit on monasteries by the great mineralogist, Baron Ignaz von Born, in the style of a Linnæan zoological dissertation, entitled "Joannis Physiophili Specimen Monachologiæ methodo Linneana Augustæ Vindelicorum, 1783", one of three copies known.

BARON KOI FURUICHI, of Tokyo, has been elected an honorary member of the Institution of Civil Engineers.

AN earthquake was recorded at Kew Observatory on Feb. 23. The first impulse was received at 18 h. 23 min. 50 sec. G.M.T. The epicentre was off the south of Greece near lat. 37° N., long. 23° E. The shock was of about the same intensity as that which occurred on Feb. 14 in the same region and caused considerable damage in Greece and Crete.

PROF. W. E. GIBBS, Ramsay professor of chemical engineering at University College, London, will deliver an address before the Institution of Chemical Engineers on "The Formation and Growth of Crystals", in the rooms of the Geological Society, Burlington House, London, W.1, on Mar. 5, at 8 P.M. All who are interested in the subject are invited to attend.

RECENT promotions and transfers in the Colonial Agricultural and Forestry Services include the following: Mr. D. C. Edwards, agricultural instructor, Sierra Leone, to be agricultural officer, Kenya; Mr. C. B. Taylor, superintendent, Agricultural Department, Nigeria, to be botanist, Nigeria; Mr. D. B. Palmer and Mr. L. R. Swindells, to be produce inspectors, Nigeria; Mr. J. C. Rammell, assistant conservator of forests, Kenya, to be senior assistant conservator of forests, Kenya.

AT a meeting of the Geological Society of London, held on Feb. 21, the following officers and new members of council were elected: *President:* Prof. E. J. Garwood; *Secretaries:* Mr. W. Campbell Smith and Prof. W. T. Gordon; *Foreign Secretary:* Sir Arthur Smith Woodward; *Treasurer:* Mr. F. N. Ashcroft; *New Members of Council:* Prof. P. G. H. Boswell, Prof. C. G. Cullis, Mr. J. F. N. Green, Sir Albert Ernest Kitson, and Dr. Bernard Smith.

AT the annual general meeting of the Quekett Microscopical Club, held on Feb. 11, the following officers and new members of the committee were elected: *President:* Mr. John Ramsbottom; *Hon. Treasurer:* Mr. C. H. Bestow; *Hon. Secretary:* Mr. W. S. Warton; *Hon. Reporter:* Mr. A. Morley Jones; *Hon. Librarian:* Mr. C. S. Todd; *Hon. Curator:* Mr. C. J. Sidwell; *Hon. Editor:* Mr. W. S. Warton; *New Members of Committee:* Mr. E. A. Robins, Mr. F. W. Chipps, Mr. J. J. Jackson, and Mr. C. Harvey.

APPLICATIONS are invited until Oct. 11 next from British subjects of either sex for the Smithson Research Fellowship, which has been established under the bequest of Mr. E. W. Smithson for research in natural science, with a view to the discovery of new laws and principles. Normally the research work of the holder of the fellowship will be carried out in the University of Cambridge. The appointment will be for four years in the first instance, with possible renewals up to eight years. The yearly stipend for the first two years will be £800. Copies of the regulations governing the fellowship, and forms of application, may be obtained from the Assistant Secretary of the Royal Society, Burlington House, Piccadilly, W.1.

A COMPREHENSIVE and attractive tour of Great Britain and Northern Ireland has been arranged to follow the World Poultry Congress to be held at the Crystal Palace on July 22–30. The tour, which is limited exclusively to delegates, will extend from July 31 to Aug. 11, and has been designed to combine a visit to places of interest to agriculturists in general and poultry farmers in particular, with a run through the beauty spots and historic centres of England, Scotland, Wales, and Ireland. The project has been assisted by the Irish Free State, which has organised a tour to be taken *en route*. Governments, municipalities, and other bodies will entertain the visitors. The cost of the tour will be twenty-five guineas.

THE Ministry of Health has issued a memorandum on the treatment of tuberculosis (*Memo.* 131 B/T.), being an analysis of work done during the year 1928 under the scheme of local authorities for the treatment of the disease. The returns include the death-rates from tuberculosis per million of population in different areas, which show considerable variations. The counties with the highest rates are Durham (1059) and Cornwall (1032), while Rutland has the lowest (501). Of the county boroughs, South Shields has the highest rate (2135) and Southport the lowest (631). Gloucester and Canterbury, which might be expected to be very similar, have rates of 689 and 1235 respectively. Of Metropolitan boroughs, Hampstead has the lowest rate (536) and Finsbury the highest (1639), the City of London being second with 1537. The average rate for all England is 924. Another memorandum (*Memo.* 146/T.) details changes necessitated by the Local Government Act, 1929, in the arrangements for the treatment of tuberculous ex-service men so far as chargeable to the Ministry of Pensions.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—An assistant bacteriologist in the Department of Pathology and Bacteriology of the University of Sheffield—The Registrar, The University, Sheffield (Mar. 3). A head of the Chemistry and Industrial Chemistry Department of the Cardiff Technical College—The Principal, Technical College, Cardiff (Mar. 8). A resident radiologist at St. Bartholomew's Hospital, Rochester—The Secretary, St. Bartholomew's Hospital, Rochester (Mar. 11). A lecturer in mining subjects at University College, Nottingham—The Registrar, University College, Nottingham (Mar. 15). A Montague Burton professor of industrial relations at the University College of South Wales and Monmouthshire—The Registrar, University College, Cardiff (Mar. 15). A chemist in the Cereal Division of the Experimental Farms Branch, Department of Agriculture, Canada—(Particulars and application forms from The Secretary, High Commissioner for Canada, Canada House, Trafalgar Square, S.W.1) The Secretary, Civil Service Commission, Ottawa, Canada (April 17). A professor of engineering at University College, Southampton—The Registrar, University College, Southampton (April 22). An assistant professor of physiology and pharmacology in the University of Alberta—The Secretary to the Board of Governors, University of Alberta, Edmonton, Alberta.

Our Astronomical Column.

New Comet 1930a.—The first cometary discovery of 1930 appears to have been made independently in two places : (1) by Mr. L. Peltier, at Delphos, Ohio ; and (2) by Drs. Schwassmann and Wachmann at Bergedorf. The following observations have come to hand from the I.A.U. Bureau, Copenhagen, the second being made by Prof. G. van Biesbroeck :

U.T.	R.A. 1930·0.	N. Decl. 1930·0.	Place.
Feb. 18d 22h 29m·4	9h 39m 40s·27	34° 46′ 11″	Bergedorf
20 4 19·9	9 22 38·93	40 21 55	Yerkes

The magnitude was given as 10 on Feb. 18, and 11 on Feb. 20. The deduced daily motion is $-13\frac{1}{2}$ min., North $4\frac{1}{2}°$. The comet is probably fairly near the earth, from its very rapid motion. Owing to its high north declination, it is observable throughout the night. Mr. Peltier was the co-discoverer with Mr. Wilk of Comet 1925 XI.

The following elements and ephemeris of Comet 1930*a*, computed by Mr. J. P. Möller, Copenhagen, have been telegraphed by the I.A.U. Bureau :

T	1930 Jan. 15·686 U.T.	
ω	325° 10′	1930·0
Ω	147 33	
i	99 55	
log q	0·03655	

EPHEMERIS FOR 0h U.T.

	R.A.	N. Decl.
Mar. 1.	7h 44m 52s	58° 24′
,, 5.	7 16 24	60 58
,, 9.	6 56 0	62 24

Astro-Photography of the Future.—Dr. G. W. Ritchey contributes another article, in continuation of that referred to in NATURE of Feb. 1, p. 180, to *L'Illustration* of Jan. 18. Several further photographs of nebulæ, both diffuse and planetary, are beautifully reproduced ; all except one of these (the obscure nebula south of ζ Orionis, photographed by Duncan) are taken from his own plates obtained with the 60-inch reflector at Mount Wilson Observatory. Dr. Ritchey gives a brief history of our knowledge of nebulæ, and describes with a certain amount of detail the particular objects illustrated. It is not clear, he says, why the chief observatories of the world, which are richly endowed, and the principal institutions formed for the advancement of science, do not unite to establish a large photographic telescope at some carefully chosen, elevated, and unpopulated place, in latitude about 25° S., where the star clouds and nebulæ of the Sagittarius region—which certainly form the most important and interesting part of the Milky Way and have been comparatively unexamined by powerful modern instruments owing to the situation of the latter in northern latitudes—could be effectively investigated. If some friend of astronomy would provide the funds for such an undertaking, unsuspected and incredible discoveries would be made, to the great profit of science and education. The resources and possibilities of celestial photography have scarcely begun to be explored. Vital details have been almost totally neglected. When they are given the attention they deserve, a new celestial photography will be born, and the results will be incomparably more useful and important for thinking humanity than those obtained up to the present.

Research Items.

A Communal House on Little Andaman.—The supplement to *The Indian Antiquary* for January is an instalment of Sir Richard Temple's "Remarks on the Andaman Islanders and their Country", which consists of extracts from a report by Mr. P. Vaux on a reconnaissance in Little Andaman on Jan. 25–Feb. 4, 1902. Mr. Vaux had been detailed to operate against the Jarawa. This tribe lived in the then untouched forests of Little Andaman, and had not been brought under the control of the administration. They indulged in periodical raids, in which murder regularly played a part. Their exact location was not known, and they had proved both elusive and unapproachable. Shortly after the date of this report, another punitive expedition was successful in dealing with them, but Mr. Vaux was killed in the attack. In this extract he describes several camps of the Jarawa, empty when he reached them, and a large communal house or camp, situated at the top of a steep hill, and approached by seven paths. It was in a clearing which had been carefully prepared. Several large trees had been felled, not only for space, but also to give outlook. Two of the entrances had sloping log platforms to serve as look-outs, and probably when the tribe was in residence (it left the camp for small hunting huts in the dry season) each entrance was guarded by similar platforms. The hut was roughly oval, being sixty feet by forty feet in dimension, with a circumference of fifty-four yards. Seven stout posts in the centre supported the roof, and from the top of the roof between these posts were 250 pigs' skulls neatly fastened up in a basket. Below the skulls was a big fireplace, while round the walls were the smaller family fireplaces, probably a dozen in number when the hut was full. Each fireplace consisted of four stakes driven in the ground. About three feet from the ground a piece of matting fastened to the stakes formed a shelf for the meat. The thatching was decorated with hundreds of fan-like bunches of leaves, and honey pots, baskets, unstrung bows, leaf water-vessels, etc., hung from the roof.

