NATURE

SATURDAY, MAY 15, 1926.

## CONTENTS.



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

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

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



## Science in Industry.

THE British Science Guild, the annual meeting of which was held on April 29, occupies a peculiar position among kindred societies. We have societies concerned with the promotion of science in general—notably the Royal Society—and of particular sciences such as chemistry, physics, geology, botany and zoology, and their numerous progeny—physical chemistry, biochemistry, and the rest. There are other societies—the Society of Chemical Industry is a good example—which devote themselves to the application of particular sciences to industry. The British Science Guild, founded by Sir Norman Lockyer in 1905 "to promote the application of scientific methods and results to social problems and public affairs," is not a scientific society, nor an institute of industry, nor an educational association. It is a national organisation, the chief purpose of which is to reconcile the interests of science industry, and education, and to co-ordinate their activities. Sir William Bragg, in a recent broadcast talk explaining the work of the Guild, said: "In originality of scientific work, mechanical ingenuity and operative skill, our race is in the forefront." This claim will be confirmed by the most cursory inspection of our national roll of men of science and invention. But there is something lacking, he suggests, and that is "a spirit of unity among all classes through the alliance of science, invention and labour working as a single force for national development and common welfare." To this "spirit of unity" the nation, beset by its war-heritage of financial and industrial problems, will have to pay increasing homage if it is to maintain its leading position, achieved in large measure through its "scientific work, mechanical ingenuity, and operative skill."

The traditional rôle of the British man of science is to discover fundamental scientific principles and to regard their application as a matter of subsidiary interest. Huxley, in his essay on the "Progress of Science," says that the history of physical science teaches that the practical advantages it offers never have been and never will be sufficiently attractive to men inspired by the inborn genius of the interpreter of Nature to give them courage to undergo the toils and make the sacrifices which that calling requires from its votaries. Their real stimulus comes from the joy of discovering the causes of things—from "the supreme delight of extending the realm of law and order ever farther towards the unattainable goals of the infinitely great and the infinitely small between which our little race is run." He refers to the practical applications of science as the "flotsam and jetsam of the tide of investigation" destined to be turned into the wages of workmen and the wealth of capitalists while the wave of scientific investigation advances proudly over the ocean of the unknown.

If Huxley adopted an exalted view of the value of pure scientific investigation, he recognised that the interests of science and industry are identical. There is happily an increasing recognition of the need for "the alliance of science, invention and labour" for which Sir William Bragg pleads, a need often illustrated by our scientific and industrial history. The classical example of the traditional rôle of the British man of science is provided by the history of the aniline dye industry, based on Sir William Perkins's discoveries. It is of interest to recall that when Perkins discovered, in 1856, the first aniline dye, 'mauvine,' he was working on the constitution of quinine. Diverse explanations have been offered of our failure to establish a great industry at an early stage on the basis of these discoveries. It has been said, for example, that after the death of the Prince Consort, Hofmann abandoned his professorship at the Royal College of Chemistry and returned to Berlin, taking with him a band of workers who possessed the expert knowledge of the aniline dyes. The late King Edward VII.'s great interest in the technological developments at South Kensington was due—so he assured Lord Haldane—to the fact that this work would have been accomplished by his father, the Prince Consort, but for his premature death. Others have suggested that the fate of the aniline dye industry in Great Britain was sealed by the control which English chemists exercised through their patents, by which so much money was made that they ceased to care whether the industry developed further.

Whatever may have been the cause, the dyestuffs industry in Great Britain was neglected, and the Germans took it up and by skill and patience developed the industry on a scale of which we are, alas, too often reminded. How much effort and money—both private and public—have been expended to recover the lost ground and what serious risks we have run in the meantime, even as regards our national security? Dr. E. F. Armstrong, in the course of his address at the annual meeting of the British Science Guild, while admitting that the fight is not yet won, was able to express optimism as to the future. He stressed the need for the application of scientific method to technical success, adding, however, that "it is more than ever true that without commercial prudence and ability, complete success is unlikely." The harvest of research ripens slowly, but the industry is finding its faith in research justified. At the present time the dyestuff industry in Great Britain is protected not by a tariff, but by absolute prohibition of the import of dyes and intermediates, except under licence, and it is satisfactory to learn that few licences are granted on the grounds of quality or price.

The original dyestuff industry in Germany, as Dr. Armstrong reminded his audience, grew into a synthetic organic chemical industry manufacturing drugs and many other synthetic products of everyday use. In addition, the industry became "a potential arsenal for chemical warfare." The improvisations made by Britain during the War involved mistakes which were paid for in human life and treasure, "but right well was the work done by our chemists; and the country can never repay, nor should she ever be allowed to forget, the debt she owes to them." Their work is being continued, and the dyestuff industry in Britain has made progress which, all things considered, is regarded as a real achievement by those in a position to judge.

The artificial silk industry occupies a brighter page in the scientific and industrial history of Great Britain. The silk thread is and has always been a manufactured article, not a natural product, whether the agent be a silkworm or a chemical worker. So long ago as the early years of the eighteenth century, Réaumur realised that what a worm could do, civilised man might also hope to accomplish. M. Bon at about this time produced gloves and stockings from a yarn formed from the web of the familiar domestic spider. The inventor and pioneer of the artificial silk industry, Hilaire de Chardonnet, deliberately applied his chemical knowledge to this problem. He succeeded in transforming cellulose into a soluble colloidal form, which he converted into a thread, and on the basis of this discovery he founded a factory in his native town, Besançon, and established a successful industry. Other processes followed, such as the Lehner process, established in Switzerland.

Of special interest to British chemists is the viscose reaction and process, by which cellulose in the form of wood-pulp is synthetically converted in two stages into the water-soluble sulphocarbonic hydrate ester. This process, discovered in 1892, was an incident in a sustained study of alkali-cellulose and the mercerising process conducted by Cross and Bevan from the year 1880. At the appropriate moment, the inventor gave invaluable assistance in the industrial application of the discovery. The industry is greatly indebted to the invention by C. Topham of the centrifugal spinning box known as the 'Topham box.' Finally, the necessary capital and enterprise were forthcoming for commercial exploitation. Messrs. Cortaulds took over the viscose experimental plant at the Kew works of the Zürich Lamp Company in 1904, and established new works at Coventry in the following year. But it was not until

1907 that the process was sufficiently advanced for industrial application on a large scale.

Another process for artificial silk production—the product is now known as 'celanese'—is based on cellulose acetate, the familiar aeroplane dope of the War, manufactured by the process of H. Dreyfus. In this case a great War industry was turned to a peaceful application. Many other processes for the production of artificial silk have been devised both in Great Britain and on the Continent. The exploitation of cellulose in its various forms has indeed attracted intensive and sustained study throughout the world. It is gratifying, especially to those who remember the chequered history of the aniline dye industry in Britain, that the viscose process, a triumph of British science and industry, has now acquired such an assured position.

Both men of science and men of affairs should read, mark and digest those contrasted histories. Their moral is fairly obvious. We have outgrown and outlived the Victorian age with its smug complacency, its narrow political creeds, its devouring animosities. To create a new world from these smouldering embers, we must recapture the Elizabethan spirit of adventure and combine with it "a spirit of unity among all classes through the alliance of science, invention and labour working as a single force for national development and human welfare." T. LL. H.

## Carbon and Silicon: the two Foundation Stones of the World.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry.* By Dr. J. W. Mellor. Vol. 6. C. (Part II). Si. Silicates. Pp. x+1024. (London: Longmans, Green and Co., 1925.) 63*s*. net.

DR. MELLOR tells us that the proverb 'diamond cut diamond' is of Hindu origin and that, "consonant with their mystic temperament and glowing imagination, the Hindus consecrated the diamond to their chief gods and attributed to it sovereign virtues."

Our temperament is such, that though mystics may prosper among us, we seem to have no imagination. If we had the least, we should worship diamond as the basis of life and every chemist would proudly display the gem as his sign of office. Every chemist, too, would marvel greatly at the properties of silicon and would seek to contrast them with those of carbon—one the symbol and substance of mobility and life, the other almost that of fixity and death. As it is, the physical chemist learns nothing of the chemistry of carbon and of life and less of that of silicon and silicates, the organic chemist nothing of silicates, though these pave the earth. Silica we can show but sadly, shut up in secrecy—yet we make gems of it and so honour it in silence.

This is the sixth volume of Dr. Mellor's stupendous treatise. Carbon and silicon, chiefly the latter, are the subject matter. It is impossible to do justice to the greatness of his work—to rate it at its proper value, to appreciate the truly scientific spirit in which, throughout the years, he has wrought for us, the excessive modesty of his presentation, his wondrous talent as a compiler, his almost uncanny faculty of unearthing information, his power of curt expression and concise statement, his logical, unbiassed attitude. That one man should accomplish so much is more than remarkable. Knowing him and having had the privilege of admission within his sanctuary, I have some understanding of his method and temperamental peculiarities, including his match-devouring capacity and his phlegm: but all may read his character in his work, if they will. What is not known is the wonderful manner in which the ways of his life are made smooth by the care of a devoted wife. Little as he is seen in the world, all who know him are his admirers and friends. He is not only the bibliophile and dictionary maker but himself a scientific worker and has long been scientific leader of the pottery industry. How entirely our Royal Society system fails in recognising scientific worth, how partial it is in its judgments, is shown by the fact that the Society, to our great loss, does not yet number him among its fellows.

Dr. Mellor's books are not for babes but every one who aspires to be rated a full-grown chemist should possess them and ponder their every page, scarce one of which does not offer many problems. They are costly but worth whatever sacrifice their purchase may entail. We may hope that when teaching is made rational and the farce is no longer perpetrated of calling upon students merely to memorise and reproduce, the existence of books such as Mellor's will be recognised and they will be treated as living instruments. Then, proof of power to read, interpret and *use* them, whenever occasion arise, will be asked for, instead of the parrot-like memorised acquaintance with the text-book now forced upon students.

The real value of the treatise lies in the demand its statements make upon the intelligence—the aid they afford as a key to the literature. Any one who has learnt to use it will have learnt to read: to ask himself what can be the meaning of the numerous, often diverse and irreconcilable statements that are on record. Indeed, the book is only to be read with full profit if it be read always in a critical comparative spirit. The author's attitude is nearly always non-committal: "Here are the statements for which you have paid me three guineas a volume, now take your choice." He never adopts the clerical (? neo-chemical), dogmatic attitude: perhaps he too rarely sums up or makes statements of odds. It is this quality, however, that gives all his writings their peculiar value and charm.

It is impossible to turn over the pages of such a book without being constantly reminded how incomplete and unreasoned is our knowledge. Take the question of the forms of carbon—" are graphite and the various 'chars' distinct forms of carbon, different from diamond?" It is clear, from X-ray analysis, that the carbon in graphite and in 'chars' is, at least in part, different from the carbon in diamond. The structure of the diamond, as determined by Sir William Bragg, is that we should expect on general chemical grounds. It may be regarded as a close-packed assemblage of regular tetrahedra. If we dissect out of a layer, a 'string' of the atoms and fully clothe these with hydrogen, we obtain a paraffin hydrocarbon—a linear assemblage in which lines drawn between the centres of contiguous carbon atoms meet at the tetrahedral angle. If, instead, we dissect out a hexagonal block of six carbon atoms and surround the system with only six hydrogen atoms, we get benzene. Graphite is clearly benzenoid and so are the chars, even the ground substance of coal: still, proof has yet to be given that pure graphite is carbon and carbon only. Sir Charles Parsons has been led to the conclusion, that no valid proof has yet been given that diamond can be produced from 'black carbon' nor indeed from any carbon compound. The heat of combustion of graphite is stated to be so near to that of diamond that a close equilibrium between the two forms is to be expected—if, indeed, they be allotropes. However complex, a purely benzenoid structure would scarcely involve blackness—this is rather to be regarded as proof of the presence of ethenoid carbon in addition to benzenoid. The writer has long inclined to the view that there is but one carbon—the diamond form—and that graphite and the black chars are hydrocarbons in which, may be, only a minute proportion of hydrogen atoms is present, yet sufficient to prevent the system lapsing into diamond.

Examination of the statements brought together by Dr. Mellor with reference to a second form of silicon but lends support to this view—in this case also there is no clear 'proof' of the existence of more than one form of the element.

It is surprising how little attention has been paid to silicon. Carborundum, which is next the diamond in hardness, also has received far too little notice. A colourless, crystalline compound, half carbon, half silicon, a product of the electric furnace, it has revolutionised the practice of machining steel work and almost made the file unnecessary but the chemist has paid it scant attention. What exactly is its structure? X-ray analysis has at least given the interesting result, that the distance apart of the atomic centres is considerably greater than that of the carbon atoms in diamond. A strict comparison is needed of the diamond with silicon and the intermediate carborundum. These fundamental problems, strangely enough, receive but indifferent attention, yet they are of surpassing interest.

Again, though it fashions the world and we are made from it, we pay no heed to carbonic acid—it's such a little one in acidity. Mellor gravely puts $K_1$ as 23,000 times $K_2$, according to some great authority's calculation, then quietly writes the formula $\genfrac{}{}{0pt}{}{HO}{HO}\!\!>\!C:O$. Reading between the lines, it is easy to see that we simply do not know what the acid is. It is not bibasic, if the evidence have any force that Worley and I have adduced, indicating that sulphuric acid is unibasic. Still, in all our student's bibles *it is written* that it is—who shall say that our science is not a religion, based upon faith, not fact; who, that we do not need a sense of humour to grasp its contradictions and more imagination to guess its riddles.

Nothing is more striking, in turning over Dr. Mellor's volumes, than the evidence they afford of our casual and unregulated methods of attack: creatures of impulse and opportunity, particularly of fashion, as we are, 'science' thus far has done little to put its big house in order. Thus, a vast amount of work has been done upon the heat of combustion of carbon compounds; yet the fundamental constant, the heat of combustion of carbon proper, in its several forms, has never been subjected to experimental criticism. The values on record are clearly open to question and the discrepancies are not slight. Such an inquiry would obviously be laborious and difficult: the vaunted 'research habit' that is now coming upon us is one which tends rather to the cultivation of the armchair problem and high-frequency advertisement.

The importance of the volume before us is to be found in the display it makes of the silicate maze. Never before has so vast a body of information upon the subject of silica and its combinations been laid bare for inspection but how disconcerting is the picture. Take statements such as the following:

" The molecular theory of organic chemistry finds no application in the chemistry of the silicates. . . . Although the existence of definite radicles is being recognised, yet the condition of this branch of chemistry is very like that of organic chemistry before Avogadro's hypothesis had been adopted as a guide. Such molecular formulæ as we have are, at present, of doubtful validity. After all has been said, the constitution of the silicates is not much in advance of A. Laurent's time, when he could say in his 'Memoir sur les silicates':

"'We have a silicate that contains $Si_{13}O_{81}Mg_{21}Al_4H_{30}$ and we discuss seriously whether the atoms have the arrangement ($11SiO_2 . 21MgO$) $2(SiO_2 . Al_2O_3)$ 15Aq; or $7(SiO_2 . 3MgO)$ $2(3SiO_2 . Al_2O_3)$ 15Aq; or $7(SiO_3 . 3MgO . 2H_2O)$ $2(3SiO_2 . Al_2O_3)$ Aq; or a hundred other similar formulæ. What is there to prove that the silica is distributed into three principal groups; that the magnesia forms two distinct combinations; that the water occupies two different places? Does this salt by its reactions split into magnesian silicate on the one hand and an aluminomagnesian silicate on the other? I have often read the discussions that have taken place on this subject and I avow that I have never found anything but what was arbitrary or according to routine; what I saw most clearly was that, in general, the greatest regard was paid to authority. . . . We should arrive at results quite as satisfactorily by putting the atomic letters of a formula into an urn and then taking them out, haphazard, to form dualistic groups.' "

Is it right, however, to say that the molecular theory of organic chemistry finds no application in the chemistry of the silicates? The peculiarity of the silicon atom seems to be its great love for oxygen combined with an astounding platonic readiness to share its love with a neighbouring atom of its own kind. I am tempted to think of quartz as built like paraffin-wax, oxygen taking the place of hydrogen, each pair of atoms being shared by two silicon atoms. Just as $CH_2$ is the ultimate unit in the one, so $Si\begin{smallmatrix}O\cdot\\O\cdot\end{smallmatrix}$ may be the ultimate unit in the other. We may picture the oxygen atoms climbing, as it were, like monkeys, spirally, up a pole of silicon atoms joined in zig-zags, just as are carbon atoms in stearic acid.

The high-temperature, optically inert form of silica, crystobalite, may conceivably be an ethenoid form of silica more akin to carbon dioxide. The X-ray workers would have us regard the silicon atoms as unpaired and linked by oxygen, each as in touch with four oxygen atoms. If so, we must think of silica in terms of oxygen rather than of silicon. The amazing hardness of quartz is astonishing from this point of view: oxygen seems to provide no soft cushion for silicon to rest upon. We ask for "more" and perhaps more chemical feeling from the rays before deciding. The key to the interpretation of silicates may well be found in petrology—a discipline thus far despised and neglected of chemists—in the study of their evolution as minerals. The chemist who is both chemist and petrologist, with geometric sense and power to interpret X-ray indications, will have open to him a vast and fertile field of exploration. The volume under notice may serve to inspire such a man. Our present neglect of geology is criminal.

Chemist and physicist need put their heads together, if we are ever to solve the problems. The development of pyro- and piezo-electric effects in quartz may be taken as an example. These are regarded by physicists as an intrinsic property of its substance. Quartz seems, however, to be an electrolyte, because of the presence of included silicate. It seems likely that all such effects in crystals are of secondary origin — perhaps mere frictional electricity manifestations.