A Statistical Measure of Civilisation.—Dr. R. M. Harper, in an article on some demographic characteristics of American educational centres in the February *Scientific Monthly*, describes an attempt to measure the degree of civilisation in twenty-five towns in the United States in which a university dominates the life of the community. Towns with large factories are excluded, and none is chosen with less than 80 per cent of white population. In the average of the twenty-three towns, adult illiteracy is 2·18 per cent, compared with 5·50 for the urban population of the whole country. Persons per family average 3·86, compared with 4·24; children average 1·38, compared with 1·58; and males represent 47·2 per cent of the population, compared with 50·1 in the urban population as a whole. This last figure is the most striking. In all the towns the percentage of females is higher than that of males, while the proportions are reversed in nearly all the States in which the towns lie. It should be noted that few of the actual students in the colleges come into the figures since the census enumerates them in their homes. Dr. Harper discusses the value of the different orders of statistics which he uses, and lays stress particularly on the sex ratio and the illiteracy count.

Food of Grasshopper Mice.—Examination of the stomach content of birds has become a standard method of assessing their food, but the method has seldom been applied to mammals, perhaps because the same doubt has never arisen as to the usefulness or harmfulness of any particular species. We would direct attention, therefore, to a good example of mammalian stomach-content assessment, which, most unusually, sets the stamp of good-conduct upon one of the rodents. Vernon Bailey and Chas. C. Sperry, in a thoroughgoing account of the life-history and habits of the genus *Onychomys*, record analyses of 96 stomachs (U.S. Dept. Agr., *Tech. Bull.* No. 145, November 1929). The materials found are specified in detail and the numbers of individuals of, say, grasses or insects, are given. This method is much more satisfactory than the volume-percentage method which has been adopted in the United States and elsewhere for the recording of the food of birds. The results were that eight-ninths of the food of *Onychomys* were found to consist of animals, mostly crickets, grasshoppers, caterpillars and moths (55·8 per cent), and beetles (20·73 per cent). Cultivated grain comprised less than 5 per cent of the food, and as it consisted mostly of wheat eaten in July, it was probably waste. It is seldom that a rodent does anything but harm to agricultural interests, but here is a little group of species and varieties which are economically beneficial.

A Rare Cephalopod.—Mr. G. C. Robson has described and discussed a new species of *Melanoteuthis* collected by Beebe during one of the *Arcturus* voyages (1926), from the deep waters near Cocos Island (E. Pacific) ("On the Rare Abyssal Octopod *Melanoteuthis beebei* (sp. n.): A Contribution to the Phylogeny of the Octopoda" by G. C. Robson, *Proc. Zool. Soc. London*, Oct. 1929). Two specimens were obtained, and these proved so interesting that a special account is given of them apart from Dr. Beebe's other cephalopods. The examination of the present species throws new light on the systematic position of the genus and probably of the family Vampyroteuthidæ to which it belongs. *Melanoteuthis*, although specialised in some respects, has several features which suggest that in it we see the most primitive octopod and that it retains characteristics of the common stock from which the Decapoda and the Octopoda arose. Chief among these is the presence of filaments contained in the velar pouches which Joubin (1928) regards as a vestigial pair of arms—a view fully confirmed by Mr. Robson. There are several distinctive features. The nervous system is diffuse, the suckers pedunculate, there is a valve in the funnel and a median plate-like shell rudiment, whilst there is no white body: characters not found in the Octopoda but resembling the Decapoda. The radula is simple and undifferentiated as in most primitive Decapoda and in *Argonauta*. There are certain features which are found in the Cirroteuthidæ and some not found in the Cirroteuthidæ but found in other octopods. The author suggests dividing the Octopoda into three sub-orders—Vampyromorpha, Cirromorpha, and Incirrata; *Melanoteuthis* belonging to the first.

Opium in the Poppy.—It was at one time thought that the elaboration of active principles in medicinal plants underwent either qualitative or quantitative attenuation when the plants were cultivated away from their natural habitat. Thus, in his "Farmacopea riformata" (Venice, 1655), Quercetano states that, when transplanted into improved soil and carefully cultivated, the opium poppy becomes less poisonous. This statement, often repeated, has been shown, by long series of experiments in Asia and in Europe, to be without foundation. A similar conclusion is arrived at from the results obtained in the Royal Botanic

Gardens at Naples. According to Cavara and Chistoni, in a paper published in the *Rendiconti dell' Accademia delle Scienze Fisiche e Matematiche di Napoli* for 1929, the morphine content of the poppy was raised, by improved cultivation and selection, from 5·46 per cent in 1923 to 10-11 per cent for the white, and to 12-14 per cent for the black poppy in 1924. Experiments on the hybridisation of the two varieties show that the opium obtained from hybrids of the fourth generation gives a high percentage of morphine. The diminishing morphine content in the opium content of successive incisions is also confirmed. Moreover, the occurrence of rain either during or after the incision exerts a peculiarly harmful effect, since not only does the opium lose its viscosity and consistency, but its morphine content is also greatly reduced.

Indian Liverworts.—The only comprehensive work upon Indian Liverworts so far has been the paper by Mitten in the *Jour. Linn. Soc.*, 5 ; 1860. Many more species have since been described, especially by Stephani, but there is much room for an illustrated account of Indian liverworts. The first step towards such a publication has been taken in the issue by the University of the Punjab, Lahore, of Part I. of the "Liverworts of the Western Himalayas and the Punjab Plain", by Shiv Ram Kashyap. This volume deals with the Anthocerotales, Marchantiales, Sphærocarpales and the Anacrogynous Jungermanniales. The Acrogynæ will be dealt with in a second volume. The author hopes that later it may be possible to issue an account of the group for the whole of India, but large collections must first be made in the eastern Himalayas and South India. In this work indigenous species receive fuller treatment and more figures. A brief discussion of the area studied and the habitat of the liverworts is given in the introduction, whilst a full glossary and a key to the genera precedes the systematic description of species.

Sylvicultural Research in India.—The paper on "Sylvicultural Research in India ; its Organisation, Problems, and Methods", by H. G. Champion, in the second issue of vol. 3 of *Forestry*, should make a wide appeal to all professional foresters of the gazetted ranks and to all interested in technical forest research throughout the British Empire. It may be contended without fear of contradiction that it would have proved impossible to write this paper a decade ago, and at the present day it could have only been written, for the Empire, by a research officer of the Forest Research Institute at Dehra Dun with all the data of the past history of sylvicultural research in India at his disposal, and the wide knowledge possessed by the author himself. It is impossible here to do more than direct attention to this valuable paper. Mr. Champion discusses the present division of the work of research between the central sylviculturist at Dehra Dun and the provincial research sylviculturists who have been appointed in all the provinces of India (and Burma) with the exception of Bombay and the Punjab. He also points out the necessity of selecting for such posts the best available officer and not the man who has shown himself a failure in executive or administrative work. He then discusses in detail the lines upon which research work is now carried out and the enormous number of problems which such work has disclosed as awaiting solution. That astonishing progress has been made during the past quarter of a century in a subject which was almost a sealed book thirty years ago the paper provides ample proof. It is with no idea of minimising the value of *Forestry* to express the hope that Mr. Champion's paper may be republished in such a form that it may become available to a wider circle of readers.

Jan Mayen.—Norwegian interest in Norway's new arctic territories in Spitsbergen, Bear Island, and Jan Mayen, is shown in the many valuable publications of the Svalbard og Ishavs-Undersökelser, which appear at frequent intervals under the collective title of *Skrifter om Svalbard og Ishavet*. A more popular series appear as *Meddelelser*, some of them extracted from other publications. One of the latest is a small pamphlet on Jan Mayen (*Norsk Geografisk Tidsskrift*, **2**, 7), which gives a summary of the structure and climate of that island, beside a full account of its history and the seal fishing in the vicinity. The paper is chiefly valuable for its full bibliography of Jan Mayen.

New Cretaceous Ostreidæ from Texas.—Two new species of Ostreidæ from the Austin Chalk of central Texas described by L. W. Stephenson (*Proc. U.S. Nat. Mus.*, vol. 76, art. 18) are of particular interest ; one, *Ostrea centerensis*, n. sp., because it has been found abundant in a zone only a foot or two in thickness without trace of further occurrence in the beds above or below. The author suggests it was a temporary immigrant from the tropical seas of the Caribbean region. The other, *Exogyra tigrina*, n. sp., is remarkable in that it offers one of those rare cases of the preservation of colour markings in a fossil. These take the form here of brownish, radiating colour bands alternating with grey bands. It recalls the similar markings on the European cretaceous *Gryphæa columba*, Lamk., cited by the late R. B. Newton (*Proc. Malac. Soc.*, vol. 7, p. 283) when treating on the subject generally, a paper Mr. Stephenson has not apparently seen.

Continental Connexions in the Cretaceous.—In the *Amer. Jour. Sci.* for January 1930, Prof. C. Schuchert discusses the important memoir on the dinosaurs and other reptiles of the Cretaceous of the Argentine recently published by F. von Huene (*Anales del Museo de la Plata*, vol. 3, series 2*a*, p. 196 ; 1929). Von Huene's hypothesis of an Asiatic-Polynesian-South American land-bridge across the southern Pacific raises again the very difficult problem of how to explain the disappearance of such extensive land-bridges. Schuchert suggests an alternative and more probable route for Asiatic migrations through Australasia to Antarctica and thence to South America or Africa. Von Huene states that South America is the home of the specialised marsupials, and that from there representatives of both diprotodonts and polyprotodonts spread to Australia but not to New Zealand. Previously the monotremes and allotheres had spread from south-eastern Asia to the Australian region, and from there the allotheres reached South America, which became a new development centre for them. These and many other affinities, some of which are summarised in the paper, between the organic worlds of South America and the lands to the west, cannot be understood without the assumption of former land connexions, particularly in the Cretaceous. At that time the larger faunal elements might have advanced by stages from Asia to South America, but, at the latest in middle Tertiary times, the continuity of the lands most have been broken through. In view of Schuchert's iconoclastic attitude towards continental drift hypotheses, it is interesting to notice that he fully recognises the geophysical difficulties in the way of assuming the foundering of land bridges, and that in seeking for a connexion between South Africa and Antarctica he is not averse to admitting a certain amount of drift to the north on the part of Africa.

Raman Effects in Liquids.—The issue of the *Physikalische Zeitschrift* for Dec. 1, 1929, contains a description of a new method of observing the Raman effect in liquids by Dr. R. Bär, of the University of Zurich, which gives more intense lines than previous methods and has cleared up some of the uncertainties with regard to the effect in benzol. The liquid is contained in a glass tube about a metre long, one end of which is widened into a cone closed by a glass plate, and the other drawn off sideways to a point to prevent reflection at the end. The light from a mercury lamp falls on the base of the cone and is focused by lenses at a point in the liquid near the apex of the cone, and the effect is observed from the side by means of a small mirror attached to the base of the cone at an angle of 45° to the axis of the tube. Evidence of the existence of increases of wave numbers by 605 and 990, that is, in the anti-Stokes law direction, and of decreases 2947 and 3179, was found in benzol, but none for the existence of the decreases 266, 1360, 1479, and 2630.

Mass-Spectra of Mercury, Krypton, and Xenon.—An investigation of the positive rays of mercury, krypton, and xenon, in which the relative abundance of the isotopes of these elements has been found by photometry of their lines in mass-spectra, is described by Dr. F. W. Aston in the February number of the *Proceedings of the Royal Society*. Whilst mercury has been found to have an atomic weight in close agreement with the accepted value of 200·61, the number calculated from the percentage abundance of the seven isotopes being $200{\cdot}62(6) \pm 0{\cdot}05$, the results for krypton and xenon are not in accord with older determinations. Their atomic weights as deduced from their densities are 82·92 (Kr) and 130·22 (Xe), whilst those calculated from the mass-spectra are $83{\cdot}77 \pm 0{\cdot}02$ and $131{\cdot}27 \pm 0{\cdot}04$. The xenon used for the density determinations had been examined by Dr. Aston with a mass-spectrograph in 1922, and was then shown to be free from krypton, the only likely impurity, so that it seems possible that the reduction of the density data may have been incorrectly made. Dr. Aston mentions that the auxiliary information that is required for the accurate deduction of an atomic weight from a density is less well known than could be desired for these two inert gases, and suggests that the density determinations should be repeated, preferably with a microbalance at low pressures.

Transparent Window Glasses.—Since the discovery that ultra-violet light of wave-lengths close to 302×10^{-7} cm. would cure rickets in children, special window glasses transparent to these rays have been introduced, and as there were indications that they lost some of their transparency with use, the U.S. Bureau of Standards has investigated the properties of a number of these glasses. *Research Paper* 113, by Messrs. Coblentz and Stair, collects the results obtained. Sunlight at Washington at midday in summer contains 0·3 per cent of the curative rays, and of this the glasses in the market at the beginning of 1929 would transmit when 0·23 cm. thick and quite new from 63 to 48 per cent. After exposure to sunlight for a summer or to the light from a quartz mercury arc for 10 hours, their transmission had fallen to 49 and 23 per cent respectively, and remained approximately at those values on further exposure. A much more serious reduction is produced if the surfaces of the glass are not kept clean and free from dust.

Formation of Nitric Oxide.—Following on a recent statement that the yield of nitric oxide formed in the arc is increased if carbon dioxide is present, Tartar and Hoard, in the January number of the *Journal of the American Chemical Society*, describe some careful experiments on this reaction. They find that, with currents of 65 milliamp., only one-sixth the concentration of nitric oxide is produced from a mixture of nitrogen and carbon dioxide as is produced from air, and the effect of reduced pressure is very slight. An increase in the yield was obtained by increasing the current by 50 per cent. The authors conclude that the reaction offers little promise as a method of nitrogen fixation in the arc.

Measurement of Coal Dust Inflammability.—One of the gravest hazards of coal mining—the coal dust explosion— is now recognised and countered by the process of stone-dusting the underground passages. Coals differ in inflammability, and in order to apply the remedy rationally a method has been devised which is described in the *Safety in Mines Research Board Paper*, No. 56, by A. L. Godbert and R. V. Wheeler (London : H.M. Stationery Office), whereby this property can be gauged in the laboratory. It consists in determining the proportion of inert dust necessary to suppress inflammation when small quantities are blown by oxygen through a heated tube. The results are comparable with those given by trials in an explosion gallery. By means of the test it was shown that the inflammability roughly increased with the content of volatile matter of the coal and more precisely was associated with the reactivity of the ulmin contents.

Ignition of Gases by Electric Spark.—The problem of discovering the exact process which takes place when a combustible gas is ignited by an electric spark is one of great importance in motor-car engineering. There are, however, so many variables to be considered when a magneto is employed for producing the spark that little progress has been made towards getting a solution. A paper by Messrs. Terada, Tumoto, and Yamamoto on the difference in the behaviour of different parts of a 'three-part spark' in igniting combustible gas mixtures, which is published in the *Scientific Papers of the Institute of Physical and Chemical Research, Tokyo*, p. 132, 1929, is of value in this connexion. They experiment on the spark obtained between equal spheres when the lead of the positive electrode is earthed or provided with a corona leakage from a needle point. The electricity was continually applied by a statical machine. In this case, when the spark gap is about three times the diameter of either sphere, it is divided into three distinct parts which are quite different from one another and are called the positive, middle, and negative parts. The middle part is the most luminous, and its spectrum shows the head of the second positive band of nitrogen superposed on a continuous spectrum. The other parts give the ordinary spark spectrum of air together with some metallic lines. Tests were made to find out the igniting power of different parts of the spectrum. A fine jet of the combustible gas being experimented on was directed towards different parts of the jet and the number of ignitions that followed was noted. The frequency of the ignitions was much the greatest in the middle of the arc and was least at the junctions of the middle part with the positive and negative parts. Since the duration of the discharge in the middle part of the arc was only about a tenth of the duration of the positive and negative parts, it was not a cumulative time effect. There is a decided difference in the mode of excitation of the molecules in the different parts of the arc, and this has a great effect on its igniting properties.

Progressive Chemistry.

THE *Journal of Chemical Education*, a beautifully printed and illustrated monthly magazine of some two hundred pages, conveys a striking and even startling impression of the popularity and progress of chemical studies in the United States. The journal, which costs two dollars fifty cents per annum, is the official organ of the Division of Chemical Education of the American Chemical Society, and its aim may be expressed in terms practically identical with those which are applied in the January issue to the closely related Chemical Foundation Inc., that is, " the advancement and maintenance of chemical education in the United States to the plane where we shall have not only the best chemistry teachers and methods of teaching this science in the world, but also have the most enlightened lay people who will appreciate the importance of the application of chemistry in all phases of life and industry ".

The staff of the journal includes six departmental editors and more than sixty contributing editors; in addition to the latter there are sixteen abstractors. Among the dozen foreign editors we notice the names of Sir James Irvine (St. Andrews), Prof. F. G. Donnan (London), Prof. K. Freudenberg (Heidelberg), Prof. E. Cohen (Utrecht), and Prof. W. D. Treadwell (Zurich). The thorough way in which the Division of Chemical Education of the American Chemical Society has set about its duties is evident from the lists of committees, members of the Senate of Chemical Education, and local organisations operating in the various States. The twelve committees upon the current list are concerned with such subjects as aids to visual instruction in chemistry, chemical education of the non-collegiate type, correlation of high-school and college chemistry, labels, professional spirit among high-school teachers, research problems, and women's club study course in chemistry.

The editorial article of the January issue contains some interesting references to Benjamin Silliman (1779–1864), the first professor of chemistry at Yale, who took up the duties of the chair in 1804. " America's first great scientific publicist ", in his early days at Philadelphia, was acquainted with Hare and Priestley the chemists, Wistar the anatomist, Barton the botanist, and Seybert the mineralogist; he therefore links these names with those of his own eminent pupils of a later age, among them " Dana, world-renowned geologist and mineralogist; Brush, whose exhaustive mineralogical chemical studies are authoritative everywhere; Johnson, pioneer leader in chemistry applied to agriculture; Willard Gibbs, first among physical chemists of modern times; T. Sterry Hunt, profound in chemical philosophy and theory ". There are articles on the tung-oil tree (with some good coloured plates), the teaching of electrochemistry (a symposium presented before the American Electrochemical Society at Toronto, in 1929), educational activities of Mellon Institute, and chemical warfare.

Among other features, there are contests for students, notices of new books and scientific articles in magazines, and illustrated abstracts of interesting papers from current chemical and educational journals —including a section entitled " Keeping up with Chemistry ". " One of the hardest and most disappointing things is to endeavour to retain an active interest in chemistry after one has graduated," is the complaint of a writer in the December *Alchemist*, the official organ of the Glasgow University Alchemists' Club. This very real difficulty would be overcome if chemists in Great Britain could develop sufficient enterprise to publish a British counterpart to the lively and stimulating American *Journal of Chemical Education*, which is now in its seventh year.

Stellar Velocities and Stellar Physics.

AT the annual meeting of the Royal Astronomical Society on Friday, Feb. 14, the president, Dr. A. C. D. Crommelin, delivered an address on the work of Dr. J. S. Plaskett, director of the Dominion Astrophysical Observatory, Victoria, B.C., to whom the Gold Medal of the Society has this year been awarded " for his valuable observations of stellar radial velocities and the important conclusions derived from them ". The award, said Dr. Crommelin, was made " not for any single outstanding result, but in recognition of the high merit of a long series of researches, extending over a quarter of a century, and marked throughout by a painstaking striving after the highest accuracy attainable, combined with an alertness in discerning problems of stellar motion and stellar physics to which the powerful observational means available might most suitably be applied ".

Dr. Plaskett's astronomical career began in 1905 at the Ottawa Dominion Observatory, where he was placed in charge of the Department of Astrophysics. His early work included the determination of stellar radial velocities for various purposes, but the instruments at his disposal would not permit of an extension of the work beyond stars of the fifth magnitude. It soon became clear to him that the greatest need in this work was the examination of fainter stars, and the possibility of obtaining a telescope of larger aperture than those he had up to that time employed began to occupy his thoughts. During a visit to Mount Wilson in 1910 to attend a meeting of the Solar Union, the desire to obtain such an instrument was greatly intensified by an appeal from Prof. Campbell for co-operation in determining the radial velocities of the fainter stars. Dr. Plaskett conceived the idea that Canada might distinguish herself among the nations by erecting a giant reflector for spectroscopic research, and on returning to Ottawa he laid his scheme before his director, Dr. W. F. King, who endorsed it with enthusiasm. Mainly through Dr. Plaskett's efforts, the 73-inch telescope—the largest in the British Empire and the second largest in the world—was erected at Victoria, and he was appropriately appointed as the first director of the new observatory established at the same time.