Dr. Mellor, perhaps unfortunately, makes no attempt to paint broadly the character either of carbon or of silicon and deals with only a few of the simple compounds of carbon. It were time that we developed such themes in setting ourselves cross-word puzzles. We assume that we understand carbon. Supposing that the would-be silicon chemist were to ask: 'What precisely are the ways in which carbon can associate with carbon? I wish to be clear, in order that I may apply your experience of carbon to silicon. Mellor nowhere tells me.' Can we answer?

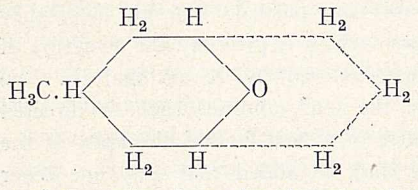
Making this and that statement, we should soon be pulled up. If our friend had the sense of logic he would soon say: 'Yes, you make that assertion but upon what evidence?' Upon revision, organic chemistry seems to the writer to be in a very loose state. It is far too much upon paper. We have made no proper use of the gift the gods would give us. Van 't Hoff began to think in terms of the solid but he only began; he made no full, logical use of the model he adopted. Probably he was carried away by the wonderful consequences of his hypothesis, by finding a satisfactory method of explaining optical activity and so, without inquiry—he was but imperfectly fledged as a chemist—fell in with the current practice of thinking in terms of single, double and triple bonds. So it came that he pictured tetrahedra as united apex to apex in paraffinic, edge to edge in ethenoid, face to face only in acetenoid compounds. He made no attempt to arrange his models in close-packed systems: in fact he took no notice of crystallographic problems.

A solid model of the carbon atom is best made by truncating a regular tetrahedron, so that each face is reduced to a hexagon, by substituting for each of the solid angles a three faced pyramid. When such "tetrahedra" are close-packed, face to face, they form a rigid mass—which is precisely the structure of the diamond, as disclosed by X-ray analysis. We have to picture the four affinities each as directed towards the centre of a face, not to the apex of the tetrahedron. It may be added that only one other form of packing, presumably the ethenoid, is possible.

The consequences of such treatment of the problem are of moment. Limitations are introduced not hitherto foreseen. The models are more suitably made by fitting four rhombic dodecahedra symmetrically together. These may be joined in line, with zig-zag centres, without restriction of length, as in paraffins.

They may also be grouped in closed systems of six, fitting closely, without stress or strain—as in hexamethylene and benzene. The arrangement in these cases is that of the diamond. A compact, symmetrically closed system cannot, however, be formed with less than six carbon atoms. Three tetrahedra can be arranged in paraffinic order but one and three then only touch at a single dodecahedral face. If the three be placed symmetrically, the third, in the median position, is in contact with one and with two at only three dodecahedral faces, that is to say, the contact is only three-eighths that of the paraffinic type; moreover, the three atomic centres are not equidistant. Four may be arranged symmetrically, in which case one and three are united as are the two in the 'symmetrical' arrangement of three, three-eighths as firmly as in a paraffin. The difficulty is with five—one and five touch at only a single dodecahedral face: yet we are told that hexamethylene rapidly passes over into methylpentamethylene. The polymethylenes, therefore, should be a fascinating field for X-ray study. Prof. W. H. Perkin has synthesised a great number of tri-, tetra- and pentamethylene derivatives: it is assumed that these are all closed systems. Convincing evidence of such constitution is needed. Prof. Perkin is known as a great user of the word 'research': by his unrivalled preparative skill he has enriched our lists with a great variety of new products. Let us hope that he will now turn to analytic studies and do a little *re*-search in his own field, so that we may learn to know his numerous progeny better and feel satisfied that they are rightly baptised. Gomberg's work has prepared us to receive surprises. We have too long talked in terms of rings. Our minds are hypnotised by looking always at loosely-strung formula.

One case is clear, that of camphor; this cannot be what it is supposed to be, a dipentamethylene derivative, which is nothing short of a geometrical impossibility. A possible, if not probable, alternative formula is the following:




In this, three carbon atoms are common to two hexamethylene groups. The dotted portion is to be thought of as upright upon the undotted. Almost every change wrought upon camphor probably involves molecular rearrangement —like the juvenile game of chairs, in which almost every child gets up and only some recover their original seats.

The suggestion the writer would make to chemists generally is that we be 'off' with the old before seeking new loves among elusive electrons and polar affinities: that we set our own rather untidy house in order before inviting our colleagues to visit and inspect us with their variously penetrating rays.

HENRY E. ARMSTRONG.

## Guides to the French Fauna.

(1) *Faune de France.* Par J.-J. Kieffer. 11: Diptères (Nématocères piqueurs); *Chironomidæ Ceratopogoninæ.* (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. iii+139. (Paris: Paul Lechevalier, 1925.) 18 francs.

(2) *Faune de France.* Par E. Séguy. 12: Diptères (Nématocères piqueurs); Ptychopteridæ, Orphnephilidæ, Simuliidæ, Culicidæ, Psychodidæ, Phlebotominæ. (Fédération française des Sociétés de Sciences naturelles: Office central de faunistique.) Pp. iii+109. (Paris: Paul Lechevalier, 1925.) 15 francs.

(1) THE two most recent fascicules of the "Faune de France" treat of those Diptera Nematocera that have piercing mouth-parts and blood-sucking propensities. The late Abbé J.-J. Kieffer's monograph of the subfamily Ceratopogoninæ provides a concise and up-to-date guide to the study of these small and obscure midges. Prior to about 1900, only about seven European genera were recognised, but during the last twenty-five years quite three times as many have been disclosed as inhabiting France alone. In that period we have learned something of the metamorphoses of several, and also that some of these flies have the curious habit of sucking the blood of other insects. The Abbé's diligence as a systematist has raised him to the front rank as an authority on the group, and it is satisfactory that he has brought together so much recent information in a convenient compass.

(2) The remaining blood-sucking groups are treated by M. Séguy, and the most important of these are the Culicidæ, which are held to include also the Dixidæ of many writers. This family is dealt with in the amazingly small number of 39 pages, which is only attainable by the use of synoptic keys in place of detailed descriptions—a feature adopted throughout the "Faune de France" series. It is almost amusing to note that after all the nomenclatorial shiftings the yellow-fever mosquito has been subjected to, that M. Séguy has thought fit to go back to its old name, *Stegomyia fasciata.* The minute papatasi flies (Phlebotomus) include four species, and there are twenty-four species of Simuliidæ enumerated.

In addition to the above blood-sucking forms, the two small families Ptychopteridæ and Orphnephilidæ are included, the last-mentioned being represented by a single species: its larva and pupa are figured after the recent work of Saunders in Cambridge. Uniformity of treatment and arrangement, in spite of its being the product of a number of specialists, are by no means minor features maintained in this useful guide to the French fauna. Its cheapness and handy proportions raise the wish that something corresponding to it existed with regard to animal life in Britain.

A. D. I.

## Colliery Management.

*Colliery Working and Management: comprising the Duties of a Colliery Manager, the Superintendence and Arrangement of Labour and Wages, and the different Systems of working Coal Seams.* By H. F. Bulman and Sir R. A. S. Redmayne. Fourth edition, thoroughly revised and much enlarged. Pp. xv+393+32 plates. (London: Crosby Lockwood and Son, 1925.) 42*s.* net.

IN the opening sentence of Chap. iv. of this work the authors ask: "What manner of man ought a colliery manager to be?" Their answer to this question should be read by all those self-elected critics who at the present time single out the coal-mining industry, from all the industries of Great Britain, in order to level wholesale charges of inefficiency. A perusal of this book reveals the wide knowledge of pure and applied science, and of sociological, commercial, and other problems, required by the colliery manager of the present day.

The book takes a broad view of the British coal-mining industry from the outlook of the colliery manager, and may be read with profit by any one concerned with the control of collieries, or by the general reader inclined to examine for himself the present condition of the science and art of mining. In Chap. i., and indeed throughout the book, interesting historical references are given to show the gradual development in technique and administration through the long history of the industry, and modern methods and practices are also described.

Of special interest is the description of past and present conditions of labour in Chap. iii., and the very full account of the events leading up to the present system of regulating wages under the National Agreement of 1921. Chap. vi. describes the organisation of labour above and below ground, and Chap. vii. gives in detail the elaborate and complicated method of making up wages bills and cost sheets. The remainder of the book is devoted to a discussion of technical methods. Chap. xviii. deals with accidents and their prevention.

The long experience of the authors in the north of England is shown by the slightly greater length devoted to descriptions of practices in this coalfield, although other coalfields are by no means neglected. In any case the authors may be forgiven this slight bias, as the leading part played until recently by the Great Northern Coalfield has undoubtedly influenced practice in other coalfields not only in Great Britain but also all over the world.

DOUGLAS HAY.

## Our Bookshelf.

*Introduction to Theoretical Physics.* By Prof. Arthur Haas. Vol. 2. Translated from the third and fourth editions by T. Verschoyle. Pp. x+414. (London: Constable and Co., Ltd., 1925.) 21*s.* net.

IN the second volume of his treatise on theoretical physics, Prof. Arthur Haas maintains the same high standard as in the first volume already noticed in these columns (NATURE, vol. 116, p. 267, 1925). The author has wonderful skill in summarising the results of recent investigations, and a sound instinct for the really important parts of his subject. The book is remarkable not only for the power of condensation exhibited, but also for the wide range of the subject matter. It is difficult to judge how the work would appeal to a reader without much previous knowledge of the subject, but it may be questioned whether the unprepared student would not find the treatment in places too condensed and the pace too fast. Thus in the very first chapter he is introduced to three types of elementary quanta—the quantum of electricity, the quanta of positive corpuscular radiation, and the quantum of action.

The quantum theory of the hydrogen atom forms the subject of the second chapter. The subject of Röntgen rays is then taken up, and an account of exceptional interest is given of the behaviour of crystals with respect to these rays. The theory of the elements, taking Moseley's law as a starting-point, forms the subject of the next chapter, and the Part of the volume dealing with atomic theory concludes with an excellent account of the general theory of spectra. Part IV. of the whole treatise deals with the theory of heat, and includes chapters on statistics and thermodynamics. The volume concludes with an exceptionally lucid discussion of the theory of relativity. Prof. Haas has supplied a brief summary of the more important work carried out between the publication of the German edition and of the present English edition of Vol. 2. The translation into English has been admirably done by Mr. Verschoyle, who acknowledges his indebtedness to Dr. R. W. Lawson.

It was no doubt impossible in the space at the author's disposal to give due credit to all the investigators who have made important contributions to the subjects described, but we are surprised to find no reference to Perrin's work on the Brownian movement, or to Richardson's work on thermionics. These are but minor criticisms, and we would conclude by giving a warm welcome to a truly noteworthy book.

H. S. ALLEN.

*The Alkali Industry.* By Prof. J. R. Partington. (Industrial Chemistry Series.) Second edition. Pp. xii + 344. (London: Baillière, Tindall and Cox, 1925.) 12*s.* 6*d.* net.

PROF. PARTINGTON'S "concise and connected sketch" of the alkali industry—to use his own words—was first published in May 1918, reprinted in December of the same year, and attained the dignity of a second edition towards the end of 1925. Its merits are many and its defects but few. Written by an academic chemist mainly for students, it is superior to most of the text-books covering the same or similar ground on account of its conciseness, its clarity and accuracy, and the judicious application of the law of mass action and of modern thermodynamics. It is also far more up-to-date than the average text-book. The few defects we have noticed are mainly due to virtues practised in excess. Thus the very concise writing, necessitated by the extent of the subject matter, introduces a 'staccato' touch that makes continuous reading a little irksome; and emphasis on the scientific aspects has subordinated such mundane considerations as costs and yields, matters of vital importance to the budding technologist. Exception has rightly been taken to the title of the book, because almost as much space has been given to acids, etc., as to alkalis: a better title would have been "The Heavy Chemical Industry," which is sufficiently vague and comprehensive for the author's purpose.

In a few respects the information given is not so precise or up-to-date as it might have been. For example, the production of synthetic ammonia in England is referred to in several places; on pp. 1 and 262 we are told that the process is operated by Brunner, Mond and Co., at Billingham-on-Tees, but on p. 199 it is stated that the factory there "is said to be operating." Many erroneous statements have been made by technical writers concerning this manufacture, yet the chairman of the Company, in his address to the annual general meeting in May last year, said that the plant for making 30 tons of ammonia per diem (equivalent to 114 tons of ammonium sulphate) had been operated for a long time, although below its output-capacity, and that it was being enlarged to produce 50 tons. In May 1925, the 30-ton plant was running smoothly at full capacity and showing profits; and measures were being taken to increase the production to 200 tons of ammonia a day.

*Drawing: its History and Uses.* By W. A. S. Benson. With a Memoir by the Hon. W. N. Bruce. Pp. xxxiii + 109. (London: Oxford University Press, 1925.) 6*s.* 6*d.* net.

THE author of this little book, who died in 1924 in his seventieth year, was a lifelong exponent of artistic expression in various forms rather than an artist in any conventional sense. His association with William Morris gave a bias in his attitude towards art which finds expression in the opening sentences of his book, in which he lays it down that the variety of purposes for which drawing serves in education and in life is not too well understood; it is not merely a gymnastic exercise or an introduction to the fine art of painting, but a mode of expression, an alternative to speech from which all forms of written language have arisen. In support of his view he traces the growth of graphic art from its earliest beginnings in the palæolithic cave, through the conventional decorative art of the neolithic period, and analogous stages of culture, in which *motif* is dependent directly or indirectly on the technique demanded by material, and through the artistic formula which gave rise to the art of writing, to the modern picture in its frame, and its relation to interior decoration. The treatment of the subject is stimulating, and it may be hoped will bring home to a wider public the significance of early forms of art less well known than that of palæolithic man.

*Natur und Mensch: die Naturwissenschaften und ihre Anwendungen.* Herausgegeben von Dr. C. W. Schmidt. Erster Band: Weltraum und Erde. Von Dr. H. H. Kritzinger und Dr. C. W. Schmidt. Pp. xii + 494 + 30 Tafeln. (Berlin und Leipzig: Walter de Gruyter und Co., 1926.) 36 gold marks.

THIS is the first of four volumes which are planned to cover all aspects of natural history in its widest sense, including geology, botany, zoology, ethnology, and the application of scientific knowledge. The first volume deals with astronomical and geological problems, the latter including physical and historical geology and mineralogy. The chapters are popular without being childish, and cover the ground with remarkable thoroughness. They are admirably illustrated with diagrams, beautifully reproduced photographs, and a few coloured plates. In fact, the book is lavishly produced, and as a popular work should make a wide appeal, even though the price is somewhat high.

*Economic Geology.* By Prof. H. Ries. Fifth edition, revised. Pp. v + 843. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1925.) 25*s.* net.

THIS fifth edition of "Economic Geology," like its predecessor the fourth, deals almost wholly with the economic geology of North America. Its excellent illustrations, numerous references, and good index, together with its balance of treatment as regards scope and descriptive detail, make it a useful and popular text-book so far as the deposits of economic minerals in North America are concerned. As regards deposits other than those of North America, however, it is much less satisfactory. Indeed, in this respect it needs both amplification and correction, and the author would do well in future editions either to make these amplifications or adopt a more appropriate title, as was done in the first three editions.

*Two Ornithologists on the Lower Danube: being a Record of a Journey to the Dobrogea and the Danube Delta, with a Systematic List of the Birds Observed.* By H. Kirke Swann. Pp. vi + 67. (London: Wheldon and Wesley, Ltd., 1925.) 5*s.* net.

THIS is a slim volume by the late Mr. Kirke Swann describing an ornithological visit to the Rumanian reaches of the Danube. The region is but little known to British ornithologists, and at the present time official restrictions make it an inconvenient one to visit. It is, however, rich in interesting birds, notably in birds of prey and in members of the heron family. Mr. McNeile adds some photographs of nests, and of the people and local scenes.

## 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.*]

### Eclogite and the Surface History of the Earth.

THE interest which has lately been evinced in the surface history of the earth has necessarily extended to the nature of the substratum underlying continents and oceans.

There appears to be general consensus of opinion that this, in its higher levels, is basaltic in character. The evidence for this is strong, and no opposing evidence of importance appears forthcoming. The physical properties of basalt are in every respect in agreement with the requirements.

But there appears to be a certain amount of evidence that at greater depths a change of character may occur. The evidence is mainly seismic, and seems to indicate material of higher density existing at levels which have been indicated as at 60 km. beneath the continental surface (Mohorovičić) and again at 40 km. beneath the oceans (Angenheister). It is generally held that such a discontinuity may be due to deep-lying peridotite, an ultra-basic rock having a density of about 3·4 and the existence of which beneath a basaltic covering has, on petrological grounds, a certain genetic probability. In my writings upon this subject I have referred to this view and to the consequences which must arise as affecting the periodicity and magnitude of the 'revolutions.'

The possibility that eclogite may be the deep-lying substance has been suggested by several writers. It is with reference to the physical consequences which may be expected to arise, should this suggestion be correct, that I would revert to the subject. I am not aware that these consequences have been pointed out previously.

Eclogite is generally classed by petrologists among the ultra-basic rocks. The classification is somewhat misleading, however. There is little or no chemical difference between eclogite and basalt, although these two rocks are very unlike in appearance and mineral composition. In Rosenbuche's "Elemente der Gesteins Lehre" (1898) six analyses of eclogite are cited. The means agree with those for gabbro and basalt as averaged by Daly or as determined by Washington for the plateau basalts or the basalts of the volcanic islands. A molten eclogite must differ in no respect from a true basaltic glass.