Of the large amount of important work which has been done both by Dr. Plaskett himself and by assistants under his direction, arising from the extended programme of radial velocity determinations thus made possible, the outstanding results relate to the study of the high temperature *O*-type stars, the character of the interstellar calcium cloud, and the rotation of the galaxy. Among the *O*-type stars, particular interest attaches to ' Plaskett's star ', a binary the components of which are respectively at least 86 and 72 times as massive as the sun. These are easily the largest figures for stellar masses so far found in our sidereal system. Dr. Plaskett assumed, in the absence of evidence to the contrary, that the stars, as seen from the earth, do not eclipse one another in their mutual revolution, but Dr. Crommelin gave reasons for doubting this. If it should be established from variation of the light that eclipses take place, more precise values of the masses will be obtainable.

The systematic investigation of the 'stationary' ionised calcium lines in the spectra of hot stars which Dr. Plaskett carried out led to the first clear demonstration that the material responsible for these lines had no motion with respect to our system of stars. His earlier suggestion that it was originally discharged by the hot stars and came to rest some distance away from them probably needs modification in view of the evidence for Eddington's hypothesis that the matter is distributed throughout interstellar space, and indeed Dr. Plaskett, in a very recent paper, has himself given some of the strongest evidence for the latter view by showing, from the consideration of three separate groups of stars, that the average distance of the cloud is half that of the stars in the spectra of which its lines appear. It must be remembered also that Eddington's work in this connexion would not have been possible but for the thoroughness and accuracy of Plaskett's original investigation.

The idea that the galaxy is rotating is not a new one, but the evidence for some former ideas on this matter is now known to be spurious. The subject has lately come to the fore again through the realisation that our stellar system is probably a spiral nebula, and therefore is in all probability rotating in the manner which the appearance of those bodies forces us to admit. Specific evidence for the rotation recently came from Oort and Lindblad, and Dr. Plaskett at once perceived that his radial velocity measurements could throw an important light on the matter. He analysed the motions of the distant stars—those of types *B* and *O*, of which he had made a special study—and was able to show that they gave clear indications of rotation about a centre in galactic longitude 324·5°, which agrees with the position given by Oort and also with that found by Shapley for the centre of the galactic system from totally different considerations based on the distribution of globular clusters. The centre of the galaxy is near the junction of the constellations Sagittarius, Ophiuchus, and Scorpio, in a 'rift' between two branches which is probably caused by obscuring matter hiding from us what would otherwise be the brightest part of the Milky Way. Dr. Plaskett's contributions to the elucidation of this problem have been characterised by the solidity and thoroughness which he has shown throughout his career, and his results, however their interpretation may vary, are permanent.

Dr. Plaskett, who has been invited to give the George Darwin lecture of the Royal Astronomical Society, has chosen as his subject "The High Temperature Stars". The lecture will be delivered on May 9, and will contain some hitherto unpublished material on these important bodies.

River Flow Records in the Ness Basin, Scotland.

TO those interested for scientific and technical reasons in the availability of trustworthy data respecting river flow in Scotland, the appearance of two unostentatious pamphlets,[1] or monographs, containing records during recent periods of the Rivers Garry and Moriston, both in the Ness Basin, Inverness-shire, will be welcome not merely for the records themselves and the information they afford at the moment, but also as indicating the inauguration of a series of observations which, if continued and extended over a period of years, cannot fail to be of considerable value when the time arrives for dealing with questions of river development.

Capt. W. N. McClean, at his own pains and expense, in conjunction with some voluntary helpers, has set on foot the systematic collection of hydrological data which no public or authoritative body in Scotland (or indeed in Great Britain) is empowered or disposed to undertake. It is true that the Scottish Meteorological Department in Edinburgh has shown itself helpful in certain directions, and that it receives rainfall returns and provides general supervision over their collection, but the brunt of river gauging work falls at present on the private investigator. "River Flow Records", the organisation of Capt. McClean and his fellow-workers, is therefore an undertaking in the public interest which is deserving of acknowledgment for its altruistic labours. The quarterly reports, which are on sale at a nominal figure, are distributed not only to all who have given facilities for, or assistance in, the taking of measurements, but also "to others who it is hoped will help in assuring continuous measurements of the water resources of the country".

The two rivers which form the subject of the monographs have equivalent catchment areas, but some appreciable variation in rainfall. The River Moriston has a catchment area above the gauging section of 149 square miles, and the River Garry an area of 148 square miles. For both rivers, therefore, a flow of 400 cusecs is equal to 0·1 inch per day on the catchment area. The flow-off of the Garry, however, is considerably greater than that of Moriston on account of the larger area under heavy rainfall at the headwaters of the former. For the two months of August and September in the period under review the ratio was as much as 3 to 2.

The comparison of flow-off and rainfall for the Moriston covers a period of a little more than nine weeks in the autumn of 1929 (July 27–Sept. 30) based on actual measurements of flow made between Sept. 13 and Sept. 26. These few measurements, Capt. McClean considers, are sufficient to enable a fair estimate to be made of the flow near Invermoriston from a moderately low river to a considerable flood, and permit of a rough prediction of flow for any recorded river height. In default of more extended observations, the figures in the tables undoubtedly will be helpful, but it is obvious that there is need to supplement and compare them with later readings over a longer period, in order to increase the range, to eliminate errors, and to secure closer approximations.

In the case of the Garry, measurements of flow were made between Aug. 27 and Sept. 11, 1929. Here, too, the records are for a very short period, but the author points to the observations which he kept of water level and rainfall during the three years 1913–15, the results of which were published in the *Proceedings of the Institution of Water Engineers* for 1927. The present records, therefore, are a resumption of the work previously carried on and unfortunately interrupted. It is of interest to note that the flow of the Garry does not change with the rapidity of that of the Moriston on account of the long narrow exit from Loch Garry. The loch rises gradually and has risen as much as 20 feet, storing at that level the equivalent of 3 inches of rainfall over its feeding area. As a consequence, floods below the loch are delayed and spread over a long period.

It is understood that not only are the present records to be continued, but also that similar readings and measurements are contemplated for other streams in the Ness Basin, including the Rivers Oich and Ness.

BRYSSON CUNNINGHAM.

[1] River Flow Records, Ness Basin: River Moriston and River Garry. Reports on River Flow, July to September 1929. Each 4 pp. + 3 tables. (Parliament Mansions, Victoria Street, S.W.1.) 1*s.* 6*d.* each.

University and Educational Intelligence.

BIRMINGHAM.—The Huxley Lecture is to be delivered on Mar. 6 by Sir William B. Hardy, Director of Food Investigation, Department of Scientific and Industrial Research, who has chosen as his subject "The Physical Basis of Life".

OXFORD.—For some time past questions of library accommodation and administration have been keenly discussed in Oxford. Some of the difficulties of the situation have been met by placing certain of the special book-collections, for example, the Radcliffe Scientific Library, under the jurisdiction of the Bodleian. But it is felt that a complete reorganisation of the whole library system, including structural enlargement, arrangements for accessibility, facilities for readers and workers, the acquisition and proper housing of books, is urgently required. For this reason the generous offer of the Rockefeller Foundation to defray the expenses of a commission to visit modern university libraries and to report on their organisation, planning, equipment, and administration, is especially to be welcomed. The commission, after finishing its inquiry, will be in a position to advise the University as to the best methods of bringing its library provision into agreement with modern requirements.

The annual report of the Visitors of the University Observatory has just been published. It contains a record of much work on the zones of the Astrographic catalogue and on seismological results up to 1926, including Prof. H. H. Turner's analysis of the earthquakes in the Philippines. A list is given of important papers by Prof. Turner and members of his staff that have appeared since the last report.

THE Borough Polytechnic, in Borough Road, London, was honoured on Feb. 20 by a visit from the Duke of York, on the occasion of the opening of its new buildings; this being the culmination of a series of similar functions which began with the opening last October by the Queen of the extension of the Regent Street Polytechnic. The Borough Polytechnic, the oldest and still the largest of the group of institutions founded under the scheme drawn up forty years ago by the South London Polytechnic Council, was opened by Lord Rosebery in September 1892. During the last seven years the volume of its work has increased by fifty per cent, and additional accommodation, for which the London County Council gave grants amounting to £80,000, had become urgently necessary. Even now, pressure on the available accommodation is excessive. The class entries total nearly 10,000, as follows: day schools, 568; day classes, etc., 287; evening departments of mechanical engineering and building, 1918; electrical engineering, 2068; chemistry, 667; chemistry of oils, colours, and varnishes, 401; mathematics, 893; tailoring, 126; bakery and confectionery, 308; art classes, 469; women's trade classes, 303; women's domestic economy classes, 664; language classes, 295; music and elocution, 374; gymnasia, 495. To the question "What can science do for industry?" many and various answers have in the course of the past few weeks been broadcast. The Duke of York dwelt, in his address, on a branch of science the votaries of which can indeed, albeit indirectly, through wise direction of consumption and beneficial influence on the moral and physical welfare of the personnel of industry, give more potent help than any other—domestic science with its correlative crafts. He commended the care taken by the Polytechnic in instructing girls and young women in the sciences and arts that make for the building up of good and comfortable homes.

Historic Natural Events.

Mar. 3-4, 1886. Hurricane in Fiji.—This very severe hurricane caused the loss of many lives and the destruction of much valuable property, and was the worst experienced for many years. It travelled from north-east, across the centre of the group, recurving over the Koro Sea and passing away to the south-east, at an average speed of nearly 15 miles per hour. It had a calm centre with a diameter of 25 or 26 miles, in which the barometer fell to about 935 mb. (27·6 inches). Near the vortex the barometric gradient was 33 mb. (nearly one inch) in 50 miles. The town of Vuna in Taviuni was completely wrecked; nearly all the houses were blown down, and then were swept away by a hurricane wave or buried in the sand and shingle. From the coast to the tops of the hills nothing remained but bare sticks and the blackened, torn, and twisted relics of the foliage. Most of the small islands suffered from the storm wave, which came in like a wall, and penetrated inland as much as 700 yards. In some places debris was left in the trees 30 feet above high-water mark. At Vanuaso a shark was killed among the houses.

Mar. 5-7, 1595. Great Floods.—The winter of 1594–95 was very severe; all the rivers of western and central Europe were frozen hard, including the Po and the lagoons of Venice. There was a great accumulation of snow, which began to melt rapidly at the end of February during a period of thaw; this and the break-up of the ice caused great ice floods in the valleys of the Rhine, Moselle, and Elbe, which broke down the strongest stone bridges. The Thames was frozen, but there is no record of flooding in London.

Mar. 6, 1716. Remarkable Aurora.—A detailed account of this wonderful aurora was drawn up by Halley at the request of the Royal Society, and is published in *Phil. Trans.*, 1716, p. 406, under the title, "An Account of the late surprising Appearance of the Lights seen in the Air, on the sixth of March last; with an Attempt to explain the Principal Phænomena". This aurora was seen from almost the whole of northern Europe and so far south as the north-west coast of Spain. In England the display commenced at 7 P.M. and lasted until 3 A.M. on the following morning when the moon rose. The most spectacular phase was from 7 P.M. until about 9 P.M., including the short-lived appearance near the zenith of a 'corona' tinged yellow, red, and a dusky green. Throughout, the display was remarkable for the variety and rapidity of its changes as well as for its brilliance. Halley remarks: "Nor is the like recorded in the English Annals since the year of our Lord 1574": also ". . . it seems, in little more than eighteen months, this sort of light has been seen in the sky, no less than five times; in the years 1707 and 1708". *Phil. Trans.*, 1716, p. 430, gives an account of the recurrence of the aurora on Mar. 31, April 1 and 2, 1716, *i.e.* about one solar rotation later. Wolf found that during the period 1716–19 sunspots were unusually numerous, though no large spot appears to have been observed about the time of this aurora.

Mar. 7, 1925. Abnormal Rains in Peru.—The coastal regions of Peru are in general almost rainless; for example, at Trujillo in the seven years 1918–24 inclusive, the total rainfall was only 1·4 inches. On Mar. 7–9, 1925, however, no less than 8·9 inches fell, and by the end of the month the total had risen to 15½ inches. Similar abnormal rains occurred all along the coast, beginning in January but reaching their maximum in March. Great floods resulted, doing serious damage to buildings, machinery, roads, and crops. The normal absence of rain is associated with the presence off the coast of the cold Humboldt

current, but at rare intervals a warm current, known as El Niño (The Child), because it usually appears about Christmas, flows down the Peruvian coast. Early in 1925 this warm current was abnormally developed, temperature rose 10° or 20° higher than usual, and violent thunderstorms occurred.

Mar. 7, 1927. Earthquake in Tango District (Japan).—A strong earthquake occurred in the Tango peninsula on the north side of the main island of Japan. The number of lives lost was 3017, while several small towns were ruined. Crust-displacements took place along two old faults nearly at right angles to one another. On the Go-mura fault, the ground shifted, along 11 miles, by so much as 9 ft. 2 in. horizontally and 2 ft. 7 in. vertically. Repeated surveys in the central tract showed that movements continued for a year or more, and that the crust was divided into a number of blocks that moved easily and not always in the same directions.

Mar. 8, 1920. Haloes in America.—A very fine display of solar haloes began at 11.30 A.M. at Ellendale, South Dakota, and other parts of the central United States. In addition to the haloes of 22° and 46°, there were visible circumscribed arcs, parhelia, anthelion of 180°, and other phenomena, some of which exhibited brilliant prismatic colours. The phenomena awakened great interest in the subject in America.

Mar. 8 (or 10), 1543. Mississippi Flood.—The history of De Soto's expedition on the North American continent states: "Then God, our Lord, hindered the work with a mighty flood of the great river, which at that time began to come down with an enormous increase of water, which in the beginning overflowed the wide level ground between the river and the cliffs; then little by little it rose to the top of the cliffs. Soon it began to flow over the fields in an immense flood, and as the land was level without any hills, there was nothing to stop the inundation. . . . On Mar. 18, 1543, . . . when the Spaniards were marching in procession, the river entered with ferocity through the gates of the town of Aminoya (a short distance below the mouth of the Arkansas River), and two days later they were unable to go through the streets except in canoes. . . . The flood was 40 days in reaching its greatest height, which was April 20, and it was a beautiful thing to look upon the sea where there had been fields, for on each side of the river the water extended over twenty leagues of land, and all of this area was navigated by canoes, and nothing was seen but the tops of the tallest trees."

Societies and Academies.

LONDON.

Royal Society, Feb. 20.—**A. C. Davies, F. Horton, and E. Blundell**: Critical potentials for the excitation of soft X-rays from iron. Critical potentials for excitation of soft X-rays from solids, and for production of secondary electrons from solids, under electronic bombardment, do not conform with the view that characteristic displacements take place of electrons forming the outermost extranuclear groups in the bombarded atoms. The experiments deal with critical potentials for soft X-ray excitation from iron, rolled into thin strip from a drawn wire, for different temperatures and also for the same specimen at room temperatures, after being subjected to various heat treatments. Many critical potentials were produced, mostly persisting throughout the subsequent conditions of the target, once they had made their appearance; only one—at 201 volts—justifies the conclusion that its presence was dependent upon the iron strip being at a high temperature.—**L. M. T. Gray and D. W. G. Style**: The absorption of light by chlorine, bromine, and their gaseous mixtures. The independence of the absorption of chlorine of the intensity or nature of the incident radiation was tested by various methods. Extinction coefficients of bromine vapour have been determined at room temperature for certain mercury arc lines. The absorptions of mixtures of chlorine and bromine confirmed the existence of BrCl.

Linnean Society, Jan. 23.—**H. W. Renkema and John Ardagh**: Aylmer Bourke Lambert and his 'Description of the Genus *Pinus*'. Lambert was the son of a country gentleman, of Boyton, Wiltshire. Among his friends at Oxford, where he matriculated in 1779, were Joseph Banks and the principal founder, in 1788, of the Linnean Society, James Edward Smith. Lambert was an original fellow of the Society and for fifty years was vice-president. His chief contributions to botanical science were the accumulation of a large library and herbarium, and the spacious monograph of the genus *Pinus*. A detailed description was given of the contents of all the copies of the volumes of the various editions to which the authors, in Holland and London respectively, have had access or on which they have been able to obtain reliable information.—**G. Tandy**: Sundry observations on *Caulerpa*. On the low wooded islands and inner reefs of the Australian Great Barrier system, two species are of importance as sand- and shingle-binders, and it is probable that nowhere else in the world are conditions so favourable for this habit. They are in the broad sense (for they are polymorphic) *C. racemosa* (Forsk.) J. C. Agardh and *C. cupressoides* (Vahl) C. A. Agardh. The latter is common on Batt Reef, which belongs to an inner series and is not a linear or true barrier reef. The former is very common on Low Isles and is a member of the turf of the mangrove park.

Physical Society, Jan. 24.—**J. M. Nuttall and E. J. Williams**: A method of examining stereoscopic photographs. The photographic plates are replaced in the cameras and illuminated, and a system of movable pin points is used to trace out the contour of the image (see NATURE, May 25, 1929, p. 799). The chief advantage of the method is its simplicity—practically no computation is required and it is not necessary to know the stereoscopic angle, the magnification, etc.—**Miss A. W. Leyshon**: Characteristics of discharge tubes under 'flashing' conditions, as determined by the use of a cathode ray oscillograph. Current-voltage characteristics are determined. Current-time and voltage-time curves are derived from the oscillograph records. The method might prove useful in investigations on intermittent discharges in various gases under different conditions of pressure and disposition of the electrodes.

Royal Meteorological Society, Feb. 19.—**G. C. Simpson**: The distribution of terrestrial radiation. (*a*) The geographical distribution of incoming and outgoing radiation during January and July has been determined and was exhibited on maps. (*b*) The incoming and outgoing radiations for each 10° zone of latitude have been calculated for each month of the year. (*c*) The result indicates great uniformity in the intensity of the outgoing terrestrial radiation, both in time and space, and that, except for small uncertain irregularities, the total outgoing radiation from the earth as a whole just balances the incoming solar radiation at all periods of the year.—**C. K. M. Douglas**: The cyclonic depressions of Nov. 16 and 23, 1928. Autographic records are reproduced showing the conditions close to the

centres of these two intense cyclones. In both cases the first cold front soon advanced beyond the trough line of the cyclone. This happens with nearly all intense cyclones, owing to the fact that the gradient wind behind the cold front is much greater than the rate of travel of the cyclone itself, even when this is large. The speed of advance of these cyclones was greater than that of the general current in which they travelled. This 'excess velocity' is characteristic of systems with warm sectors.

DUBLIN.

Royal Irish Academy (at Belfast), Feb. 10.—K. G. Emeléus: Velocities of ions in the cathode dark space. Existing data for the distribution of velocities in positive rays are discussed with the view of obtaining the distribution at the front surface of the cathode; little definite information is obtained, but an analogy is found between the capture of electrons by protons and by α-particles. The distribution at the cathode is calculated from Aston's and Brown and Thomson's results for the space-charge in the dark space. The possible effect of the cathode glow in distributing the velocities of particles traversing it is discussed, with the bearing of the results on sputtering.—A. Mahr: The Viking sword from Ballinderry, Co. Westmeath. The blade shows the inlaid name of the maker, Ulfberht, a well-known Frankish smith whose blades have been found scattered from France to Esthonia. Another name, Hiltipreht, appears on the silver gilted quillon. The name is Bavarian or Austrian, and Hiltipreht must have worked somewhere on the Low Rhine, where the Norsemen got their first supply of such weapons. Hiltipreht was not the owner but the cutler of the sword. In 841 the Vikings destroyed the famous town Wijck bij Duurstede in South Holland, at the time the important emporium for Scandinavian trade. Our sword was presumably then brought to Norway and from Norway to Ireland. Thorgestr, first Norwegian King of Dublin, raided Clonmacnois in 843, and as the Ballinderry Crannog is only a few miles distant we may assume that the sword came into Irish hands on this occasion.—J. K. Charlesworth: Some geological observations on the origin of the Irish fauna and flora. During the glacial period, life was impossible in Ireland and off the western coast and just possible in the case of Arctic forms off the southern coast. A fauna and flora entered over a land connexion during the Aurignacean oscillation, but with the exception of the Arctic species was probably exterminated during the succeeding glaciation. The greater part of the Irish fauna and flora entered post-glacially by a land-bridge, aided by accidental dispersal.

PARIS.