The physical properties of the two types differ, however, in a very important respect; the density of solid basalt is about 3·0; that of eclogite 3·4 This difference would, of course, cause it to affect the propagation of seismic waves just as would peridotite. The mineral composition of eclogite is radically different from that of a gabbro or basalt. It consists mainly of a pyroxene and a garnet, the latter having a density of about 3·7. It is the abundance of this mineral (which may be regarded as replacing the normal plagioclase and olivine of the gabbros) which confers its high density upon the rock. It is significant that this mineral shows unmistakable signs of instability. "Its presence," write Hatch and Wells in their recent valuable "Petrology of the Igneous Rocks," "indicates consolidation under very great pressure, otherwise its components would have appeared as olivine and plagioclase. Eclogite is, therefore, heteromorphous with gabbro."

It is very probable that at the great pressures prevailing deep in the substratum this rock would come into existence. No process of magmatic differentiation is required. When the basaltic magma had parted with its heat of liquefication, and in the course of sufficient time, we may expect that this substance will take the place of the magma. Of course, this view does not negative the possibility that peridotic layers, resulting from magmatic differentiation, may also exist.

The presence of a deep-lying stratum of eclogite carries with it consequences the significance of which may be considerable and which, indeed, may have played an important part in the events of the surface history of the earth. This appears when we consider the great volume-change which must attend its liquefication, and again its subsequent resumption of the solid and crystalline state. For in the fluid state it possesses the density of a basaltic glass; when it is finally consolidated and crystallised it possesses the density of a true ultra-basic rock.

It is probable that under the conditions of viscosity prevailing in the depths a considerable time-element must enter into its resumption of the crystalline state. But there is abundance of time. The effects at the surface of the earth would, in this case, be long-continued and attended with gradually expiring orogenic movements—all the more effective as occurring when the ocean floor had recovered much of its original strength and rigidity.

Eclogite is a rare substance at the surface of the earth. Its origin has been ascribed to extreme dynamo-metamorphism of gabbroid rocks. Its radioactivity has not as yet been specially investigated, but there is no reason to believe that it differs from that of gabbros, dolerites and basalts. J. JOLY.

Trinity College, Dublin,
April 22.

### The Source of Stellar Energy.

MANY besides astronomers will have received pleasure from reading Prof. Eddington's lecture which appears in NATURE of May 1, but I doubt whether mathematicians, physicists or chemists will be prepared to accept his proposed means of escape from the difficulties which beset his theories. He considers (in spite of mathematical proof to the contrary) that a star built on the uranium model—built, that is, of matter in which the generation of energy proceeds spontaneously without regard to changes of temperature and density—would be unstable. He then proposes to secure stability by supposing the star to be built on what may well be described as the gunpowder model: "To save the star we must suppose that the increase of temperature and density . . . causes an increase in $E$," $E$ being the rate at which the star generates energy.

This seems to be a step from an imaginary frying-pan into a real fire; if the uranium star were unstable, surely the gunpowder star would be doubly so. Any increase of temperature resulting from a small disturbance would cause more energy to be generated, thus heating the star still further, producing still more energy, and so on indefinitely. This is what is meant by instability. To Prof. Eddington's dramatic question, "Can we suppose that energy issues freely from matter at 40,000,000° as steam issues from water at 100°?" the only possible answer seems to be a prosaic "No." When steam issues from water at 100° there is a positive 'latent heat' of transformation of about 536 cal. per gm. This regulates the issue of steam; 1 gm. issues from the water for each 536 calories of heat supplied to the water. If the latent heat had the negative value of −536 cal.

per gm., no steady supply of heat would be needed, and we could evaporate a whole ocean by dropping in a lighted cigarette. Now the transformation of matter into radiation has a huge negative latent heat equal to $-C^2/J$ or $-2\cdot15\times10^{13}$, and if the heat set free by generation of energy itself causes more generation of energy, we at once have a highly unstable state. In the case imagined by Prof. Eddington, as soon as the centre of a star reached 40,000,000° the heat generated would raise the neighbouring parts to 40,000,000°; these would generate more heat, and so on, the high temperature spreading explosively through the star. The true analogy would not be the issue of steam from water but the explosion of a magazine of gunpowder. The whole question is of course one for exact mathematical treatment. In an investigation which Prof. Eddington does not mention (*Mon. Not. R.A.S.*, October 1925) I have shown that the uranium star would be stable and the gunpowder star unstable. The investigation goes further than this, and shows that considerations of stability practically limit us to the uranium model.

Although the central temperature of most stars is near to 40,000,000°, that of some of the brightest stars in the sky is as low as one or two million degrees (*e.g.* Antares, Betelgeux). This seems to negative the idea that a temperature of 40,000,000° is associated with any special generation of energy. Apart from all theories, the astronomical fact which requires explanation is that 40,000,000° appears to be a sort of upper limit, never exceeded by stellar matter, and that the central temperatures of most of the stars are fairly near to this limit. I suppose 95 per cent. of visible stars have central temperatures between 24 and 36 million degrees, although nothing can be said as to dark stars. My own view is that for some reason not yet fully explained, the transformation of matter into energy is inhibited somewhat abruptly at about this temperature, so that most stars balance their generation and expenditure of energy by taking up a temperature within the range mentioned. It is just within this range that ordinary atomic nuclei become stripped bare of electrons, and this may explain the stoppage in the generation of energy; perhaps only bound electrons are liable to annihilation.

Prof. Eddington states very frankly the difficulties that he sees in his own theories (although I think there are many more than he sees). But by omitting all mention of the successes claimed by rival theories he conveys the impression that the whole problem is in a state of confusion and inconsistency. I consider the situation ought to be painted in far brighter colours. A lot of the confusion arises, I think, from Prof. Eddington repeatedly saying 'unstable' when he ought to say 'stable,' and vice versa. Incidentally he also says 'overstability' when he means plain everyday instability with a time-factor $e^{(\alpha\pm i\beta)t}$; this explains the difficulty he finds in steering his star "between the Scylla of instability and the Charybdis of overstability." Conditions of stability, rightly handled, lead inevitably to stars built on the uranium model, and this in turn leads, practically inevitably, to the view of stellar evolution I have recently put forward (*Mon. Not. R.A.S.*, October 1925, and NATURE, January 2, p. 18). This escapes the difficulties which trouble Prof. Eddington, and seems so far to agree well with observation.

As Prof. Eddington raises the question of the origin of the idea of annihilation of matter as a source of sub-atomic energy, may I be permitted to add that the first mention I can find of it occurs in a letter by myself in NATURE (vol. 70, p. 101, June 2, 1904) in pre-relativity days, in which I considered the possibility of there being "conservation neither of mass nor of material energy" but "an increase of material energy at the expense of the destruction of a certain amount of matter." The earliest reference I can find to it in Prof. Eddington's writings also occurs in a letter to NATURE (vol. 99, p. 445, August 2, 1917), thirteen years later, in which he says the idea was suggested by me. J. H. JEANS.

May 1.

---

**The Drop-weight Method for the Determination of Surface Tension and the Weight of the Ideal Drop.**

FOR nearly fifty years certain errors, which concern the weight of the maximum drop of liquid which will remain hanging from the lower circular face of a vertical cylinder and that of the drop which falls, have been present in the literature without adequate correction. It is true that during this period, and even earlier, correct treatments of the subject have appeared, but without the effect of diminishing the popularity of the errors. Unfortunately, the most prominent of these, that the weight of the drop which falls is equal to a constant multiplied by the circumference of the tip, is still given support by the statement of prominent text-books that it is sufficiently accurate for practical purposes, even although—but this they do not state—errors of so much as 60 per cent. may be involved.

It is not the purpose of this letter to discuss such an apparent blunder, but to consider certain fallacies which are even more objectionable because they are much more insidious. One of these in particular has been given such a marked recrudescence that Harkins and Brown have been severely criticised in NATURE, the *Philosophical Magazine*, and the *Journal of the Chemical Society*, for their failure to subscribe to the error, even although their paper on this subject (*J. Am. Chem. Soc.*, 41, 499, 1919) was written several years before its recent vigorous revival, and they were therefore entirely unaware that it would so soon become the vogue of the period.

Harkins and Brown introduced the conception of the weight of the *ideal drop* as equal to $2\pi r\gamma$ or the circumference of the tip multiplied by the surface tension ($c\gamma$). It happens that this is just the weight of liquid upheld by the surface tension in a capillary tube, but the choice of this value was due to two reasons. First, this is the weight given by the most complete theory concerning the form of drops, that of Lohnstein, for either the maximum drop which will hang or the drop which falls from an infinitesimal tip. Secondly, it is the value approached, as the tips become smaller, by the *actual weight* of the falling as well as of the hanging drop, as shown by the data of Harkins and Brown, together with a single point of Ollivier, and the work of others.

Notwithstanding the above facts, Iredale (*Phil. Mag.*, 45, 1088, 1923) asserts that the weight of the ideal drop is not $2\pi r\gamma$, but is only half this, or $\pi r\gamma$. Upon the basis of this assertion he intimates that the simple and exact method for the calculation of the surface tension from the weight of the falling drop as given by Harkins and Brown should be supplanted by his method, one which is in fact not entirely correct, and is in addition indirect, cumbersome, and involved, since it requires eight arithmetical operations to give a partly erroneous result in place of the four essential to our exact method. Also the most fundamental operation involved is taken directly from our work, and the data used are wholly those of Harkins and Brown.

Iredale gives as his reason for the choice of $\pi r\gamma$ the statement that in 1881 Worthington obtained this as the value of the weight of a drop which has a vertical contact with the tip. While it is true that Worthington did obtain this value, he did so only by neglecting a term which is fundamentally important in the theory of the form of hanging drops. Only two pages earlier Worthington includes this term, but in an endeavour to correct a fancied error attributed to Quincke, he neglects it. Thus he obtains the equation for the weight ($W$) of the drop as $W=2\pi r\gamma - \pi r^2\gamma/r = \pi r\gamma$ in which $r$ is the radius of the tip, and also the radius of curvature of the drop in the plane of contact, only by neglecting $1/s$, the curvature in the meridian. That Worthington used the conception of curvature in a dual sense was pointed out to the writer by Dr. A. C. Lunn, professor of applied mathematics in the University of Chicago. The correct equation is, obviously, $W=2\pi r\gamma - \pi r^2\gamma\left(\frac{1}{r}+\frac{1}{s}\right)$, which does *not* give $\pi r\gamma$. To obtain vertical contact the tip must be very small (the more exact condition is that $r/a$ shall be very small) *in which case* $s$ has a sign opposite that of $r$, and furthermore is nearly equal to $r$ in absolute magnitude, so the term $1/r+1/s$ is either very small or else equal to zero. For this reason the weight of the maximum hanging drop approaches $2\pi r\gamma$, and not $\pi r\gamma$, as the radius of the tip becomes extremely small.

It may be mentioned also that the equation $K^2=\gamma_1\rho_2/\gamma_2\rho_1$ used by Iredale to calculate surface tension ($\rho$ = density) is incorrect from the theoretical point of view, and, in general, does not give such exact results as the theoretically correct form, equivalent to $K^2=\gamma_1\rho_2 g_2/\gamma_2\rho_2 g_1$, used by Harkins and Brown, even although he uses our data to obtain the values of $K^2$.

Thus Iredale's criticisms of the methods of calculation used by Harkins and Brown are wholly the result of his own errors. Since, however, his experimental work seems to be good, and he makes no application of the relation of $W=\pi r\gamma$, and since the error actually involved in the equation which he uses to apply the data of Harkins and Brown obtained in Chicago in his calculations, where $g$ is different, happens to be small in its effect upon his own results, the present letter need not and would not have been written if Rideal and his associates had not espoused the fallacies and used them as the basis of reiterated criticisms in various journals. Thus, in reviewing Taylor's "Treatise of Physical Chemistry" in NATURE of February 28, 1925, Rideal states: "It is a pity that the erroneous conceptions concerning the determination of the surface tension of solutions by the drop-weight method are finding a place in standard text-books. Harkins' extension of Lohnstein's work on this subject might well be replaced by that of Iredale in a future edition." The peculiar nature of this criticism may best be realised when it is learned that the treatise to which the review relates does not contain any statement which presents the writer's "extension of Lohnstein's work." It does give, without previous reference to Lohnstein or myself, the opinion of the contributor to the "Treatise" that "the surface tension is therefore equal to a constant times the weight of the drop where this constant has to be evaluated. This has been done by Harkins." The reference appended is to a preliminary paper printed three years before that of Harkins and Brown.

In an article in another journal, Dr. T. F. Young and I expect to give a more extensive treatment of the relations mentioned in the present letter, since sufficient space is not available here for a discussion of all of the factors involved.

WILLIAM D. HARKINS.

**The Disappearance of the Crystalline Style.**

JUDGING by his letter in NATURE for April 10, p. 518, I do not think that Mr. Berkeley quite understands my theory as to the cause of the dissolution of the crystalline style, or the reasons why I am unable to agree with his opinion that the disappearance of the style in molluscs kept under anaerobic conditions may be, in part, "a direct response to the lack of oxygen."

Mr. Berkeley is to be congratulated on his discovery (*Journ. Exp. Zool.*, vol. 37, p. 477) of the presence of an oxidase, possibly accompanied by an oxidising agent, in the substance of the style. I have been able to confirm his findings, as I have found an oxidase in the styles of all the lamellibranchs which I have examined, and I am at present carrying out further experiments on the subject with the style of *Ostrea edulis*. At the same time, Mr. Berkeley appears to me to make unwarranted assumptions when he endeavours on the basis of this discovery to account for the dissolution of the style.

I have shown (*Journ. Mar. Biol. Ass.*, vol. 13, p. 938), and have since confirmed in further experiments, an account of which will shortly be published in the same journal, that the style dissolves rapidly in water which is alkaline or slightly acid, but that at a certain critical *p*H (which varies according to the species but is usually in the region of 4·0, and probably represents the isoelectric point of the globulin of which the mass of the style is composed) it ceases to be dissolved or is dissolved extremely slowly. Since the fluid in the stomach always has a *p*H above this critical point (in spite of the fact that, as a result of the dissolution in it of the acid style substance, the *p*H of the stomach is invariably lower than that of any other region of the gut), it follows that the head of the style which projects into the stomach will be dissolved away—quite irrespective of the oxygen demands—while at the same time fresh material is being secreted in the style-sac behind. Under normal conditions, therefore, the style is only maintained as a result of a balance between the rate of its secretion and the rate of its dissolution. Mr. Berkeley does not seem to grasp the essentially physical nature of the dissolution, since he refers to the "consumption of the style substance for digestive purposes."

When a mollusc possessing a style is placed under adverse conditions, details of which are given in my paper, the style disappears—*but only in those animals in which the style lies in a groove in free communication with the gut.* In animals such as *Mya arenaria*, on the other hand, in which the style lies in a separate cæcum, only the *head* of the style is dissolved away even though the animals are kept out of water for *fourteen days*. Surely it is not unreasonable to suppose that the balance between rate of secretion and the rate of dissolution has been disturbed: the vital activities of the animals have been reduced and so secretion lowered. But dissolution still proceeds at the usual rate, and as a result the style will be dissolved except when it lies in a separate cæcum, when only the head can be dissolved, the remainder being sheltered from the action of the dissolving fluid. Mr. Berkeley criticises my experiments on the ground that they all resulted in the animals being kept under anaerobic conditions, but, as Dr. Orton (*Fishery Investigations*, Ser. 2, vol. 6, No. 3, p. 54) has stated to be the case in *Ostrea edulis* and as I have found in *Mytilus edulis*—both lamellibranchs with the style in free communication with the gut—the style is often absent in animals which are in poor condition even though the water is well aerated.

The style is re-formed when animals are replaced under normal conditions, and the presence of food is *not* essential for this process as the work of recent investigators has shown. Mr. Berkeley considers this evidence in favour of his theory, since the style is regenerated by aeration alone. But I fail to see that it invalidates my theory, since in these circumstances the vital activities of the animals will be restored—even though they are starved, for lamellibranchs can undergo months of starvation and be still perfectly healthy at the end—and secretion of the style substance will be increased until it resumes its normal dimensions, and so the usual balance between the rate of production of the style and the rate of dissolution will be regained.

Again, and this is a point to which Mr. Berkeley does not refer, if his theory is correct there should be some correlation between the size of the style and the habitat of the animal. If an animal possessing a style is normally exposed to anaerobic conditions, one would expect that it would have a larger style than one which never suffered from lack of oxygen. There is, however, no such correlation, a fact to which I directed attention in my paper, while exactly the same point was raised by Prof. T. C. Nelson (*Biol. Bull.*, vol. 49, p. 86) in a review of recent work on the crystalline style published about the same time as my own paper, both of us being in complete ignorance of the work of the other. He compares the habitat of *Pisidium idahoense*, which lives in the mud at the bottom of Lake Mendota, Wisconsin, "where for two-thirds of the year the water may be completely devoid of oxygen," with that of Mactra, which lives "in or close to the breaker line along sandy coasts, where the water at all seasons of the year is saturated with oxygen." Yet the style of Pisidium is no larger than that of related species living in well-aerated water, while the styles of all species of Mactra are exceptionally firm and large.

Like Prof. Nelson, I find myself unable to accept Mr. Berkeley's views as to the cause of the disappearance of the style, nor do I agree with him that the matter should be considered *sub judice*; since I consider that my experiments demonstrate clearly that the dissolution of the style is a purely physical process and not in any way, in the words of Mr. Berkeley, "an expression of an effort on the part of the animal to offset the strain on its vital activity induced by anaerobiosis."

C. M. YONGE.

The Laboratory, Citadel Hill,
Plymouth, April 20.

## Ultramicroscopic Organisms of Filterable Viruses.

IT appears to me that the fundamental significance (apart from its medical importance) of Mr. J. E. Barnard's[1] observations on the ultramicroscopic organisms known as filterable viruses has not been sufficiently recognised by biologists. These observations show the existence of a group of organisms as different from bacteria as bacteria are from yeasts or molds. The term cell cannot properly, in my opinion, be applied to them. Mr. Barnard's observations and photographs with ultra-violet light, particularly of the organism causing bovine pleuropneumonia, show minute hollow vesicles devoid of nucleus or of a cell wall in any proper sense. The 'wall' of the vesicle is evidently the living material of the organism, and it appears justifiable to apply to its substance the term protoplasm. But its methods of reproduction show that there can be little differentiation of the presumably protein materials composing this 'wall.'

These organisms appear to multiply in two ways: (1) by the appearance of minute papillæ on the surface of the vesicles. These are later attached to the vesicle only by threads, and they finally grow into new vesicles. This process bears some resemblance to the budding of yeast cells, but there are fundamental differences. (2) A vesicle may elongate into a flattened hollow structure which then breaks up into a row or group of particles like the papillæ, having the same property of growing into vesicles. This process might perhaps be compared with gonidia formation in such bacteria as Crenothrix. It was also found that the vesicle stage could be separated from the particle stage by filtration through a collodion membrane.

This group of ultramicroscopic organisms in its extreme simplicity and methods of reproduction brings us a distinct step nearer the inorganic. They are not strictly cells in the sense in which that term has hitherto been used by biologists. We appear to have here organisms reduced to their lowest terms, undifferentiated particles of protoplasmic material which can grow into hollow vesicles reproducing by budding and fragmentation. It becomes a question whether any organisms could be yet smaller and still show the essential phenomena of life. I suggest for these organisms the name *Protonta*, to contrast them with the plant and animal unicells which Haeckel grouped together as the Protista. It is quite possible that a world of organisms of this class exists, which are neither plants nor animals nor cells, and are as extensive and ubiquitous as the Protists. We have no present means of recognising their existence except in the case of those which are, like the virus diseases, parasitic in animals and plants.

That these organisms stand distinctly nearer the inorganic than bacteria is obvious. Investigations of the so-called d'Herelle phenomenon and of enzymes by similar methods, by showing the condition of aggregation of these bodies, will help to indicate just how wide is the gap which still separates such bodies from the strictly inorganic.

My apology for intruding into this field must be that it is one in which I have long been interested.

R. R. GATES.

King's College, Strand, London, W.C.2.

[1] "The Microscopical Examination of Filterable Viruses," *Lancet*, 1925, pp. 117-123.

## Half-integral Vibrational Quantum Numbers in the Magnesium Hydride Bands.

THE new quantum mechanics predicts[1] that both the rotational and vibrational quantum numbers in band spectra should have half-integral values. Numerous examples of half-integral rotational quantum numbers have been reported in recent work, but as yet only one case where the evidence is in favour of half-integral vibrational quantum numbers has been recorded. Mulliken has shown[2] that the magnitude of the isotope effect in the BO bands is such as to argue for the adoption of half-vibrational quantum numbers. Indeed, accurate observations of isotope effects apparently constitute the only available method for getting evidence on this point.

P. Rudnick and the writer[3] have recently noted the presence of the approximately correct rotational isotope effect in the fundamental (λ5211) band of magnesium hydride. I have made some new calculations of our data with the object of deciding as to the

[1] W. Heisenberg, *Zeit. f. Physik*, 33, 879, 1925.
[2] R. S. Mulliken, *Phys. Review*, 25, 279, 1925.
[3] *Astro. Journal*, 63, 20, 1926.

applicability of half-vibrational quantum numbers to these bands, with the following result: Assuming half-integral values for $n'$ and $n''$, the initial and final vibrational quantum numbers, with a minimum value $+\frac{1}{2}$, the band-origins of this system can be represented approximately by the equation

$$\nu = \left.\begin{matrix}19217\\19224\end{matrix}\right\} + (1603{\cdot}5n' - 34{\cdot}75n'^2) - (1493{\cdot}5n'' - 31{\cdot}25n''^2).$$

Placing the values of these coefficients in the equation for the vibrational isotopic displacement as given by Mulliken,[4] and taking the isotopes of magnesium to be 24, 25, and 26, one readily computes that for the $\frac{1}{2}\longrightarrow\frac{1}{2}$ band,

$$\nu^n_{25} - \nu^n_{24} = -0{\cdot}042 \text{ cm.}^{-1},$$

$$\nu^n_{26} - \nu^n_{24} = -0{\cdot}082 \text{ cm.}^{-1}.$$

That is, the faint pairs of lines due to the less abundant isotopes 25 and 26 found on the low-frequency side of each strong doublet in the $Q$ and $R$ branches should be displaced by these amounts in addition to the (much larger) rotational isotopic displacement (also to the red). As a matter of fact, of 27 recorded pairs of Mg (26) lines, every one is displaced farther from the Mg (24) pair than is allowable as a pure rotational isotopic effect. The average increased displacement is $-0{\cdot}073$ cm.$^{-1}$, which is in good agreement with the theoretical value $-0{\cdot}082$ cm.$^{-1}$, considering the smallness of the shift. For the Mg (25) pairs the agreement is not quite so satisfactory (the measurements of the lines being less accurate), the observed average increased displacement, however, being fair, $-0{\cdot}029$ cm.$^{-1}$, as opposed to $-0{\cdot}042$ cm.$^{-1}$, as given by the theory. It is to be concluded, then, from these results that the vibrational quantum numbers in this band system must be given half-integral values.

WILLIAM W. WATSON.
Ryerson Physical Laboratory,
University of Chicago.
April 3.

[4] *Phys. Review*, **25**, 127, 1925.

## Origin of Yolk in the Eggs of Spiders.

IN a remarkable paper on the oocyte of *Pholcus phalangiodes* published in the last century (*Arch. de Biol.*, tome 15, 1898), Van Bambeke described a juxta-nuclear ring, the pallial layer or the pallial substance (see Wilson's "The Cell," third edition, p. 340), which with the growth of the oocyte separates from the nucleus, and, after fragmenting finely throughout the cytoplasm directly, gives rise to fatty deutoplasm. He also described ordinary yolk spheres which are albuminous in nature and arise independently in the cytoplasm.

During the last winter I have been working on the eggs of the common spider in Patiala, and I have been very much impressed by the remarkable accuracy of Van Bambeke's account in spite of the serious shortcomings of the technique (so far as the fixation of lipoids is concerned) in vogue in his time. I have shown that the pallial layer of Van Bambeke really consists of granular mitochondria, embedded in which are the Golgi elements in the form of rings or crescents. Indeed, Van Bambeke figures granules and rings in his pallial substance, but naturally he was not able to identify them. Mitochondria, of course, had been discovered earlier, but the Golgi apparatus was not yet known.

I strongly confirm Van Bambeke's statement that there are two kinds of yolk in the egg of spiders—fatty and albuminous. Further, his statement that the albuminous yolk arises *de novo*, and the fatty yolk is derived from the pallial substance, is correct.

Now the pallial substance consists of mitochondria and the Golgi elements. Is the fatty yolk derived from the mitochondria or from the Golgi elements? I have proved that the Golgi elements are directly metamorphosed into the fatty yolk, as in Lithobius (Nath, *Proc. Camb. Phil. Soc. Biol. Sci.*, 1924), *Helix aspersa* (Brambell, *Brit. Jour. Expt. Biol.*, vol. 1), Saccocirrus (Gatenby, *Quart. Jour. Micr. Sci.*, 1922), Patella (Ludford, *J.R.M.S.*, 1918), and possibly in Palamnæus (Nath, *Proc. Roy. Soc.*, London, 1925). The mitochondria remain unchanged. A full account will be published later.

VISHWA NATH.
Bhupindra Research Laboratory,
Mohindra College, Patiala, India.
April 7.

## On the Occurrence of $2n+1$ and other Chromosomal Mutants.

CHROMOSOMAL mutants with one extra chromosome (or the corresponding $n+1$ gametes) have been found in Oenothera, Datura, Matthiola, Nicotiana, Uvularia, and perhaps Mirabilis. It seems probable that they could be found in many other plants, if investigation *ad hoc* were made, either as somatic or gametic mutations. Such $2n+1$ offspring have also been found fairly often in Drosophila, and doubtless occur in other animals.

We have now a tolerably rapid method for counting the chromosomes of mammals, by the use of pieces of the amnion, stained with hæmatoxylin, and

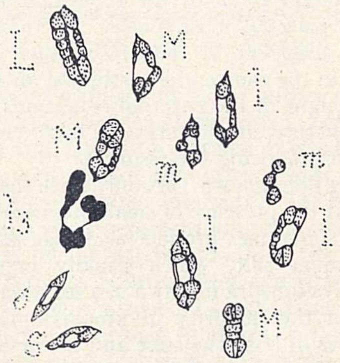


FIG. 1.—Group of chromosomes of $2n+1$ Datura mutant with an extra No. III. chromosome. Metaphase of reduction division. Camera drawing showing one trivalent and eleven bivalents.

mounted in balsam. It is possible that portions of this membrane may be examined directly in iron-acetocarmine. In this case the chromosomal number of individual mammals could often be rapidly determined at birth. It would be of especial interest to know whether $2n+1$ forms occur in man. There should be, of course, 24 possible $2n+1$ forms in Homo (disregarding the Y chromosome), which is the same number as in tobacco. The possible occurrence of haploids, triploids, or tetraploids in mammals (as in several plants and in Drosophila) is also of interest, since $2n$ gametes have been seen (Painter) in Homo It is hoped that investigations may be made on this point in mice, rats, or guinea-pigs.

JOHN BELLING.
Carnegie Institution of Washington,
Cold Spring Harbor, N.Y.

ERRATA.—"The Problem of X-Ray Line Intensities": NATURE of May 1, p. 622. Paragraph 3, line 4, for *0·030* read *0·093*; line 12, for 80·04 cm. read 8·04 cm.

## The Growth of Crystals.[1]

By Prof. C. H. DESCH, F.R.S.

GEOMETRICAL crystallography, which has reached a state of such remarkable perfection since its beginnings a century and a half ago, is concerned with the conditions of symmetry in crystals and with their possible faces, but it attaches little importance to the relative development of those faces, so that variations of habit, of such interest to the mineralogist, are mostly ignored. Since crystals of strikingly different habit, such as the many varieties of calcite, may all be derived from the same primitive crystal, their peculiarities must be due to variations in the conditions during growth, and this fact gives to the study of the growth of crystals a special importance.

A simple crystal immersed in a solution of the right degree of supersaturation may continue to grow whilst retaining its original shape unimpaired, as in the perfect octahedra of the alums which have been prepared by some manufacturing firms. Such crystals may grow to a large size without change of shape; and when an octahedron of chrome alum, for example, is allowed to grow in a solution of the isomorphous common alum, the regularity of growth is obvious from the uniformity of the colourless sheath enveloping the coloured nucleus. The increase in size has been brought about by the deposition of a uniform layer of new material on each face. On the other hand, faces may disappear or new faces may make their appearance in the course of growth, and an explanation has to be sought in the external conditions and in the internal structure of the crystal, both factors being concerned in producing the result.

It has long been known, certainly since the eighteenth century, that the presence of small quantities of foreign matter will sometimes produce a change of crystalline form. Common salt, which usually crystallises in cubes, forms octahedra if grown in a solution containing urea. When the quantity of urea is small, crystals with the faces of both the cube and the octahedron are produced. The crystals of organic compounds often vary very greatly according to the solvent which has been used. Such facts as these give the first clue to the problem of growth.

### THE SPACE LATTICE IN CRYSTALLOGRAPHY.

The use of X-rays in the study of crystal structure has placed crystallography on an entirely new footing. All modern studies of crystals start from the idea of the space lattice. The atoms, whether occurring singly or grouped to form molecules, are so arranged in space that a single unit is exactly repeated at regular intervals in three dimensions. Through such an assemblage planes may be drawn in any direction. Certain planes so drawn will contain a greater number of atoms in a given area than any planes drawn in a different direction, and it is these closely packed planes which play the principal part in crystal structure. Moreover, in crystals in which the atoms are of more than one kind, different planes may contain the atoms in different relative proportions, so that they may be assumed not to be chemically identical. Any plane may be imagined as a possible face of the crystal, although only a few of them are realisable in practice.

The several planes must have different chemical properties. This follows from our conception of the space lattice. The forces which hold the atoms in position are electrical in character, and depend on the number and arrangement of the electrons in each atom. The chemical behaviour is dependent on the same conditions, and the chemical properties of a crystalline surface must vary with the grouping of the atoms within it. What chemists often call residual affinity must vary with the denseness of packing of the atoms in a plane, so that each set of similar faces must have its own chemical characteristics. This supposition is confirmed by the action of chemical agents on crystals. In the etching of metals by acids it is easily seen that the reagent penetrates more readily along certain planes than in any other direction, as clear facets, of cubes or octahedra in most instances, make their appearance and give the characteristic lustre to the etched surface.

### THE PROCESS OF CRYSTAL GROWTH.

It has been shown by Johnsen, Gross, and others that the faces which survive during growth are those which have the lowest velocity of growth in a normal direction, and that these are in general the most closely packed planes. More openly packed planes have a higher velocity of growth, but their relative area diminishes as the crystal increases in size, and they ultimately disappear. The experiments of Nacken on salol and benzophenone are instructive. By attaching a small crystal of salol to a copper hemisphere immersed in the molten substance maintained at a constant temperature, and withdrawing heat by cooling a copper rod attached to the hemisphere, the rate of cooling could be varied; and it was found that when this was very slow the liberation of latent heat by the solidification of the salol and its removal by conduction kept pace with one another, and the surface of the growing crystal was spherical or nearly so, being determined only by the thermal conductivity, which varies only slightly in the direction of the different crystallographic axes. As the rate of cooling is increased, the growth perpendicular to certain directions fails to keep pace with the rest, and faces having a low velocity of perpendicular growth begin to make their appearance, at first with oval outlines. As the crystal increases in size, the area of such faces increases until their boundaries meet, and the crystal at last assumes its typical form, with plane faces and straight edges.

The experiments of Volmer and others on the formation of crystals of zinc and mercury in an evacuated vessel, by the impact of a stream of molecules of the metal on a plane surface, have thrown much light on the process. Nuclei are at first formed, and those grow which have the basal plane (the crystals being hexagonal) perpendicular to the direction of the stream. This plane has the lowest velocity of growth in a direction normal to itself. With mercury at $-60°$ C.

[1] Substance of two lectures delivered at the Royal Institution on March 16 and 23.

thin leaflets result, the thickness of which is only one ten-thousandth of the diameter. A quantitative interpretation of these experiments, together with those of Marcelin, which proved growth to be a discontinuous process, occurring by the formation of successive thin sheets, leads to the conclusion that atoms or molecules are first adsorbed as a layer of unit thickness, the atoms or molecules in which have a certain freedom of movement. In the course of such movement, groupings which may be regarded as two-dimensional crystal nuclei may arise, and the whole layer then assumes an orderly arrangement, in conformity with the underlying space lattice.

Since adsorption plays so large a part in growth it is not surprising that an alteration of habit may be produced by the presence of impurities. The observations of Gaubert on lead nitrate are particularly instructive. This salt separates from water in octahedra, but when methylene blue is added cubic faces appear, these faces being stained blue while the octahedral faces remain colourless. As the quantity of the dye is increased, the crystals become completely cubic, with blue faces. Evidently adsorption of the colouring matter by the cube face has lessened its rate of growth, so that it survives at the expense of the more rapidly growing octahedral face. It is probable that differences of habit in naturally occurring minerals are largely due to the influence of small quantities of foreign matter, but a very small quantity may suffice, so that the impurity responsible for the result may not have been detected in the course of an analysis.

Well-developed crystals are usually formed by comparatively slow growth, so that as material is withdrawn from the solution, or as heat is given out by the solidification of a melt, there is ample time for readjustment. Miers has shown that the solution in immediate contact with the growing face of a crystal of a salt is actually denser than the bulk of the solution, suggesting that the dissolved molecules undergo a preliminary rearrangement in the liquid before separation as a solid. For this view there is some evidence, notably from the fact, observed by Nasini and others, that solutions which are undercooled through the freezing-point show small discontinuities in properties, although no solid separates. It will be of considerable interest to examine this point by means of the X-ray method.

On the other hand, when growth is very rapid, the supply of material by diffusion may not keep pace with it, and the conditions are disturbed. Simple geometrical considerations show that the sharp angles of the crystal are more favourably placed for the reception of material by diffusion than the middle parts of faces, so that growth occurs at the angles by preference. The effect is cumulative, so that the crystal assumes a star shape, which in course of time undergoes branching, the process being repeated at each branch. This is the origin of dendritic crystals, which are so common in Nature. They are most easily obtained by allowing crystallisation to take place rapidly, as when a solution of a salt is evaporated quickly on a glass slide. The internal symmetry of the crystal is not destroyed, and most such crystals may be regarded as parallel growths, one axis being usually favoured. Thus native copper branches in the direction of the octahedral axes, whilst common salt forms growths parallel with the trigonal axes.