Academy of Sciences, Jan. 20.—Charles Moureu, Charles Dufraisse, and Pierre Lotte: The phenomena of luminescence in the satellites of rubrene. Two phosphorescent hydrocarbons: the so-called 'brown' substance and the yellow substance.—Jean Baptiste Senderens and Jean Aboulenc: The catalytic dehydration of the fatty alcohols by alkaline bisulphates. The boiling points of the first members of the series up to isobutyl alcohol are too low for any reaction with sodium bisulphate to take place, but from isoamyl alcohol onwards mixtures of ether and hydrocarbon are obtained. Normal heptyl alcohol gives heptyl ether without heptylene.—Marcel Delépine was elected a member in the Section of Chemistry, in the place of the late Charles Moureu.—L. Godeaux: The connected points of cyclic involutions belonging to an algebraic surface.—P. Vincensini: Certain normal congruences.—Bertrand Gambier: Systems of circles, of spheres, and of hyperspheres.—Pierre Humbert: Bessel functions of the third order.—K. Kunugui: The classes of dimensions.—J. A. Grégoire: A new mode of transmission of rotations with conservation of the velocity between two shafts with variable angle. Hooke's joint, a combination of two Cardan's joints, although theoretically perfect, gives rise to practical difficulties. The new joint proposed is theoretically homokinetic, and has been practically realised in connexion with motor-cars.—Renaux: Contribution to the study of the reduction of photographic negatives. Discussion of a method of studying the position of stars from photographs.—J. Dufay: A new astronomical photometer: application to the study of two variable stars with eclipses.—J. Galibourg: The ageing of cold-hardened metals. A continuation of the study of the effects of cold-hardening on nickel.—P. Vaillant: The absorption of cobalt salts in concentrated solutions. From the whole of the experimental results obtained, it is concluded that for solutions of cobalt salts the modifications arising in the absorption spectrum from the substitution of one anion for another, from a change of concentration, or from a change of solvent, can be reduced to a Kundt displacement and a change of intensity. These results are not necessarily in disagreement with the ionic theory.—P. Dutoit and Chr. Zbinden: The spectrographic analysis of organs. The ashes of about fifty human organs have been submitted to spectrographic analysis by the arc spectrum method: a summary of the results is given.—Edlén and Ericson: The spectrum of aluminium in the extreme ultra-violet.—E. Sevin: The means of deciding between the corpuscular nature and the purely undulatory nature of light and of the X-rays.—Fahir Emir: Surface solutions on mercury. Study of oleic acid. A description of the special precautions taken to prevent oxidation of the mercury surface. The thickness of the saturated film found was 24 A., as against 23 A. found previously for water. This confirms the hypothesis of molecular juxtaposition at the point of saturation.—Victor Henri: The heat of dissociation of the molecule of oxygen and the energy of activation of the oxygen atom. From work based on the study of the absorption spectrum of nitrogen peroxide, the energy of the normal dissociation of the oxygen molecule is deduced as 128,000 calories.—Mlle. Suzanne Veil: A mixed nickel-cobalt oxide and the corresponding ferrite.—L. Meunier and M. Lesbre: A new method of observation of the evolution of solutions of chromic salts.—R. Bernard and P. Job: The oxidation of cobalt salts in alkaline media. From a spectrophotometric study of this reaction, it appears that the passage from the cobaltous to the cobaltic state is through the intermediary of a percobaltic compound, CoO_2, in which the cobalt is tetravalent.—J. Grard: Bromomalonic dialdehyde. This exists in the forms CHO.CHBr.CHO and CH(OH):CBr.CHO; the second of these possesses acid properties and gives well crystallised metallic salts.—L. Palfray and B. Rothstein: The 1, 3-cyclohexanediol (resorcite) stereochemical isomers and halogen derivatives.—F. François: The selenoxanthydrols. Their basicity. The replacement of the oxygen of xanthydrol by selenium does not change the basic character of this alcohol.—H. Besairie and Mlle. E. Basse: New stratigraphical and palæontological observations on the lower and middle Cretaceous of the province of Maintirano (west of Madagascar).—Raymond Furon: Some new points of the geology of the western Sudan (Diawara, Kaarta, and Fouladougou).—Laurent Rigotard: The rôle of sulphur in the formation of plant soil. A study of the part played by sulphur in the formation of Alpine soils.—Louis Dangeard: The presence of *Solenopora* in the oolitic and pisolitic formations of

the Lusitanian of Mortagne (Orne).—**M. Bridel** and **C. Charaux**: Researches on the variation of the coloration of plants in the course of drying. A new chromogen, oroberol, extracted from *Orobus tuberosus*.—**B. Soyer**: The variation of the permeability of the cells in the course of growth in a ligneous plant. Measurements of the permeability of the plant cell show that the migrations in spring and autumn are accompanied by marked modifications in the cellular permeability, modifications facilitating the circulation of the liquids in the tissues.—**P. Chevey**: The value of the method of examination of the scales applied to fishes of the intertropical zone. A difference of only 4°-5° C. between the summer and winter temperatures of the sea is sufficient to change the rate of growth of fishes as shown on the scales. Conclusions are drawn regarding the thermal changes in the coastal waters of Siam, Cochin China, and Tonkin.—**J. Millot**: Colulus and non-functional fibre producing structures in the Araneideæ.—**C. N. Dawydoff**: Some observations on the *Ctenoplana* of Chinese seas.—**L. Garrelon, D. Santenoise, H. Verdier**, and **M. Vidacovitch**: The pancreas and pneumogastric excitability. The pancreas exerts an important action on the functional activity of the growing nervous system, by secreting and pouring into the blood a vagotonising hormone not identical with insulin.—**René Hazard** and **Michel Polonovski**: The physiological rôle of the tertiary amine function in the pyrrolidine-piperidine nucleus. The importance of the idea of isomerism.—**R. Meesemaecker**: A new colour reaction of ergosterol. The differentiation of ergosterol from irradiated ergosterol. The colour is developed by addition of anhydrous zinc chloride, with or without acetic anhydride, to the ergosterol in chloroform solution. With zinc chloride alone, the colour depends on whether the sample has been exposed to light or not.—**L. Lutz**: The soluble ferments secreted by the Hymenomycetes. Hydrocarbons and terpene oxides, constituents of the essential oils and the antioxygen function.—**M. Azéma** and **H. Pied**: Vanadium in the blood of Ascidians. The presence of vanadium in the blood of *Phallusia mamillata*, first discovered by Henze, is confirmed, and two other Ascidians, *Ascidia mentula* and *Phallusia fumigata*, also gave strong spectroscopic evidence of the presence of vanadium. *Botrylloides*, and *B. smaragdas* also contained vanadium, but in smaller amount.—**Constantino Gorini**: Heterogeneous mammary cocci, their dissociation.—**E. Plantureux**: The nature of the transmissible lysis of bacteria.—**Arnault Tzanck** and **Jean Charrier**: The treatment of grave hæmorrhage of different forms.

BRUSSELS.

Royal Academy of Belgium, July 6.—**Cl. Servais**: The geometry of the tetrahedron (3). The congruence of the axes of symmetry of the paraboloids conjugated to a tetrahedron.—**Th. de Donder**: Affinity (2). Study of physico-chemical systems with the added condition that the masses may vary.—**Th. de Donder**: The invariantive theory of the calculus of variations (6).—**André Jamotte**: Note on the discovery of a *Glossopteris* flora in the Lukuga valley, in the neighbourhood of Greinerville (Belgian Congo). The flora described shows great affinities with that of the middle part of the Ecca series of the typical region of the Karroo. The Ecca series is considered to be of Permian age.—**Erwin Schuntner**: The application of continuous groups to discontinuous linear groups.—**Constant Lurquin**: The criteria of probability in the sense of Bienaymé-Tchebycheff.

Aug. 3.—**Raymond Defay**: Introduction to the thermodynamics of open systems.—**Erwin Schuntner**: The application of continuous groups to discontinuous linear groups (2).—**Lucien Godeaux**: Remarks on the envelope of the Lie quadrics of a surface.—**P. E. Bourgeois** and **J. F. Cox**: Contribution to the research on the cause of the non-uniform distribution of the longitudes of the peristars of the spectroscopic double stars.

ROME.

Royal National Academy of the Lincei: Communications received during the vacation, 1929.—**O. M. Corbino**: Functioning of the triode with strong magnetic coupling with an iron nucleus between plate circuit and grid circuit.—**A. Angeli** and **Zvi Jolles**: Certain oxidation processes determined by normal diazo-hydrates. It was shown recently that, under the action of stannous hydroxide, normal diazobenzene hydrate loses its oxygen atom to give rise to a highly labile product, $C_6H_5.N:NH$, which afterwards undergoes a series of transformations, one of these resulting in the formation of benzene. This oxidising action of diazobenzene hydrate has now been demonstrated with ferrous hydroxide, hydrogen peroxide, hydroxylamine, potassium ferrocyanide, and ammonium sulphide.—**B. Longo** and **C. Paderi**: The biological significance of alkaloids on plants. Experiment shows that alkaloids act, both on seeds and on plants containing them, as true excitants. The exciting action is specific in the case of plants, but not with seeds.—**B. de Finetti**: The possibility of exceptional values for a law of aleatory increments.—**G. Colonnetti**: Alterations in the elastic condition of a mortised arch effected by addition of a chain.—**B. Finzi**: Observations on the regular motion of viscous liquids.—**F. Lamberti**: The component elementary motions of the relative baricentric motion of a material system.—**E. Raimondi**: Dynamic effect of a translatory current investing a thin cylinder in the neighbourhood of an independent plane wall.—**M. Merola**: Study of the variable SX Herculis. A series of 82 photometric observations made on this star at Capodimonte between Aug. 27, 1927, and Dec. 1, 1928, allow of the determination of two maxima and two minima, thus confirming the irregularity of the period and of the light curve noticed by other observers.—**S. Aurino**: The photometric system of Naples. Comparison of the Draper Catalogue with the Astrographic Catalogue of Catania reveals the existence of a systematic error in the Draper Catalogue function of stellar magnitude. The photometric system of Naples appears to be in excellent agreement with Miss Leavitt's system of photographic photometry (Harvard).—**C. Cannata**: The ballistic hypothesis and the verification of the law of areas in the orbits of telescopic stars. Results are given which show that, for the orbits of telescopic stars, the perturbations induced by the ballistic hypothesis are generally insignificant. Moreover, with rare double stars in which such perturbations appear relatively conspicuous, these are always within the limits of observational errors. For orbits of slight eccentricity, the perturbations leave undisturbed the obedience to Kepler's second law.—**E. Persico** and **F. Scandone**: The Hall effect with extended electrodes (2).—**M. Lelli**: W. Thomson's minimum heat theorem. Comparison is made between the Joule heat evolved in unit time by a conductor traversed by a current and that evolved when, not the current intensity, but the values of the potential (supposed everywhere continuous) at the electrodes are fixed, and when also at every point Ohm's law of movement but not that of continuity of current is satisfied. This is equivalent to comparing the effective stationary regime naturally established in the conductor with others provoked by keeping the terminal potentials unchanged by immission in certain zones and emission in others. The result shows that, in the former case, the Joule heat generated is at a minimum, an extension

of Thomson's minimum heat theorem being thus deduced. The corresponding theorem of electrostatics is capable of analogous extension.—**F. de Carli**: Viscosity isotherms of binary mixtures (5): The system nitrobenzene-stannic bromide. Thermal analysis of this system does not reveal the formation of a compound between the components, but investigation of the viscosity-composition relationship demonstrates the existence of an additive compound, probably $2C_6H_5 . NO_2$, $SnBr_4$, stable in the liquid state.—**Giambattista Dal Piaz**: Geological data on the regions of the Aurine Alps and of the Giant Vedrettes (Upper Adige) (2).—**G. Brunelli**: The skeleton of teleostians studied by means of radiography, in relation to the mechanics of movement.—**U. Cassinis** and **L. Bracaloni**: Normal and alimentary alcoholhæmia during physical exercise (2).