The process of diffusion may be hindered, and dendritic growth encouraged, by making the solution more viscous, as by adding gum. In highly viscous materials, such as glasses, slags, and pitchstones, very beautiful dendritic growths are frequently present. The 'trees' formed by the electrolysis of solutions of metallic salts have a similar structure.

### PERIODIC CRYSTALLISATION.

Periodic crystallisation is an interesting phenomenon, which again has a bearing on the origin of naturally occurring mineral structures. It was observed more than seventy years ago by Brewster in ancient glass which had undergone a process of decay. It may arise from several different causes in different substances.

The effect is very simply observed in molten salol. When a thin layer is melted on a slide and allowed to cool, slender needles are seen to radiate from each centre. The advancing point of each needle withdraws material from the liquid, and a gap is left, the molten salol standing up as a wall in front of the crystal edge. Owing to its viscosity, an appreciable time is required for the liquid to flow until it is again in contact with the crystal, when growth is resumed. This process is repeated, so that the advance of the needle is intermittent, and the crystal when complete is marked by transverse lines indicating the stages of growth. The process may be followed under the microscope with ease.

Some salts crystallise from water with a very definite periodicity, the best example being potassium dichromate, a thin layer of a solution of which, if rapidly evaporated, will yield concentric rings of minute crystals with very regular intervals. The effect is here no doubt one of supersaturation, the solution being impoverished by the separation of one ring of crystals, so that the process is interrupted until the right concentration is again reached by diffusion, and so on. Similar structures are seen in glazes on porcelain and, although more rarely, in slags. They are closely connected with the phenomenon of periodic precipitation in jellies, the formation of Liesegang's rings.

The study of periodic crystallisation throws light on some natural structures, especially of agates, which are in all probability formed by the periodic crystallisation of silica from the gelatinous contents of a cavity in a rock. Ruskin maintained that the banding in agates was due, not to periodic infiltration of a liquid, but to segregation, and his view is confirmed by modern work. In particular, the so-called canals, which have been supposed to represent the passages by which liquid entered and left the cavity, are seen, by laboratory experiments on periodic crystallisation, to be merely geometrical effects produced by the meeting of different systems of advancing bands.

Dendritic and periodic crystallisation depend on more complex causes than change of habit, and are correspondingly more difficult to study in a quantitative manner; but there can be little doubt that the examination of the chemical properties of the several planes in crystals will throw much light on these as on other problems of crystallisation.

## New Arctic Expeditions.

THREE expeditions, each aiming to cross by air the unknown regions in the heart of the Arctic Ocean, have been or are at work in the north. Capt. R. Amundsen, profiting from his experience of last year, when he found his range of flight seriously limited by lack of petrol, substituted a semi-rigid Italian airship for an aeroplane. The *Norge*, under the command of its designer, Col. U. Nobile, and piloted by Major G. F. Scott, reached Pulham from Rome on April 11, Oslo on April 14, Leningrad on April 15, and King's Bay, Spitsbergen, early in May. The polar flight took place on May 11-13, the *Norge* passing over the Pole at 2 A.M. on May 12. On her flight from Rome to Pulham the *Norge* covered 1400 miles at an average speed of 47 miles an hour. Only two of the three 250 horse-power engines were used, each being rested in turn. From Spitsbergen to Point Barrow in Alaska via the Pole is 1800 miles, and in favourable weather Capt. Amundsen appears to have crossed in 45 hours.

The *Norge* descended safely at Teller, 650 miles from Point Barrow, having accomplished a total distance of 3393 miles from Spitsbergen in 72 hours. Damage was caused to the balloon fabric by fragments of ice, due to condensing moisture, being thrown violently from the propellers. Capt. Amundsen reports that lack of sleep and freezing of food supplies were the only discomforts on the journey. Thin ice and some open water were seen at the Pole, where the *Norge* descended to within 600 ft. of the sea.

The *Norge's* fuel capacity is seven tons, which, at a speed of 50 miles an hour, gives her a range of 3000 miles, in calm air, or about 60 hours. Her gas capacity of 660,000 cubic feet is about a third that of R. 33. Her length is 348 ft., and her maximum speed is 60 miles per hour. Wireless communication was maintained throughout the flight. The crew numbered 15, including Capt. Amundsen, Col. U. Nobile, and Mr. L. Ellsworth. Lieut. Larsen was the pilot.

An American expedition under Lieut.-Commander R. E. Byrd, U.S. Navy, with Mr. F. Bennett as pilot, is also at King's Bay with a three-engined Fokker monoplane. The original plans included six flights. According to the *Times*, the first was to be one of 400 miles from Spitsbergen to Peary Land, North Greenland, to land oil and provisions. On returning to the base the aeroplane was to make a second journey to Peary Land with more supplies, and then leave on an 850 miles' flight to the Pole and back. On May 9, Lieut.-Comdr. Byrd left on a flight to the north and returned in 15½ hours, announcing that he had reached the Pole. Confirmation is still lacking.

The third flying expedition is the Detroit Arctic expedition under Mr. G. H. Wilkins, who has arrived at Point Barrow with two Fokker aeroplanes. With Mr. C. B. Eielson as pilot, Mr. Wilkins proposes to fly northward over the heart of the unexplored Beaufort Sea. If no land is discovered he hopes to continue across the Pole to Spitsbergen. On the other hand, if land is found, the aeroplane will return to Point Barrow and both machines will go north and attempt to make a base on the new land, whence one aeroplane will continue to Spitsbergen. Mr. Wilkins, who gained his polar experience with Mr. Stefansson, proposes to adopt his former leader's precept; he will carry as much petrol as possible, and depend on seals for food if he is forced to descend. Near land this may prove possible, but Mr. Stefansson in 1914 crossed areas of the Beaufort Sea in which he saw no seals, and Capt. Amundsen last year reported only one seal at the place of his forced descent.

It is unlikely that any of these expeditions will report new land. Evidence of its existence in the unexplored parts of the Arctic Ocean is lacking, and the results of the recent expedition of the *Maud* supports this point of view. In any event, it is improbable that rapid flights across polar regions can achieve results of great scientific interest.

Less sensational, but more promising in results, are several expeditions to Greenland. Prof. W. H. Hobbs, of Michigan, is leading an expedition to study the glacial anticyclone. He proposes to sail in July for his main base at Holstenberg, a little north of the Arctic Circle on the west coast of Greenland, where the ice-free margin of the land is about 100 miles wide. Here in a sheltered valley the main base, with a hangar for two aeroplanes, will be established. A second station will be near the coast at a height of about 1000 metres, a third at about 2500 metres on the ice cap, and a fourth, well in the interior, in the area of calms and light winds which Prof. Hobbs believes to exist in the heart of the anticyclone. This last station will be visited frequently, but the other three will be inhabited, it is hoped, for fifteen months and will be in charge of Mr. P. Freuchen, the Danish explorer of Greenland. A snow motor and two aeroplanes will be used to establish the stations and main base connexions. There will also be wireless communication with Godthaab and with Dr. L. Koch's expedition on Scoresby Sound. Prof. Hobbs, who will return with many of his staff in October, has received the collaboration of Mr. V. Douglas, Dr. W. Koeltz, and Prof. H. T. Barnes. The expedition has the support of the U.S. Coast and Geodetic Survey and the U.S. Weather Bureau.

An expedition of seven members under Mr. J. M. Wordie is leaving Aberdeen in June for the east coast of Greenland. Mr. Wordie, who was foiled in his attempt to reach the coast in 1924, intends to make for Shannon Island, and, having got through the pack-ice, to make southward to Franz Josef fjord for geological work. The expedition will return at the end of the summer, but is carrying the necessary equipment and stores in case of a forced wintering, which, however, is improbable since in September the coast south of Scoresby Sound is relatively free from ice. Further south, Dr. L. Koch intends to continue his exploration of Greenland from a base on Scoresby Sound, where an Eskimo colony was founded last summer. Other colonies are to be founded in the same district on the site of former Eskimo settlements at Cape Stewart, Cape Hope, and Cape Tobin. The Field Museum of Chicago announces a collecting expedition under Dr. D. B. Macmillan to sail in July to Baffin Land and Ellesmere Land. Several other Arctic expeditions have been prepared for this summer, including a French attempt under Lieut. Sales northward from Spitsbergen in motor sledges, but their start is uncertain. R. N. Rudmose Brown.

## News and Views.

THE scheme proposed by Sir Frank Heath for the re-organisation of the Commonwealth Institute of Science and Industry has been tabled in the Australian House of Representatives. The outstanding aim in the scheme is to obtain the utmost co-operation of all the States with the Commonwealth in the formulation of advice through carefully selected men of responsible position and wide outlook, it being recognised that the vast distances of Australia and the wide range of its climates demand a degree of decentralisation much greater than is necessary or desirable in a smaller and more populous country. It is recommended that the purposes of the Institute be defined under three heads: (1) To provide for the training of young men and women in scientific research and for the encouragement of research workers who have already shown capacity for original work; (2) To take responsibility for conducting scientific investigations into problems of importance either (*a*) to the whole industrial activities of the Commonwealth, whether primary or secondary, or (*b*) to the interests of Australian consumers as a whole; (3) To encourage and assist under suitable conditions the solution of scientific problems of importance to particular States or groups of States, which, though urgent in themselves, do not affect the whole Dominion.

THREE derivative functions for the Commonwealth Institute of Science and Industry are added to the main purposes set out in Sir Frank Heath's scheme for re-organisation: (*a*) To act as a clearing-house for information on scientific matters affecting the industries of the country; (*b*) To act as the principal and official means of *liaison* in scientific matters between the Governments of the Commonwealth and those of Great Britain and other parts of the British Empire; (*c*) To become, as it wins the confidence of the world of industry and science, the adviser of the Government on the scientific aspects of policy. It is proposed that the Institute be constituted a body corporate consisting of the Prime Minister for the time being and an advisory council of a chairman and eight members, under the title of the Department of Research in Science and Industry. The chairman and two members are to be appointed by the Governor-General and are to form an executive committee with very extensive powers. The other six members are to be the chairmen of State advisory committees. Each of the latter is to include two members nominated by the State Government from its scientific staff, two members of the State University nominated by the Australian National Research Council, and two representatives of the principal industries of the State.

IT is suggested that the advisory council which is to constitute the body corporate of the Commonwealth Institute of Science and Industry should meet twice annually at equal six-monthly intervals. It may initiate proposals for research and must consider proposals sent to it by State committees. Between these meetings the executive committee may exercise all the powers of the council. The chief executive and accounting officer to the Institute will be appointed by the Governor-General and act as secretary to the advisory council. As member of his staff he will have in each State an officer who will be secretary of the State advisory committee. The responsibilities placed upon the executive committee of three will be continuous and important, though it is not proposed that its members should be full-time officers. Sir Frank Heath urges that in their selection the first test to be applied should be the certainty that their presence on the advisory council will bring prestige and public confidence to the work of the Institute. Taken as a whole, the proposals for general organisation and future operations follow, as closely as circumstances permit, the lines which have proved successful in the Department of Scientific and Industrial Research in Great Britain, and provision is made for developing the maximum possible co-operation between the British and Australian organisations.

THE annual Halley Lecture of the University of Oxford was delivered on May 5 by Dr. G. M. B. Dobson, Lincoln College, University lecturer in meteorology, who took as his subject "The Uppermost Regions of the Earth's Atmosphere." The higher regions of the atmosphere were defined as having a lower limit of say 20 kilometres. Exploration of these tracts is difficult: something can be done by means of dirigibles and balloons: Goddard in America has suggested rockets, by which he hopes to obtain instrumental readings up to a height of two or three hundred kilometres. The amount of each gas present in the atmosphere seems to be fairly constant at moderate altitudes; above these, the large bulk of hydrogen emitted by volcanoes introduces a difference, which would make a difference in the pressure. Some information as to the higher regions can be gathered from the aurora borealis. The occurrence of this phenomenon shows some correspondence with the period (27 or 28 days) of the sun's rotation. Sunspots are often, but not always, present at the time of an auroral display. At the fine display of a few weeks ago there was no visible sunspot. The spectrum of the aurora shows the presence of nitrogen; there is also a characteristic bright line in the green, probably due to oxygen and helium bombarded by electromagnetic particles. A second source of information is the appearance of meteors, chiefly consisting of iron. These become visible at a height of from 30 to 160 kilometres. The temperature of the air, which falls at first, appears to rise again at heights above 120 kilometres. Observations of the trails of meteors enable us to estimate the direction of the wind at different heights. Yet another means of learning something of the constitution of the upper atmosphere is the phenomenon of 'luminous clouds.' These often resemble the 'northern lights,' but their spectrum is that of sunlight, and is without the bright green line characteristic of the aurora. They probably consist of dust from volcanoes, and not of water-vapour. The distribution of dust-clouds shows foci of intensity within areas of vacancy; this is analogous with the distribution of the sound of an explosion.

AIR VICE-MARSHAL SIR W. SEFTON BRANCKER gave some interesting information concerning air transport on the occasion of the fifth Gustave Canet Memorial Lecture which he delivered before the Junior Institution of Engineers on April 30. He said that in no case within Europe has air transport paid its way; it exists only by the grace of subsidies. The British company Imperial Airways has complete freedom in its policy, and, with its predecessors, has already carried more than 70,000 passengers across the Channel, with only four fatal accidents. The first British Empire air-link outside Europe is about to be established. Imperial Airways have accepted a contract to operate a fortnightly service between Cairo and Karachi via Baghdad, to commence on January 1, 1927. Four days are permitted for the voyage of 2500 miles, but it is proposed ultimately to perform the journey in thirty hours. The British Government has decided to go on with airship development, two big ships being at present on order. The present plan is to operate an experimental service to India, with a base at Karachi and a temporary calling-station at Ismailia. The most difficult problem which confronts air transport is the reduction of costs to render a Government subsidy unnecessary; the total cost of carriage by air is now about 5*s.* a ton-mile at 90 miles an hour. The predominant factors are overhead charges, operating costs, and revenue. Obsolescence and depreciation are usually estimated at 20 per cent. per annum, but that is not sufficient. Most of the existing machines ought to be replaced by all-metal craft fitted with air-cooled engines and provided with stability and economy devices. As regards engine maintenance, it was stated that about 60 per cent. of engine defects are due to the water system, valve breakage or distortion, or oil circulation. The development of the heavy oil engine for use in the air is going on steadily. The engine is appreciably heavier than the normal petrol engine, but shows considerable saving in weight of fuel burnt per horse-power.

IN the course of a Chadwick Public Lecture delivered at Bangor on May 4, on "The Collection and Utilisation of Small Water Supplies for Rural Communities and Single Houses," Mr. Henry C. Adams said that the recovery and utilisation of underground waters is of comparatively recent origin. In the earliest ages streams and springs formed the only supply of water; to-day they still form the only supply for many thousands of the population in Great Britain, but they can no longer be regarded as essentially a pure or even a safe source of supply for potable purposes. The amount of water which may reasonably be required varies within wide limits. For cottage property 10 gal. per head per day is an ample allowance; indeed, when water has to be carried for use the consumption frequently does not exceed 8 gallons. When, however, a piped supply is afterwards laid on, consumption generally increases at once to about 15 gal. Natural filtration through a considerable depth of permeable strata will arrest the organic and bacterial impurities in the water, but in default of this, artificial filtration is the most practical and effective method to adopt. If space is limited it may be preferable to put down mechanical or rapid filters in place of sand filters. In 1914 the Ministry of Health reported that 285 million gallons of water a day was supplied in Great Britain for domestic purposes from underground sources, excluding springs. The nature of the source from which water is obtained changes as one traverses England. On the east, with its porous surface strata, surface supplies are generally unknown, saving for occasional springs here and there. In the Midlands, examples are found of water from all types of sources; while on the west coast, with its impermeable rocky surfaces, deep underground supplies are practically unknown and surface waters are used almost entirely.

MR. P. DUNSHEATH gave an interesting lecture on "Science in the Cable Industry" to the Royal Society of Arts on March 3, which has recently been published in the Society's journal. The application of science to cable making is not entirely a modern innovation. More than sixty years ago Kelvin gave a theory of electrical transmission in the submarine cable. Generally speaking, the cable industry has flourished under the direction of practical men guided by masses of collected data rather than by scientific principles. Cable making has been an art rather than a science. During the last fifteen years, however, the introduction of high electric pressures has made it necessary for the designer and manufacturer to have both the highest technical skill available, and also the help of scientific men with a thorough knowledge of the latest theories. In the lecturer's opinion, cable manufacture offers to-day the widest and most promising field for scientific research. The problems are mainly in connexion with conductors and insulators, and their solution demands the highest mathematical and experimental skill. The British Electrical and Allied Industries Research Association and the National Physical Laboratory have done work which has been of the greatest commercial value to the industry, and the work of the individual researcher has been of equal importance. Cable of British manufacture has always been in the front rank in the markets of the world, and scientific research is being utilised to the full to enable it to keep that position.

THE increasingly important part played by light in the modern treatment of disease is illustrated by the receipt recently of numbers of two journals devoted entirely to this subject. *Raggi Ultravioletti*, published at Milan, is a monthly review of ultra-violet therapy, which has now reached its second year of publication. It contains original articles on the treatment of diseases such as rickets and tuberculosis by means of light, short clinical notes on cases of interest and abstracts of current literature. Improvements in technique and medical news are also included. It should be of interest especially in bringing forward the Italian viewpoint on various diseases of world-wide distribution. The other publication received is *Modern Sunlight*, which has recently been published in London. This journal, while including a number of short scientific articles, is primarily devoted to supplying information on the subject of sunlight, natural or artificial, to the lay public. The important part which can be played by ultra-violet light in the treatment and cure of certain diseases may tend to an over-enthusiastic use of it in all kinds of conditions, with a certain amount of resulting disappointment. The fact, however, that these rays seem to play a part in the improvement of the general health of the body, suggests that they may usefully be combined with a specific treatment in a large number of diseases in which the general health has deteriorated. An appreciation of their uses and abuses on the part of the general public will avoid the dangers of over-enthusiasm and lead to their more ready use in conditions in which they are definitely indicated.

WE welcome the appearance of the first number (January 1926) of the *Indian Journal of Psychology*, a quarterly publication and the official organ of the Indian Psychological Association. The article of most general interest is by Dr. N. N. Sengupta on "Psychology, its Present Development and Outlook." The author reviews the chief trends of present-day psychological studies, relating them to their historical background, and outlines the more dominant schools of thought. He points out the enormous wealth of untouched material available in India, with its many races, religions, and cultures, enabling problems to be studied on a large scale, which in England are inevitably vitiated through insufficiency of data. He states that psychology in India is not so advanced as its importance demands, and gives as reasons its close dependence on philosophy, the tendency to be content with mystical explanations, the unnatural divorce between general and experimental work, and the vagueness as to its relation to physiology. It may be some consolation to the author to be assured that India is not the only country where such conditions prevail. The same difficulties appear in many English controversies. However, certain branches of psychology have emancipated themselves from the thraldom of preconceived notions and are making efforts to build securely on observation. India will doubtless not lag far behind. Dr. Sengupta makes a special plea for the co-ordination of many workers. If his schemes can be realised even in a small degree, India will have much to teach England, and we wish the new movement every success.

WE much regret to announce the deaths of Dr. H. B. Guppy, F.R.S., distinguished for his work on plant dispersion and coral-reef formation in the Pacific, which occurred on April 23, at the age of seventy-one years; and of Mr. Stephen Paget, founder of the Research Defence Society and author of the biography of Sir Victor Horsley, on May 8, aged seventy years.

WE learn from *Science* that Dr. Edgar F. Smith, professor of chemistry at the University of Pennsylvania, has been awarded the second Priestley medal, bestowed every three years by the American Chemical Society upon a chemist for outstanding achievement in the science. The first Priestley medallist of chemistry was Ira Remsen, former president and professor of chemistry of the Johns Hopkins University.

MR. C. CUTHBERTSON, F.R.S., who is working at the Davy-Faraday Research Laboratory, 20 Albemarle Street, London, W.1, informs us that he requires 20 c.c. or more of krypton and xenon for research purposes. Inquiry at likely sources has been unsuccessful, and we understand that there is considerable difficulty in obtaining any of these gases in Great Britain. Mr. Cuthbertson would welcome information relating to available supplies.

THE Air Ministry announces that applications to enter machines for the Air Ministry Helicopter Competition, 1925–26, which closed last April, were received from thirty-four competitors, but only one competitor actually sent a machine to Farnborough, where the tests were to be carried out. This machine did not, however, carry out any of the tests, and none of the prizes offered has been won. It has been decided not to renew the competition.

THE following awards for the period 1923–25 have been made by the Royal Society of Edinburgh: Keith Prize to Prof. H. W. Turnbull, professor of mathematics in the University of St. Andrews, for his papers on hyper-algebra, invariant theory, and algebraic geometry, published in the *Proceedings of the Royal Society of Edinburgh*; Neill Prize to Prof. F. O. Bower, for his recent contributions to botanical knowledge, and in recognition of his published work extending over a period of forty-five years.

AT the end of the present session Prof. A. G. Perkin will retire from the chair of colour chemistry and dyeing in the University of Leeds, severing thereby a connexion with the University which has extended over thirty-four years. In view of Prof. Perkin's long period of service and the valuable work which he has done in building up a school of research into colour chemistry and the chemistry of natural colouring matters, work which is of great value to the textile and dye industries, a committee has been formed for the purpose of raising a fund which will enable the esteem in which Prof. Perkin is held to be signalised, either by the presentation to the University of his portrait, or in some other suitable manner. Subscriptions are invited for this purpose, and should be sent to Prof. A. F. Barker, The University, Leeds.

THE Royal Society will receive from Messrs. Brunner, Mond and Co., Ltd., a donation of 500*l.* in respect of the current year towards the cost of scientific papers on the physical side. The Society will also receive a Publication Grant of 2500*l.* from H.M. Government during the current year. Both grants are available for helping the publications of other scientific societies as well as for assisting the separate publication of books, memoirs, etc., of a scientific nature. Applications for grants for the current year will be adjudged by the Council of the Royal Society at its meeting early in July, but should be received before the Council meeting of June 10. Applications from societies will be received by the secretaries of the Royal Society; those from individuals must be brought forward by members of Council.

THE Rockefeller Medical Fellowships for the academic year 1926–1927 will shortly be awarded by the Medical Research Council, and applications should be lodged with the Council not later than June 10. These Fellowships are provided from a fund with which the Medical Research Council has been entrusted by the Rockefeller Foundation. Fellowships are awarded by the Council to graduates who have had some training in research work in the primary sciences of medicine or in clinical medicine or surgery and are likely to profit by a period of work at a university or other chosen centre in the United States before taking up positions for higher teaching or research in the British Isles. A Fellowship will have the value of not less than 350*l*. a year for a single Fellow, with extra allowance for a married Fellow; travelling expenses and allowances will be made in addition. Full particulars and forms of application are obtainable from the Secretary, Medical Research Council, 15 York Buildings, Adelphi, London, W.C.2.

WE much regret that in the paragraph in our issue of May 1, p. 630, referring to the bicentenary of the birth of Major-General William Roy, who initiated the primary triangulation of Great Britain, the name "Roy" was printed as "Ray."

THE editors of "Organic Syntheses," an annual publication of satisfactory methods for the preparation of organic chemicals, now have at hand a large number of preparations in addition to those to be included in Volume 6, which is now in press, and in Volume 7, which will soon go to the printer. Chemists interested in any of these preparations can procure copies from Prof. Frank C. Whitmore, Northwestern University, Evanston, Illinois.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—An assistant lecturer in geography in the University of Manchester—The Internal Registrar (June 21). A professor of anatomy at the Royal Veterinary College—The Secretary, Royal Veterinary College, Camden Town, N.W. (July 1). A radio engineer, a physicist or radio engineer, a radio engineer, and a radio experimentalist—The Secretary, Royal Engineer Board, 14 Grosvenor Gardens, S.W.1. A senior physics master at Oundle School—The Headmaster, The School, Oundle, Northants.

## Our Astronomical Column.

NAKED-EYE SUNSPOT.—Two months have elapsed since the last appearance of a naked-eye spot, No. 5, reported in NATURE for March 6. The present group of spots was seen as a naked-eye object for a few days only. It was of the typical 'stream' formation; that is, a well-defined regular spot followed at a distance of 8° or 10° of solar longitude by an irregular spot breaking up into a cluster. These two chief components are found to be almost invariably of opposite polarity. The longitude of this group is not far from that of the great northern spot of December and January, the position of which still remains marked by faculæ. Details of the new spot are as follows:

| No. | Date on Disc. | Central Meridian Passage. | Latitude. | Area. |
|---|---|---|---|---|
| 6 | May 8-20 | May 13·7 | 20° S | 1/1100 |

(Area expresses the proportion covered of the sun's hemisphere.)

NOVA IN A SPIRAL NEBULA.—A telegram from the I.A.U. Bureau, Copenhagen, announces the discovery of another faint nova in a spiral nebula, Messier 61, in the constellation Virgo. The position for 1926·0 is R.A. $12^h$ $18{\cdot}3^m$, N. Decl. 4° 54′. The magnitude is given as 13. The discovery was made at the Königstuhl Observatory, Heidelberg, by Prof. M. Wolf and Herr Reinmuth, evidently by photography. The spiral character of this nebula was detected at Parsonstown by the late Earl of Rosse.

The nova is distant 70″ from the nucleus, in position angle 351°.

It is important to follow these distant novæ for as long a time as possible, in order to compare their light-curves with those of galactic novæ. It will be remembered that Dr. Hubble was able to trace the light-curves of the faint Cepheids in M31 and M33 down to magnitude 19 or 20.

THE SUN'S VELOCITY DERIVED FROM FAINT STARS.—*Lick Observatory Bulletin* No. 374 describes a research by P. van de Kamp on the solar velocity derived from the radial velocities of stars of average magnitude 9·2. The research was intended to test Seares's result that the sun's velocity is greater with respect to faint stars than to bright ones, amounting to 25 km./sec. for tenth-magnitude stars. The spectra were photographed with a one-prism spectrograph mounted on the 36-inch refractor. The scale is small, and the individual results rather untrustworthy, but the errors should nearly go out in the mean. The list comprised 105 stars, equally divided between the apex and antapex regions. Their spectral type is as follows (from Henry Draper Catalogue): A and F 45 stars, G 32 stars, K 28 stars.

The resulting value of the sun's velocity is 18 km./sec., the values from the different spectral types being accordant. This value is slightly smaller than the usually accepted value, derived from brighter stars, and thus fails to support Seares's hypothesis. Some other approximate methods of obtaining the velocity with respect to faint stars are discussed, and found to indicate still lower velocities than the present research. The absolute magnitudes of the K stars were estimated as lying between $-1{\cdot}6$ and $+3{\cdot}1$, so that none of them are faint dwarfs. The assumed position of the solar apex was R.A. 270°, Decl. $+30°$.

## Research Items.

THE HUMAN FACTOR IN ACCIDENTS.—The importance to industry of a study of accidents, major and minor, cannot be exaggerated, but when definite causative relations are sought the difficulties and complexities seem to render scientific treatment almost impossible. The immediate relation is between machinery and an accident, and quite rightly have efforts been made to diminish the risk due to machinery. More detailed study reveals, however, a number of determinants which point to less obvious factors. Report No. 34 of the Industrial Fatigue Research Board (H.M.S.O., price 5*s.*) is a contribution by Miss Newbold to the study of the human factor in the causation of accidents. It is a statistical analysis of minor accidents reported from many firms and covering a considerable period of time. It is found (1) that in nearly all the groups the average number of accidents is much influenced by a comparatively small number of workers, and that the distributions among the workers are far from chance; (2) that there are many indications that some part is due to personal tendency; (3) that the people who have the most accidents are, on the whole, those who pay most visits to the ambulance room for minor sicknesses. The study is very important not only for what it brings forward in the way of positive evidence, but as an example of scientific method applied to a very difficult problem where vague speculation and prejudice frequently masquerade as fact. The writer suggests that further detailed investigation should be undertaken along the lines of individual study and experimental psychology.

MAN IN THE GLACIAL PERIOD IN GREAT BRITAIN.—In *Man* for April, Mr. J. Reid Moir discusses the inferences to be drawn from the discovery of a palæolithic implement on the foreshore at Eccles-on-Sea, Norfolk, by Mr. W. W. R. Spelman. The implement is an oval core-implement, unpatinated and unrolled. Its form and flaking assign it to the class of specimens concerning which, in the present state of our knowledge, it can only be stated that they belong either to Late Chelles or Early Acheulean. The unabraded condition of the implement suggests that it must have been uncovered just prior to discovery from a bed underlying the beach, as the sandy beach and low cliff reveal no humanly flaked flints. Such a bed must have been the stratum designated as 'First Till.' In all probability the First Till represents one of the deposits laid down during the second Glacial Period of East Anglia, and was separated from the Upper Chalky Boulder Clay (of the third Glacial Period of East Anglia) by the inter-glacial phase represented at Hoxne, Foxhall Road, Ipswich, and elsewhere. As St. Acheul implements occur in this phase, it becomes of importance to ascertain whether the present implement is of Chellean or Acheulean date. The main fact, however, is that a definite flint implement of Lower Palæolithic Age has been found under conditions making it probable that the specimen was derived from a glacial boulder clay and thus affords additional evidence of the existence of man in England during the glacial period.

RESEARCH IN THE FAYUM.—In *Ancient Egypt* for March, extracts are given from correspondence from Miss Gertrude Caton-Thompson, and Miss Elinor W. Gardiner, who are working in the Fayum on behalf of the British School of Archæology in Egypt with the view of linking the archæology to the close of geological changes. Writing from Dîmeh, a little south of the lake, Miss Caton-Thompson says that it is plain that there was more than one simple rise and fall of the lake in Pleistocene times. A shore line 189-190 feet above the present lake (46 ft. over sea) yields much evidence of the prehistoric people. On a slope down to the Birket Qarun, flint was obtained at 176 feet on a ridge on which it was unlikely to have been washed (*i.e.* 32 feet over sea, submerged since 9000 B.C.). Pigmies with pigmy cores came down to 138 feet (6 feet below sea, submerged since 17,000 B.C.). Investigations at Kom have settled the question of the contemporaneity of the polished flints, the pottery, and the bone arrows, but only one culture is represented. Miss Gardiner writes that the most important fact in the geology of the area is that the Fayum people were living on an old lake surface and not tertiary rock as supposed. There is distinct evidence of two lakes. The older dried up and the deposits denuded very considerably before the waters of the second lake gained access to the Fayum. A section in a wady shows gravels full of flints, mostly wind worn, at 185 feet above lake level, probably belonging to the older lake beds. The surface of the gravel is 185 feet above lake level (submerged since 8000 B.C.). A considerable number of Fayum implements were found upon it. (The statements in brackets are from explanatory notes by the editor of *Ancient Egypt.*)

A DIET CHART.—We have received a copy of the "Grassendale" Diet Chart prepared by S. G. Willimott and Frank Wokes, Grassendale, Liverpool (price 6*d.*), which appears to have been designed for the benefit of the general practitioner of medicine who wishes to place his patient on a known diet before sending samples of blood, urine, etc., to a biochemical laboratory for chemical examination. At the same time, it should be of use to all who wish to treat their patients by means of strict dieting. The information given on the chart is comprehensive: for a large variety of natural, and a few patent, foods the following data are set forth in a series of columns; the percentage composition (carbohydrate, protein, and fat), the energy value, the digestibility coefficient of the carbohydrate present, and the most important of the inorganic elements contained in the food, and whether it leads to the formation of acid or base in the body, its relative power in this respect being indicated by a numerical figure. At the same time, the relative content of the material in the three vitamins, A, B, and C, and the presence of purines, are also indicated. Blank columns are given for entering the amounts of each food eaten in the twenty-four hours and for the results of the calculations of the quantities of protein, fat, or carbohydrate assimilated. Explanatory notes of the chart are given on the back: those on vitamins might perhaps have been a little clearer; dry seeds contain vitamin B, but on germination it is vitamin C which appears in large quantities. The information given in the chart should be of use in dieting cases of diabetes mellitus, gout, and nephritis, being available in a compact and handy form; whilst sent to the laboratory with the specimen it will enable a more correct interpretation to be placed on the results of the chemical examination.

THE SWIM BLADDER OF SOME INDIAN FISHES.—In his thesis recently presented to the Faculty of Sciences in Paris, D. R. Bhattacharya has given an account of the structure and relations of the swim bladder of Indian fishes belonging to the families Sciænidæ and Ophiocephalidæ. In the former the swim bladder is oval and extends the whole length of the abdomen. Issuing from it is a complex system of branches passing to the head and to the tail—those in the head region have an arborescent form, and some of them enter into relation with the auditory capsule, being separated from the perilymph only by thin fibrous tissue. Some of the blind branches also penetrate the operculum and the pectoral fin and their ends come to lie just under the skin. In *Sciænoides pama*, two lateral lobes arise from the swim bladder and extend between the peritoneal epithelium and the body-wall and form a complete sac around the body cavity. A dorsal sac is formed in a similar manner and completely envelops the swim bladder dorsally. The two sacs meet laterally, and thus in a dissection one comes upon this large sac enveloping the swim bladder. In the Ophiocephalidæ the swim bladder is an elongate sac extending from the anterior part of the abdomen to the tail, and does not give off diverticula. Details are given of the glands of the swim bladder in each family.

EFFECT OF LIGHT ON THE MOVEMENT OF EARTHWORMS.—E. Nomura has made (*Science Reports Tohoku Imp. Univ.*, Japan, fourth series, vol. 1, pp. 293-409, 1926) careful investigations on the effect of light on the movement of *Allolobophora fœtida* to test the differential effect of light on fresh and on fatigued worms, to ascertain the average limit of the free or random movements, the influence of light—horizontal, and from above, and in flashes—on worms with the cerebral ganglia removed and on worms in the course of regeneration. His general conclusions may be summarised as follows: The orientation of the worm is determined by the antagonistic functioning of the cerebral ganglia and of the ventral nerve cord. The brain causes negative orientation and forward crawling, while the nerve cord causes positive orientation and crawling either backwards or forwards. By the predominant influence of the brain the longer exposure to light of stronger intensity causes the stronger negative phototaxis. With light of a given intensity the strongest negative phototaxis is produced when the light rays fall at an angle of about 25° to the horizontal. The most anterior part of the ventral nerve cord causes the strongest positive orientation, the more posterior parts cause a progressively less pronounced reaction—that is, the worms exhibit axial gradient in these reactions.

SOME NON-MARINE MOLLUSCA OF THE WESTERN HEMISPHERE.—A fifth part of Dr. H. A. Pilsbry's notes and descriptions of South American land and fresh-water molluscs, that were begun in 1924, has appeared detailing various new species, including one of that remarkable land snail Megaspira (*Proc. Acad. Nat. Sci. Philad.* 77). The same author on later pages in the same publication, deals with other new non-marine mollusca. The most remarkable of these is a very small Physa from Zion Canyon, Utah. No snail can be found in the swift-running stream at the bottom of the canyon, but where the water trickles out of the rock joints of the almost vertical walls of the canyon, the wet rock faces become coated with green algæ, and it is on these isolated patches of algæ the little *Physa zionis* lives. This account is followed by descriptions of new non-marine shells from Querétaro, Mexico.