Official Publications Received.

BRITISH.

The Quarterly Journal of the Geological Society. Vol. 85, Part 4, No. 340, December 31st, 1929. Pp. 389-689+plates 23-47. (London: Longmans, Green and Co., Ltd.) 7*s*. 6*d*.

River Flow Records: Ness Basin. River Garry (Inverness-shire): Report on River Flow, July to September 1929. By W. N. McClean. Pp. 4+3 tables. (London: River Flow Records.) 1*s*. 6*d*.

World's Poultry Congress, Crystal Palace, London, 22nd to 30th July 1930. The Post-Congress Tour, 31st July to 11th Aug. 1930. Pp. 24. (London: Ministry of Agriculture.)

Proceedings of the Cambridge Philosophical Society. Vol. 26, Part 1, January. Pp. 121. (Cambridge: At the University Press.) 7*s*. 6*d*. net.

Air Ministry: Aeronautical Research Committee. Reports and Memoranda. No. 1266 (E. 34): Experiments on Flame Extinction in Gaseous Mixtures. By Squadron Leader W. Helmore. Work performed for the Aeronautical Research Committee at the Cambridge University Engineering Laboratory. (I.C.E. 680, revised.) Pp. 17+4 plates. (London: H.M. Stationery Office.) 1*s*. net.

Pharmaceutical Society of Great Britain: Pharmacological Laboratories. Fourth Annual Report, 1929. Pp. 16. (London.)

Worcestershire County Council: Agricultural Education Sub-Committee. Ox Warble Fly: Report on the Demonstration and Experiments carried out in Worcestershire in 1928 and 1929. Pp. 26. (Worcester.)

Liverpool Observatory and Tidal Institute. Annual Report, 1929. Pp. 15. (Liverpool.)

Gold Coast Survey Department. Professional Paper No. 1: Notes on the Application of the Method of Least Squares to the Adjustment of Triangulation and Level and Traverse Networks. By J. Clendinning and F. Yates. Pp. iii+81. (Accra: Government Printing Office.) 10*s*.

Transactions and Proceedings of the New Zealand Institute. Vol. 60, Part 3, September 1929. Pp. iv+379-520+plates 33-59. (Wellington, N.Z.)

Hull Museum Publications. No. 161: Meaux Abbey. By T. Sheppard. Pp. 32. No. 162: Catalogue of the Mortimer Collection of Prehistoric Remains from East Yorkshire Barrows. By T. Sheppard. Pp. viii+146. 1*s*. No. 163: Hull Museum Treasures. By T. Sheppard. Pp. 32. No. 164: Cissbury; Evolution of Furniture; Lincolnshire Worthies. By T. Sheppard. Pp. 22. No. 165: Catalogue of the Fewster Collection of F. S. Smith's Sketches of Old Hull. By T. Sheppard. Pp. v+32. No. 166: The Position a Museum should hold in the Life of a Community? by Sir Frederic G. Kenyon; The Mortimer Collection of East Yorkshire Antiquities, by T. Sheppard. Pp. 10. (Hull.)

Proceedings of the Geologists' Association. Edited by A. K. Wells. Vol. 40, Part 4, January 31st. Pp. 307-394+plates 27-32. (London: Edward Stanford, Ltd.) 5*s*.

Journal of the Chemical Society. January. Pp. iii+185+xvi. (London.)

Department of Scientific and Industrial Research. Report for the Year 1928-29. (Cmd. 3471.) Pp. v+200. (London: H.M. Stationery Office.) 3*s*. 6*d*. net.

FOREIGN.

United States Department of Agriculture: Weather Bureau. Monthly Weather Review. Supplement No. 32: Climatological Data for Southern South America. By W. W. Reed. (W.B. No. 995.) Pp. ii+23. (Washington, D.C.: Government Printing Office.) 10 cents.

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 81. A Further Collection of Birds from Siam. By Rodolphe Meyer de Schaunsee. Pp. 523-588. Notes on Japanese and Chinese Fishes. By Henry W. Fowler. Pp. 589-616. (Philadelphia.)

Proceedings of the United States National Museum. Vol. 79, Art 18: Two New Mollusks of the Genera Ostrea and Exogyra from the Austin Chalk, Texas. By Lloyd W. Stephenson. (No. 2815.) Pp. 6+3 plates. (Washington, D.C.: Government Printing Office.)

Publikace Pražské Státní Hvězdárny. Čis. 6: The Spectral Distribution of Stars, magnitude 7·0 and brighter, in the Henry Draper Catalogue. By Dr. Otto Seydl. Part 1: Text and Tables. Pp. 54. Part 2: Maps. Pp. ii+14 maps. (Prague.)

Bulletin of the American Museum of Natural History. Vol. 59, Art. 2: The Pennsylvanian Tetrapods of Linton, Ohio. By Alfred S. Romer. Pp. 77-147. (New York City.)

United States Department of Commerce: Coast and Geodetic Survey. Serial No. 455: Results of Magnetic Observations made by the United States Coast and Geodetic Survey in 1928. By Daniel L. Hazard. Pp. ii+35. (Washington, D.C.: Government Printing Office.) 10 cents.

The University of Colorado Studies. Vol. 17, No. 3: Abstracts of Theses for Higher Degrees in the Graduate School, 1929. (University of Colorado Bulletin, Vol. 29, No. 14, General Series No. 275.) Pp. 193-263. (Boulder, Colo.) 1 dollar.

Unione Astronomica Internazionale. Immagini spettroscopiche del bordo solare osservate a Catania, Madrid, Zô-Sè e Zurigo negli anni 1925 e 1926. Pubblicate per cura del R. Osservatorio Astrofisico di Arcetri. Pp. 11+19 tavole. (Firenze.)

Pubblicazioni della R. Università degli Studi di Firenze. Fascicolo N. 46: Osservazioni e Memorie del R. Osservatorio Astrofisico di Arcetri. Pp. 98+2 tavole. (Firenze.)

CATALOGUES.

X-Ray Couches, Screening Stands, Tube Stands, etc. Pp. 24. (London: Watson and Sons (Electro-Medical) Ltd.)

The "Sunic" Surgical Diathermy Apparatus. Pp. 4. (London: Watson and Sons (Electro-Medical) Ltd.)

English Colour Plate Books of the Nineteenth Century: a Catalogue of Books of Sport, Travel and Humour. (New Series, No. 5.) Pp. 32+7 plates. (London: Francis Edwards, Ltd.)

Diary of Societies.

FRIDAY, FEBRUARY 28.

ELECTRICAL ASSOCIATION FOR WOMEN (at 46 Kensington Court), at 3.—L. L. Robinson: Tariffs.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—C. H. N. Lock: The Equations of Motion of a Viscous Fluid in Tensor Notation.—W. L. Watton: A New Type of Dewar Flask, for Use as a Calorimeter.—R. O. Cherry: Field Intensity Measurements around some Australian Broadcasting Stations.

ROYAL SOCIETY OF MEDICINE (Disease in Children Section), at 5.30.

JUNIOR INSTITUTION OF ENGINEERS (Informal Meeting), at 7.30.—J. Rowcroft: The Design of Dynamos for Automobiles.

ROYAL SOCIETY OF MEDICINE (Epidemiology Section), at 8.—Sir Leonard Rogers: Further Experience in Forecasting Epidemics in India and their Bearing on the Reduction of Cholera Epidemics.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. G. I. Taylor: A Tour in the East Indies.

INSTITUTION OF ELECTRICAL ENGINEERS (West Wales—Swansea—Sub-Centre).—L. C. Grant: The Breaking Performance of High-Power Switchgear and of a New Form of Quenched-Arc Switch.

SATURDAY, MARCH 1.

GEOLOGISTS' ASSOCIATION (at Museum of Practical Geology, Jermyn Street), at 2.30.—C. P. Chatwin: Demonstration of The Palæontology of the Reigate Sheet.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—W. Rothenstein: Nineteenth Century Painting in France and England (2).

MATHEMATICAL ASSOCIATION (London Branch) (at Bedford College), at 3.—Prof. W. M. Roberts: Energy and some Points in Statics.

GILBERT WHITE FELLOWSHIP (at Queen Square, W.C.1), at 3.—Conversazione and Exhibition.

MONDAY, MARCH 3.

ROYAL SOCIETY, EDINBURGH, at 4.30.—W. N. McClean: River Flows of the Ness Basin.—Gertrude Lilian Elles and C. E. Tilley: Metamorphism in Relation to Structure in the Scottish Highlands.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Lieut.-Col. T. C. Skinner: The Significance of the Old Testament Scriptures to our Lord Jesus Christ.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Affections of Lymphatic Glands.

SOCIETY OF ENGINEERS (at Geological Society), at 6.—J. Pickin: Machine Tools, followed by a Film entitled A British Key Industry.

ROYAL INSTITUTION OF GREAT BRITAIN, at 6.—General Meeting.

INSTITUTION OF AUTOMOBILE ENGINEERS (Bristol Centre) (at Merchant Venturers' Technical College, Bristol), at 7.—H. R. Ricardo: Combustion in Diesel Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. J. Fisher and others: Discussion on Push-Button Control.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Lt.-Col. S. E. Monkhouse and L. C. Grant: The Heating of Buildings Electrically by means of Thermal Storage.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section—London) (Annual Meeting), at 7.—Informal Discussion on Workshop Practice at Home and Abroad.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—F. Pick: The Design of Modern Railway Stations in Europe and America.

ROYAL SOCIETY OF ARTS, at 8.—A. B. Searle: Recent Improvements in Methods of Brickmaking (Cantor Lectures) (3).

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—Dr. C. Ainsworth Mitchell: Circumstantial Evidence from Fibres and Hairs.—H. M. Langton: The Splitting of Castor Oil.