MODIFICATIONS IN THE CALYX OF PRIMULA.—Since recording in NATURE of April 10, p. 518, the occurrence in phyllody of the calyx *Primula vulgaris* (Huds.), Mr. F. R. Browning writes that he has seen hybrids of *P. vulgaris* with *P. veris*, sometimes termed *P. variabilis*, Goup., showing a completely petaloid calyx. The three flowers examined were 'pin-eyed,' two of them having five petals and five petaloid sepals, which alternate with them normally. The third flower has six petals and five petaloid sepals; the sixth is diminutive though decidedly petaloid. It also differs from the others in that it has not the well-marked ridge at the midrib, which characterises the other sepals. The size attained by this unusual calyx is in all cases the same as that attained by its enclosed corolla.

DOMESTICATED PLANTS IN SPANISH AMERICA.—An interesting field of research is opened up in a paper on the plant content of adobe bricks by George W. Hendry and Margaret P. Kelly which has been published by the California Historical Society. Missionaries and travellers who visited California in the Spanish period are known to have introduced a number of cultivated plants into the country, but precise information, especially as to varieties, is lacking. An examination of bricks from a number of buildings, ranging in date from 1771 to 1845, although representing a small sample only, has furnished a considerable amount of exact information on the point. The adobe bricks were made of a variety of soils, ranging from sandy loam to heavy loam, some natural, others the result of artificial mixing, and contained organic matter chopped into two-inch lengths, usually wheat or barley straw, but also weeds and grasses of various kinds. Of the twenty-two weeds, eleven are introduced European species. Six varieties of wheat were identified. This establishes a new date for the introduction of Big Club wheat (*T. Compactum Humboldii*) not previously known as a mission crop. One wheat, California Club wheat (*T. Compactum Crinaceum*), is not grown in California to-day, but disappeared prior to the Mexican period (1822–45), and another, a beardless wheat (*T. Vulgare Albidum*), is unknown. Propo wheat (*T. Vulgare Graecum*), supposed to have been introduced from a Chilean strain about 1875, was also found, and may have persisted from the original Spanish stock. Only one variety of barley (*H. Vulgare Pallidum typica*) was found. One wild oat kernel is of doubtful authenticity. Of two cultivated oats, *Avena sativa*, which belongs to a group not adapted to central California, may represent an unsuccessful experiment.

CHROMOSOMES OF ROSES.—In a reprint from his *Experiments in Genetics*, Dr. C. C. Hurst discusses the origin of species in Rosa. Starting with a hypothetical decaploid rose (which would have ten times seven chromosomes), he supposes that the various septets of chromosomes became differentiated under sub-polar conditions, so that each set was pre-adapted to a different climate. This all happened within a single (hypothetical) decaploid species of rose. The hexaploid, pentaploid and diploid existing species were afterwards formed by the throwing off of different septets of chromosomes successively until the present diploid species were arrived at, each adapted to different conditions. This highly hypothetical speculation is contrary to all that is known concerning polyploidy in other plants. It also implies a sort of evolution *in vacuo* of the chromatin, which is contrary to every experimental evolutionary view of the relation between the organism and its environment. The evidence from other plant genera is that polyploid species are derived from diploid ancestors, and not the reverse.

MEAN SEA-LEVEL IN THE OCEANS.—The relation between wind or current and mean sea-level in the Indian and Atlantic Oceans and adjacent seas is discussed by P. H. Gallé in a short paper in the Proceedings of the Koninklijke Akademie van Wetenschappen te Amsterdam, vol. 27, No. 10. Mr. Gallé concludes that the range in mean sea-level is mainly due to fluctuations of wind and current, either near at hand or far distant. He believes that while the north-east trades and the equatorial current are causes of fluctuations in mean sea-level on the European coast, the main cause must be looked for in fluctuations of the north Atlantic high- and low- pressure systems. The correlation factor between monthly departures of the velocity of the current and strength of the wind and departures from mean sea-level is given as varying between 0·829 and 0·957. The time relation between changes of velocity in the equatorial current and mean sea-level on Atlantic coasts varies from one month in the Azores to three months in the English Channel and four months on the north coast of Norway.

ATLANTIC DOLDRUMS.—The Meteorological Office, Air Ministry, in "Geophysical Memoirs," No. 28 (London: H.M. Stationery Office, 1926. Price 1s. 6d. net), has issued a discussion of "The Doldrums of the Atlantic" by Mr. C. S. Durst. The author rightly gives considerable credit to Captain Toynbee, the first Marine Superintendent of the Meteorological Office, for his study of this district and the publication of the observations for the Nine Ten-Degree Squares comprising the area of the Atlantic Doldrums. A previous discussion was undertaken of Square 3. The copious letterpress accompanying these charts by Captain Toynbee is full of valuable information, especially on the direction of upper clouds with the different surface winds. The author notes that the minimum of pressure in the Doldrum belt follows the position of greatest humidity rather than the position of maximum temperature, and he is of opinion that over the ocean it would seem that convection must be started dynamically rather than thermally. If obtainable, synchronous weather charts over the Doldrum area would add much to our present knowledge of this interesting region.

THE COLOUR OF RED FORMATIONS.—In the *Journal of Geology*, No. 2, 1926, a valuable discussion of the origin of the colour of red beds is presented by G. E. Dorsey. It is shown that the non-red rocks often contain more iron and even more ferric oxide than do the red beds. The red colour is due not merely to oxidation—which is widespread—but to dehydration. Favourable conditions for the production of the red hydroxide, turgite, and the red oxide, hæmatite, are found in warm moist climates, and not, as has previously been asserted, in deserts or semi-arid regions. Ferric hydrate turns red spontaneously by dehydration, even under water, if given time enough. In the tropical belts heat favours dehydration, and the heavy cover of vegetation keeps the soil from being rapidly removed, so that time is available for the reaction to proceed. Most sediments are carried to the seas and there, exposed to the reducing action of the decay of marine organisms, they lose any red colour they originally possessed. But red detritus is able to retain its colour if it comes to rest upon the continents where no widespread reduction is in progress. Thus for the most part the red formations of the geological column represent continental deposits; though it is recognised that occasional wedges may be found in marine series, like that now forming off the mouth of the Amazon, where fresh water and red detritus are sufficiently abundant to force the true marine conditions farther off-shore.

INVESTIGATIONS ON THE EARTH'S CRUST.—The *Year Book*, No. 24, for 1925 of the Carnegie Institution of Washington includes, *inter alia*, reports on the work of (i.) the Geophysical Laboratory directed by Arthur L. Day, (ii.) the Advisory Committee on Seismology, and (iii.) of certain physicists associated with the Institution. The latter include S. J. Barnett, formerly attached to the Department of Terrestrial Magnetism, who is continuing his valuable researches on rotation by magnetisation, and vice versa, at the California Institute of Technology, Pasadena. Much of the work done under R. A. Millikan in the Norman Bridge Laboratory at Pasadena is also subsidised by the Institution. In the Geophysical Laboratory at Washington a large part of the work has consisted of experiments involving very high pressures; the attainment of a pressure of 15,000 atmospheres (225,000 lb. per sq. in.) on a small sample of material has now become "a matter of simple routine": this corresponds to the pressure at a depth of 30 miles below the surface of the earth. Still higher pressures are readily obtained, but beyond the limit stated the work is liable to be interrupted by expensive and annoying explosions. The compressibilities of the more important rocks and minerals have been investigated under these high pressures: the results are of special interest in determining the speed of earthquake waves through the earth. Less directly, the work bears on the temperature within the earth, and has led to an estimate of 850° C. at 30 miles depth, and 1700° at 100 miles, values which are much lower than has generally been supposed. Laboratory studies and 'field' observations (at Vesuvius and elsewhere) on volcanic problems have also been considerably advanced. The Committee on Seismology plans to establish a central seismological laboratory at Pasadena, and has completed the development of new instrumental installations for the accurate measurement of the horizontal and vertical components of local as distinct from widespread earth movements (such as ordinary seismographs record). It is hoped to furnish a considerable number of seismological stations with such installations. In co-operation with the Coast and Geodetic Survey, triangulations are in progress for the determination of relative surface displacements in a large region around California. The measurements already made indicate that the stations on the west side of the fault between Monterey and the Santa Barbara Channel have all been moving northward, the maximum movement recorded, whatever its source, being about 24 feet, at a station situated a few miles west of the city of Santa Barbara.

A MICROLUMINOMETER LIGHT SOURCE.—At the meeting of the Physical Society on May 14, Dr. Fournier d'Albe demonstrated an apparatus for producing very minute measurable fluxes of light and illumination. The original source of light was a small glow lamp of $\frac{1}{6}$ c.p. candle power, which illuminated a ground-glass disc with an aperture of $\frac{1}{2}$ in. This disc acted as a secondary source of $\frac{1}{25}$ c.p. in the direction of propagation. A number of lengths of tubing, 2 in. long, were telescoped together, each length ending in a $\frac{1}{16}$ in. diaphragm covered with ground glass. The amount of light emerging from each successive diaphragm was $\frac{1}{250}$th part of the light emerging from its predecessor. The candle power thus obtained was $1·6 \times 10^{-4}$ c.p. at the first stop, $6·4 \times 10^{-7}$ c.p. at the second stop, $25·6 \times 10^{-10}$ c.p. at the third stop, and $10^{-11}$ at the fourth stop. The light emerging from the fourth stop is quite invisible, even after prolonged accommodation, and represents, indeed, a star of about the seventh magnitude. The microluminometer source is intended for a comparison of the efficiencies of photoelectric cells and selenium respectively in detecting faint light. It is claimed that the faintest source is measurable within 2 per cent.

## The Indian Science Congress at Bombay.

UNDER the presidency of Mr. A. Howard, Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India, the thirteenth annual meeting of the Indian Science Congress was held at Bombay on January 4-9. In addition to sectional meetings, joint discussions were held on recent scientific work directed to the improvement of cotton-growing (Sections of Agriculture, Mathematics and Physics, Zoology and Botany) and on the structure of the atom and quantum theory (Sections of Mathematics and Physics and Chemistry). Public lectures on droughts and famines, by Dr. H. H. Mann, on life at higher altitudes in Western Tibet, by Prof. Shiv Ram Kashyap, and on modern applications of X-rays, by Prof. H. Parameshwaran, were arranged, as well as visits to places of scientific interest in the neighbourhood of Bombay.

Brief accounts indicating the activities of some of the sections of the Congress are printed below.

In his presidential address, Mr. A. Howard, after dwelling on the predominance in modern scientific agriculture of the biological sciences, went on to stress the diversity of the sciences with which modern research in agriculture is concerned. The study of the growth of the economic plant, according to Mr. Howard, opens up the great problem of the agriculture of the near future, and that is the *intensive* cultivation of improved varieties ; it is not sufficient to breed new varieties : the methods by which maximum production can be obtained must be studied. From his general argument, Mr. Howard developed the thesis that the need of the future is team work. The real subjects of research in agriculture have far outgrown the old tradition inspired by the work of Liebig : the attack through a single science is no longer possible. It is rightly pointed out, however, that successful team work presupposes the presence of a competent leader and, it may be added, a spirit of subordination to which men with the real pioneering aptitudes do not readily submit.

An unusual and suggestive feature of Mr. Howard's address was the special reference to the connexion between canal irrigation and public health. He thinks that no satisfactory explanation has yet been given of the correlation between canal irrigation and the prevalence of malaria. He pointed out that the connexion cannot be wholly due to the formation by canals of breeding grounds for mosquitoes, and suggested that a contributory cause may be nutritional —the deficiency in the food crops grown with canal water of essential mineral and other ingredients. He urged the need for immediate investigation and deplored the cessation, for financial reasons, of the work of McCarrison (*Jour. Roy. Soc. of Arts*, 83, 1925, p. 152) in this direction. This investigator showed that certain nutritional diseases were prevalent in Madras as the result of differences in the manurial treatment of the millet crop.

In relation to the diseases of plants, also, Mr. Howard broke fresh ground with a suggestion that cultural conditions rather than specific infection play the most important part in the causation of outbreaks. In some of his work at Quetta in connexion with fruit growing, he was able to show that attacks of aphis could be induced experimentally by altering the time of irrigation. He found, again, that Eincorn (*Tr. monococeum*), which is generally believed to be immune to *Puccinia graminis*, becomes highly susceptible when grown in the hot climate of Pusa in Bengal. Mr. Howard's reputation in applied botany is so well established that his views, particularly on possible administrative developments, merit serious consideration.

The programme of the Section of Anthropology indicates an active and serious interest in the varied problems of Indian ethnology and culture. If, however, those who took part in the proceedings had flung their nets wide, it is to be regretted that the burden of ethnological investigation still appears to rest on the shoulders of a few, and that the number of individual workers taking part was small. Further, while religious and sociological investigations were well represented, the study of material culture received little attention.

Among so many communications presenting features of interest it may appear invidious to select any for mention ; but attention may be directed to Mr. L. A. Cammiade's account of the Kurnool bone caves in relation to the problem of prehistoric man in India ; Sarat Chandra Roy's description of the Asurs, a tribe of iron-smelters of Ranchi ; Sarat Chandra Mitra's record of two recent cases of exorcism, one from Southern Bengal, for driving out the spirit of disease sent by Kali, a second from eastern Bengal, where treatment of a person possessed of a ghost by repeated immersion in water resulted fatally. The same author recorded two cases of propitiation by self-mutilation : a man cut off the tip of his tongue as an offering to Tapeswari at Cawnpur, while another individual in Kathiawara cut off his own head as an offering to Siva. An interesting rite to prevent hydrophobia, also recorded by Sarat Chandra Mitra, involves the turning by incantations, but otherwise unaided, of a saucer on which the patient stands. D. N. Majumdar presented further communications dealing with the customs of the Hos of Kolhan in continuation of those already published in several Indian periodicals.

In the Section of Zoology, under the presidency of Prof. H. R. Mehra of Benares, twenty-nine of the thirty-one papers presented are by Indian workers. They afford evidence of considerable scientific activity in the observation more especially of protozoa, parasitic worms, and Arthropoda.

Under the presidency of the Rev. W. E. Blatter, no less than 52 papers were communicated to the Section of Botany. These range over a wide field, many of them recording results of very general interest. The president is himself responsible for several ecological papers, mainly on the Indus delta ; C. McCann also presented several papers on the grasses of the Bombay presidency; whilst several Indian workers supplied records of studies of special vegetation formations. The life-history of various Indian plants also received attention ; a number of interesting communications in plant physiology are reported, and papers on parasitic fungi, on marine and fresh-water algæ, on cytology, teratology, heterophylly, and other biological features of interest in Indian plants, are included. In fact, the proceedings of the section suggest that the prosecution of research upon the interesting vegetation of India is actively pursued, and that Indian investigators are themselves taking a prominent share in the work.

The proceedings of the Section of Geology were noteworthy for the many papers devoted to Burma and its problems. A. S. Subbaiyer dealt with the production and reserves of petroleum and its stratigraphical distribution. He concludes that there may still be vast unexplored resources in the little-known Eocene oil-fields. In a third paper he discussed the genetic relationship between coal and oil, and suggests mapping the fixed carbon ratios in conjunction with structures as likely to lead to successful results, particularly along the Pakokku foot-hills. H. L. Chhibber contributed a valuable account of the extinct volcano Mt. Popa, one of the most conspicuous landmarks of Upper Burma. He also described the ferruginous concretions of the Irrawaddian Series, and the ancient slag-heaps and deserted furnaces found in the neighbourhood of Mt. Popa. Another paper by the same author described ferruginous bands of a rhythmic character occurring in the silicified tuffs of Kyankpadaung. H. L. Chhibber and L. D. Stamp collaborated in a paper dealing with the origin and constitution of the fossil wood which is such a conspicuous feature of the late Tertiary beds of Burma. The petrography of Green Island, near the mouth of the Salween, is described by L. D. Stamp, who directs attention to the extensive assimilation, lit-par-lit injection, and development of banded gneisses that have taken place. K. K. Mathur *et aliter* discussed the mechanism of intrusion and the differentiation of the laccolith of Mt. Girner, the rocks of which were described many years ago by Dr. J. W. Evans. The Ranikot beds at Thal were shown by L. M. Davies to present a more complete series of the earliest Eocene horizons than has been discovered elsewhere. B. Sahni is engaged on a revision of the fossil plants in the collection of the Geological Survey, and presented a summary of his work on the conifers, ranging from the Lower Gondwana to the Cretaceous. Other papers dealt with cordierite, staurolite and mica, and various local faunas and strata; and J. Ribeiro describes the natural caves recently discovered in Bombay. The large number of contributors and the wide variety of subjects discussed testify to the healthy activity of geological research in India and Burma.

Nearly a hundred papers were presented to the Section of Mathematics and Physics. Seven of these deal with pure mathematics, five with hydrodynamical problems, and two with relativity and non-Euclidean space. The physical papers cover a wide range. Surface tension, efflux of gases, motion of projectiles, vibrating strings, flame temperatures, entropy, radiation, scattering of light, spectra, X-ray investigation of crystals, magnetism, electrolysis, photo-electricity and wireless signalling, were all discussed, while the weather, rainfall and floods of Bengal were not forgotten. Prof. M. N. Saha, as president of the section, read a valuable paper on the application of subatomic thermodynamics to astro-physics, portions of which were printed in NATURE of May 8. The programme showed that India is keeping well abreast of recent developments in the mathematical and physical sciences.