TWICKENHAM LITERARY AND SCIENTIFIC SOCIETY (at Free Library, Twickenham), at 8.—Rev. Dr. J. J. Doyle: Some Aspects of Higher Education in the United States.

INSTITUTION OF THE RUBBER INDUSTRY (London and District Section) (at Engineers' Club, Coventry Street).—Dr. H. A. Daynes: Methods and Appliances used for the Control of some Manufacturing Processes in the Rubber Industry.

TUESDAY, MARCH 4.

ROYAL SOCIETY OF ARTS (Indian Section), at 4.30.—T. M. Ainscough: British Trade with India.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. A. Glover: The Incidence of Rheumatic Diseases (Milroy Lectures) (1).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Sir William Bragg: X-ray Determination of the Structure of Cellulose and Similar Substances (4).

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—A. B. Martynov: On the Trichopterous Fauna of China and Eastern Tibet.—Dr. R. E. Drake-Brockman: A Review of the Antelopes of the Genera *Madoqua* and *Rhynchotragus*.—M. Burton: Norwegian Sponges from the Norman Collection.—Dr. Marie V. Lebour: The Larval Stages of *Caridion* (Crustacea) with a Description of a New Species.—H. W. Kew: On the Spermatophores of the Pseudoscorpions *Chthonius* and *Obisium*.—W. S. Bristowe: A Supplementary Note on the Mating Habits of Spiders.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—E. H. Smythe and E. G. Weeks: Low-Temperature Carbonisation of Fuel, with Special Reference to its Combination with the Production of Electricity.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—R. N. Speaight: Some Interesting Personalities in Photography.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Royal Society of Arts), at 7.45.—H. R. Ricardo: Combustion in Diesel Engines.

ROYAL SOCIETY OF MEDICINE (Orthopædics Section), at 8.30.—S. A. S. Malkin and others: Discussion on Spasmodic Flat Foot.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre).—J. J. Denton: Television—Progress and Applications.

WEDNESDAY, MARCH 5.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—H. J. Lucas: Some Developments of the Piezo-Electric Crystal as a Frequency Standard.—J. E. P. Vigoureux: The Valve-Maintained Quartz Oscillator.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (at 29 Hart Street, W.C.1), at 7.—Discussion on The Space Required for Central Station Equipment.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.15.—B. A. Robinson: Address.

SOCIETY OF PUBLIC ANALYSTS AND OTHER ANALYTICAL CHEMISTS (at Chemical Society), at 8.—Dr. S. Judd Lewis: (*a*) The Spectroscopic Investigation of Jams and the like; (*b*) A Simple Polarimetric Test for Sugars in Jams; (*c*) A New Kjeldahl Distillation Apparatus.—Prof. M. S. Eldin Bey: The Detection and Identification of Alkaloids in the Saliva and Salivary Glands.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. R. Ling: Brewing as a Branch of Science.

INSTITUTION OF CHEMICAL ENGINEERS (at Geological Society), at 8.—Prof. W. E. Gibbs: The Formation and Growth of Crystals.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 8.30.—Pathological Evening.

ROYAL MICROSCOPICAL SOCIETY (Biological Section).

THURSDAY, MARCH 6.

ROYAL SOCIETY, at 4.30.—*Papers probably to be read:*—W. J. Elford: Structure in very Permeable Collodion Gel Films and its Significance in Filtration Problems.—T. W. Wormell: Vertical Electric Currents below Thunderstorms and Showers.—Dr. N. K. Adam: The Structure of Surface Films.

LINNEAN SOCIETY OF LONDON, at 5.—Dr. S. M. Manton: Notes on the Segmental Excretory Organs of Crustacea. V. On the Maxillary Glands of the Syncarida.—Prof. G. E. Nicholls: Addendum to his paper on *Micraspides*.—Major R. W. G. Hingston: In the Canopy of the Forest—British Guiana.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. J. A. Glover: The Incidence of Rheumatic Diseases (Milroy Lectures) (2).

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—J. B. S. Haldane: Some Problems of Genetics.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Major F. M. Green and H. C. H. Townend: Resistance of Air-cooled Engines.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Birmingham University), at 6.30.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group—Annual General Meeting), at 7.

SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (jointly with Institute of Fuel) (at Bristol University), at 7.30.—Dr. F. S. Sinnatt: The Cleaning of Coal.

CHEMICAL SOCIETY, at 8.—G. W. Fenton and Prof. C. K. Ingold: Influence of Poles and Polar Linkings on the Course Pursued by Elimination Reactions. Part VII. A Generalised Form of the Olefinic Degradation of Sulphones.—Prof. C. K. Ingold and J. A. Jessop: (*a*) Influence of Poles and Polar Linkings on the Course Pursued by Elimination Reactions. Part VIII. The Methylenic and Paraffinic Degradations of Sulphones. (*b*) Part IX. Isolation of Substance Believed to Contain a Semi-polar Double Linking with Participating Carbon.

PHILOLOGICAL SOCIETY (at University College), at 8.—N. B. Jopson: Work of the London Board of Comparative Philology.

FRIDAY, MARCH 7.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 2.45.—T. B. Layton: Demonstration of The Rhinological Anatomy of the Naso-frontal Duct and the Hiatus Semilunaris.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—The History of Mountains. Opener: Dr. Harold Jeffreys.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—L. W. Schuster: The Strength and Design of Fusion Welds for Unfired Pressure Vessels.

SOCIETY OF CHEMICAL INDUSTRY (Manchester Section) (at Engineers' Club, Manchester), at 7.—Dr. F. L. Pyman: Fine Chemicals.

INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—A. E. Moore and W. T. Slater: An Investigation of the Frequency Variations in Induction Watt-hour Meters.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group—Annual General Meeting), at 7.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (Informal Meeting) (at Bolbec Hall, Newcastle-upon-Tyne), at 7.15.—W. D. Horsley and others: Discussion on The Effect of the Use of Electricity in Workshops on Efficiency and Costs.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Lt.-Col. G. J. Hartley: Chile and Engineering in Chile.

INSTITUTE OF METALS (London Local Section) (at 83 Pall Mall), at 7.30.—A. Coad Pryor: The Manufacture of Glass and some of its more Interesting Properties.

GEOLOGISTS' ASSOCIATION (at University College), at 7.30.—Dr. A. E. Trueman: The Lower Lias (Bucklandi Zone) of Nash Point, Glamorgan.—A. A. Fitch: The Geology of Etchingham and Robertsbridge, Sussex.—G. S. Sweeting: The Geological Structure of the Ashburnham, Battle and Crowhurst Districts, Sussex, with Notes on the Wealden Iron Ore.

ROYAL SOCIETY OF MEDICINE (Anæsthetics Section), at 8.30.—Dr. C. Donald: Spinal Analgesia with Spinocain.—Dr. H. Jones: Percain 'Ciba', a New Regional and Spinal Analgesic, with Special Reference to High Thoracic Nerve-root (Splanchnic) Block.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. C. Tate Regan: Angler Fishes.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (jointly with Glasgow Section) (at Institution of Engineers and Shipbuilders, Glasgow).—J. S. F. Gard and R. F. Robinson: The Insulation of Heated and Cooled Surfaces.

OXFORD UNIVERSITY JUNIOR SCIENTIFIC CLUB.—Prof. C. E. Ingles: The Construction of a Great Suspension Bridge.

SATURDAY, MARCH 8.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Atomic Nuclei and their Structure (1).

PUBLIC LECTURES.

FRIDAY, FEBRUARY 28.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY (Department of Mathematics), at 5.30.—Prof. C. Størmer: The Mathematical Theory of the Polar Aurora. (Succeeding Lectures on Mar. 5 and 7.)

UNIVERSITY COLLEGE, at 5.30.—Prof. E. Gilson: L'Idée de Dieu dans la Philosophie de Descartes. (Succeeding Lecture on Mar. 3.)

SATURDAY, MARCH 1.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Dr. W. G. Ivens: The Solomon Islands and their People.

MONDAY, MARCH 3.

MEDICAL SOCIETY OF LONDON, at 5.15.—Mrs. Stella Churchill: Infant Welfare Schemes (Chadwick Lecture).

BIRKBECK COLLEGE, at 5.30.—Prof. Beresford Pite: An Isometric Diagram of the Construction of the Dome of St. Paul's Cathedral. Drawn by R. B. Brook-Greaves.

TUESDAY, MARCH 4.

UNIVERSITY COLLEGE, at 5.30.—Prof. J. de Vries: Early Teutonic Civilisation. (Succeeding Lectures on Mar. 7 and 11.)

BIRKBECK COLLEGE CHEMICAL SOCIETY, at 6.—Prof. A. McKenzie: The Migration of Hydrocarbon Radicles in Optically Active Compounds.

WEDNESDAY, MARCH 5.

KING'S COLLEGE, at 5.30.—Prof. P. N. Milyukof: The Past and Present in Russian History.

LONDON SCHOOL OF ECONOMICS, at 6.—Dr. G. H. Miles: The Problem of Incentives in Industry. (Succeeding Lectures on Mar. 12 and 19.)

BELFAST MUSEUM, at 8.—W. R. Gordon: The Progress of Modern Painting.

THURSDAY, MARCH 6.

UNIVERSITY COLLEGE, at 5.15.—Prof. O. Meyerhof: Chemistry of Muscle in relation to Problems of Cellular Physiology. (Succeeding Lectures on Mar. 7, 10, and 12.)

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY, at 5.30.—Dr. W. F. Bewley: Diseases of Glasshouse Plants. (Succeeding Lectures on Mar. 13 and 20.)

UNIVERSITY OF BIRMINGHAM.—Sir William B. Hardy: The Physical Basis of Life (Huxley Lecture).

SATURDAY, MARCH 8.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Prof. J. R. Ainsworth Davis: Casting Life in New Moulds.

CONFERENCE.

FEBRUARY 28 AND MARCH 1.

ASSOCIATION OF TECHNICAL INSTITUTIONS (at Skinners' Hall, Dowgate Hill, E.C.4).

Friday, February 28, at 10.30 A.M.—Lord Eustace Percy: Presidential Address.

C. R. Keene: The Relationship between the Teaching of Art and Technology.

Friday, February 28 (*afternoon*), and *Saturday, March* 1 (*morning*).—F. W. Goodenough: The Teaching of Salesmanship in Technical Colleges.

G. H. Gater: A Descriptive Account of Technical Education in London.

E. Salter Davies, Sir Percy Jackson, and Principal J. H. Everett: The Raising of the School Leaving Age and its Effect upon Technical Education.

Principal R. S. Clay and others: Discussion on Technical Education for the Plumbing Trade, with Special Reference to the Rural Apprentice.