## Co-operation in Oceanography.

UNDER the title "L'Oceanographie dans la Vie International," Prof. Odon de Buen writes an interesting account of the various organisations which are materially assisting the co-operation of adjacent countries in oceanographical investigations (*Scientia*, February 1, 1926). The international movement is particularly active both in physical and biological oceanography, where the problems encountered by each country extend far beyond its own coasts, and the natural difficulties and expense of collecting data at frequent intervals over a wide area of the ocean necessitate such collaboration.

This necessity is increasing. Our present knowledge of the average conditions of the seas is built up from numerous painstaking observations made by a limited number of expeditions carried out from time to time. The fluctuations in the fisheries, of national importance to the countries concerned, centre interest more and more upon the fluctuations rather than upon the average condition in the physical and chemical conditions of the seas.

The Conseil Permanent International pour l'Exploration de la Mer now includes those countries bordering on the continental shelf from Norway to Portugal and Spain. Its influence in furthering our knowledge of the oceans in general has been potent since its foundation in 1899. Similar organisations deal with the publication of data and the co-ordination of investigations, both in the Mediterranean and also in the fertile area famed for its cod fishery north-east of North America.

These three co-ordinating organisations are represented in the Oceanographical Section of the Union International Geodesique et Geophysique by their respective presidents. It is of interest to hear that this section has commenced the difficult enterprise of publishing an annual *Bibliographical Bulletin*.

As any feral industry grows, whether it be hunting animals or fish, an accurate knowledge of the factors which control fluctuations in the population of the hunted animal becomes increasingly useful to the hunting nations. It is to gather this knowledge that the network of organisations has sprung up, fathered originally by the Scandinavian countries, to whom their fishing industry is an asset of relatively great importance. An interest in the sea is inherent in all seafaring nations, and concerted action has already been of great help to the progress of scientific oceanography.

## The Swiss National Park.

PROF. CARL SCHROETER of Zürich delivered the fourth Hooker lecture at the Linnean Society on April 15 on the Swiss National Park. The movement for Nature protection is very strong in Switzerland, and civil law permits even expropriation in the interest of natural and historical monuments. The formation of the League for the Protection of Nature (Naturschutzbund) has made the matter a national one; it has about 30,000 members, who pay an annual subscription of 2 francs, or 50 francs for life membership. The League has been instrumental in many ways, but the most effective measure is the creation of the Swiss National Park, which occupies about 54 square miles in the Lower Engadine. Here shooting, fishing, manuring, grazing, mowing and wood-cutting are entirely prohibited. No flower or twig may be gathered, no animal killed, no stone removed, and even fallen trees must remain undisturbed. There are no hotels, only simple Alpine shelter huts, and camping and the lighting of fires is not allowed. The aim is to exclude the effect of human interference so far as possible: scenery, plants and animals are absolutely protected.

The Park is controlled by five trustees nominated by the Government, which pays the rent (up to 30,000 francs per annum). The League pays the incidental expenses (*e.g.* there are four resident keepers) and for scientific research which is organised by the Swiss Society for the Advancement of Science.

The size of the Park and its physiography allow of Nature equilibrium. The mean elevation is high; the snow-line consequently reaches so much as 3000 metres; the tree-limit 2300 metres. It is well wooded with extensive forests of the erect mountain pine (*Pinus* *montana* var. *arborea*) and *Pinus Cembra*; mixed woods of spruce and larch, an endemic variety of Scotch pine (*Pinus sylvestris* var. *engadinensis*), and extensive areas of creeping mountain pine (*P. montana* var. *prostrata*). The herbaceous flora is rich and varied, the different geological strata allowing of both calcicole and calcifuge plants; the division between the floras of the western and the eastern Alps passes through the Park, many of the Swiss eastern species occurring only here. Animal life is abundant—chamois, marmots, deer, roes, foxes, mountain- and heath-cocks, golden eagle, etc.

After ten years of reservation the favourable effect is clearly visible: the flora of the now abandoned pastures has developed abundantly. The number of animals has much increased. From 1918 to 1925 deer had increased from 12 to 90; roe from 60 to 190; chamois from 1000 to 1250; mountain cock from 10 to 60, heath-cock from 40 to 190; ptarmigan from 120 to 310, and golden eagle from 15 to 40. The preservation of certain beasts of prey is requisite as a hygienic measure, as they kill sick animals first.

The last bear was killed in the Park in 1904. The ibex disappeared from Switzerland in 1809, but an effort is being made to reintroduce it from colonies at St. Gallen and Interlaken, which have arisen from young animals smuggled from the valley of Aosti.

All the influences of man due to shooting, fishing, wood-cutting, haymaking and so on will take time to efface, and the successional changes are being studied by a special commission of fourteen members elected in 1915 and divided into four sections, geologico-geographical, climatological, botanical, and zoological. So far forty investigators have worked in the Park. Several monographic studies have been published, and an attempt is being made to get a "complete notion of the inorganic and organic nature of our National Park."

The lecture was illustrated by a magnificent series of coloured lantern slides.

## University and Educational Intelligence.

BRISTOL.—The Society of Merchant Venturers offers for competition fifteen scholarships tenable in the Faculty of Engineering of the University of Bristol, provided and maintained in the Merchant Venturers' Technical College. Candidates must be not less than 17 years of age and must have matriculated. The scholarships provide free tuition: one of the scholarships is open to pupils in any secondary school receiving grants from the Board of Education; three are restricted to pupils of secondary schools in the counties of Gloucestershire, Somerset, and Wiltshire (one to each county); ten are restricted to the sons of officers in His Majesty's Service who were killed in the War, and whose mothers or guardians are in needy circumstances; one is restricted to a son of a citizen of Bethune who has passed either the B. ès L. or the B. ès Sc. examination. A War Memorial scholarship is also offered, with a preference to a candidate who needs pecuniary help, who is the son of a former student who lost his life while serving with H.M. Forces during the War.

CAMBRIDGE.—The late Sir John B. Harrison bequeathed to the Sedgwick Museum his collection of more than 2000 rock slices; these were made from the rocks of British Guiana and the West Indies.

Dr. F. J. Gaskell, of Gonville and Caius College, has been appointed demonstrator in medicine, and Mr. E. G. Holmes, of Christ's College, has been appointed as assistant to the Downing professor of medicine.

A lectureship in advanced and economic entomology has been advertised as vacant; the stipend will be 350*l.* with a "fellowship allowance" of 150*l.* if the holder is not a fellow of a college. From this it would seem that the principle of granting an extra emolument to persons on the staff of the University who are not fellows of colleges has been conceded. Similar provisions are made in the conditions of appointment to lectureships in moral science and Persian which are also announced.

The General Board of Studies has presented a report on the readership in ethnology. The present office was created for the duration of Dr. Haddon's tenure, and he has announced his intention of retiring at the end of the present academic year. The Board considers that the subject is now well established in Cambridge and its educational importance generally admitted; it is therefore suggested that the readership should become a permanent university post.

OXFORD.—On May 12, Mr. G. R. de Beer, fellow of Merton College, the lately appointed John Wilfred Jenkinson lecturer in embryology, delivered an inaugural lecture on the organisation of the embryo. He made special mention of the embryological work of the late J. W. Jenkinson, in whose memory the lectureship has been founded; and directed particular attention to the orientation of the embryo, as manifested in the results of transplantation and in the phenomena of the 'grey crescent.'

---

DR. I. J. KLIGLER, formerly of the Rockefeller Institute and for the past three years Director of the Malaria Research Unit attached to the Department of Health of the Government of Palestine, has been appointed head of the new Department of Hygiene established at the Hebrew University of Jerusalem.

THE University Grants Committee's Returns for 1924–25 give 41,794 as the total number of full-time students of both sexes in the universities and university colleges of Great Britain in receipt of Treasury Grants. This is less by 1098 than in the preceding year, but the decrease is more than accounted for by the decrease (1458) in the number of students assisted under the Government scheme for the higher education of ex-service men. The tables in which the full-time students are classified according to faculties show decreases under medicine (970 men and 367 women) and technology (496 men) and increases under arts, including theology, fine arts, law, music, commerce, economics, and education (557 men and 353 women). A large proportion of the decrease in the medical group is accounted for by the dental students. In the Scottish Medical Schools there were 537 fewer men and 178 fewer women last year than in the year before. Under engineering, metallurgy, and applied chemistry there were decreases: from 3413 to 3036, from 187 to 140 and from 338 to 280 respectively, whilst the number of mining students increased from 263 to 275. The table exhibiting the home and university residence of full-time students shows that 49 per cent. came from homes within a 30-miles radius, 42 per cent. from other parts of the British Isles, 6 per cent. from other parts of the British Empire, and 3 per cent. from foreign countries. Of the men, 19 per cent., and of the women, 33 per cent. were accommodated in colleges or hostels. Next to Oxford and Cambridge and the Durham Colleges, University College (now the University of) Reading ranks highest in regard to the number of full-time students thus accommodated. The number of students in lodgings was 14,070, or 34 per cent. of the total number.

## Contemporary Birthdays.

**May 15, 1847.** Sir E. Ray Lankester, K.C.B., F.R.S.

**May 18, 1867.** Prof. Edward Fawcett, F.R.S.

**May 19, 1876.** Prof. William King Gregory, Corr. Mem. Zool. Soc. Lond.

**May 22, 1860.** Major B. F. S. Baden-Powell, F.R.A.S.

**May 23, 1864.** Sir Arthur Smith Woodward, F.R.S.

---

Sir E. RAY LANKESTER, emeritus professor of zoology in University College, London, and a foreign member of the Paris Academy of Sciences, is a Londoner. He was educated at St. Paul's School, Downing College, Cambridge, and Christ Church, Oxford. From 1891 until 1898 Lankester was professor of comparative anatomy in the University of Oxford; afterwards he was for some years Fullerian professor of physiology in the Royal Institution. In 1898 he was appointed director of the Natural History Departments of the British Museum, retaining office until 1906. Just over forty years ago he received one of the Royal medals of the Royal Society, at the hands of Prof. Huxley, its president, for labours even then extending over two decades, in the field of animal morphology and palæontology. We believe that no other man of science lives to-day who can lay claim to any kindred personal act on Huxley's part. "Prof. Lankester," said the president, "has been active in many directions, and has everywhere left his mark, not only as an energetic teacher and accurate worker and a philosophical thinker; but as one who, in times when the example is more than ever valuable, has always been careful to remember that speculation should be the servant and not the master of the biologist."

Prof. FAWCETT, who holds the chair of anatomy and is Dean of the Faculty of Medicine in the University of Bristol, was educated at Blencow Grammar School and the University of Edinburgh.

Prof. WILLIAM K. GREGORY, palæontologist and morphologist, was born at New York City, and educated at Columbia University. Research assistant to Prof. H. F. Osborn (the newly-elected foreign member of the Royal Society) from 1879 until 1913, he afterwards became assistant curator of the Department of Vertebrate Palæontology in the American Museum of Natural History, where he is now curator of the Department of Comparative Anatomy. On his special subjects Prof. Gregory has long been an illuminating lecturer in Columbia University. He is the author of "The Orders of Mammals" (1910), "On the Structure and Relations of Notharctus, an American Eocene Primate" (1919), "The Origin and Evolution of the Human Dentition" (1922).

Major B. F. S. BADEN-POWELL was educated at the Charterhouse. Early interested in aeronautics, he devised man-lifting kites. He is a past honorary secretary and past president of the Aeronautical Society, an institution which owes much to his energies in days gone by.

Sir A. SMITH WOODWARD, the well-known geologist, was born at Macclesfield, and educated at Manchester Grammar School and Owens College. Entering the Natural History Department of the British Museum in 1882, he attained finally the Keepership of the geological section. Sir Arthur is a past president of the Geological Society, and of the Linnean Society. In 1917 he was a Royal medallist of the Royal Society.

## Societies and Academies.

LONDON.

**Geological Society**, April 21.—L. R. **Cox**: *Anthracopupa britannica* sp. nov., a land gastropod from the Keele beds of Northern Worcestershire. The occurrence is recorded, for the first time, of a pulmonate gastropod in British Carboniferous rocks. The specimens were collected by Mr. W. Wickham King in 1924 from a grey calcareous claystone, interstratified with the vermilion marls of the lower part of the Keele beds, on the northern slope of Clent Hill. One species is a land shell, referable to the family Pupillidæ; it is very close to *Anthracopupa vermilionensis* (Bradley), from the Coal Measures of Illinois, but is slightly stouter, and differs in detail.—H. P. **Lewis**: On a rock-building bryozoan with phosphatised skeleton from the basal Arenig rocks of Ffestiniog (North Wales). The black, usually ovoid masses in the basal Arenig rocks (Garth Grit) on both sides of the Harlech Dome, have been designated 'lumps,' 'pebbles,' and 'nodules.' On the evidence of etched surfaces and microscope-sections, the structure of these masses is found to be originally organic, but modified later by inorganic processes. A new genus of the Ceramoporidæ of Ulrich is described. It is represented by one species—the earliest bryozoan known in British rocks. It was responsible for the building-up of the nodular masses, which contain a large amount of calcium phosphate.—C. A. **Matley**: The geology of the Cayman Islands (British West Indies), and their relation to the Bartlett Trough. With an appendix on the species of Lepidocyclina and Carpenteria from Cayman Brac and their geological significance, by T. W. **Vaughan**. The Cayman Islands are an isolated group of three islands, with an area of 100 square miles, all very similar in their geological structure and history, although each is a separate faulted block. The islands are built entirely of calcareous rocks free from terrigenous materials other than fine dust. There are two formations present, an older Bluff Limestone, and a newer, Ironshore Formation, lying unconformably upon the former, which makes a coastal terrace with a maximum height of 12 to 15 feet above the sea. The Bluff Limestone, a white, massive, semicrystalline limestone, containing casts of mollusca, badly preserved corals, nullipores, and foraminifera, resembles lithologically many parts of the White Limestone of Jamaica. Cayman Brac is Middle Oligocene, while Little Cayman and Grand Cayman seem to be of Miocene age, not newer than Lower Miocene. On the coastal shelf formed round each island by marine erosion the calcareous Ironshore Formation, with its mollusca and corals of living species, was deposited. Its emergence, in Pleistocene or recent times, as a low platform backed by the ancient cliffs, is probably the result of a fall of sea-level. The almost completely submerged Cayman Ridge on which the islands stand, and the Bartlett Trough which flanks it on the south, are examined in the light of the Wegener hypothesis. The Ridge may once have lain near the Jamaica-Honduras Ridge, with Jamaica itself confronting the Sierra Maestra of Cuba; further, the separation has taken place by the development of a great crustal fissure (initiated probably in Pliocene, or at the earliest in Middle Miocene, times) which has become the Bartlett Trough.

PARIS.

**Academy of Sciences**, April 12.—Paul **Appell**: The arithmetical nature of Euler's constant.—André **Blondel**: Contribution to the theory of the musical singing arc.—Léon **Guillet**: The addition of nitrogen to ordinary and special steels. Superficial hardening of certain steels is produced by heating to about 500° C. in a current of ammonia. A study of this reaction, with special reference to the nature of the steel, shows that ordinary steels become fragile. Nickel steels give no increase in superficial hardness, but slight increases are shown by chrome steels, manganese steels, silicon steels. Remarkable increases are given by aluminium steels.—**Winogradsky**: The fixing power of soils (for nitrogen).—Paul **Vuillemin**: The family of the Sarcosporidia.—Bertrand **Gambier**: The deformation of tetrahedral surfaces, with conservation of a conjugated network and rigidity of an asymptotic.—Miécislas **Biernacki**: A theorem of M. Denjoy.—Julius **Wolff**: A generalisation of a theorem of Schwarz.—Ernest **Esclangon**: The mechanical and optical asymmetry of space in respect to the absolute movement of the earth.—R. **Baticle**: A solution of the problem of a wall sustaining a powdered mass.—**Turpain** and **Bony de Lavergne**: Experiments on the Magnus effect.—A. **Dauvillier**: The nature of soft X-rays. A discussion of the causes of the differences between the experimental results of the author and Holweck.—Francis **Perrin**: The fluorescence of long duration of salts of uranium, solid and in solution. Experiments confirming the view that the luminescence of uranium salts is a fluorescence of long duration, analogous with the short fluorescence of certain colouring matters, such as fluorescine.—Ch. **Courtot** and C. **Pomomis**: Researches on diphenylene sulphide. A development of the most probable formula for the diaminodiphenylene sulphide described in a previous communication.—A. **Demay**: The cristallophyllian stratigraphy of the Pilatus massif near Saint-Étienne.—Paul **Corbin** and Nicolas **Oulianoff**: The elements of the two tectonics, hercynian and alpine, observable in the protogine of Mont Blanc.—**Michel-Durand**: The solvents for tannins. The tannins soluble in alcohol or in acetone are also soluble in water, and the use of these liquids in succession for extraction, even including ether, gives no higher yield than hot water.—Th. **Krascheninnikoff**: The gaseous exchanges of the brown algæ of the Arctic region exposed at low tide. In the Arctic region (island of Kildine) in algæ exposed to the air at low tide, there is very energetic assimilation, which, under good lighting conditions, is much more intense than the respiration, resulting in the formation of large quantities of organic material.—Émile F. **Terroine** and R. **Bonnet**: The causes of the specific dynamic action of the proteids.—E. **Fleurent**: The composition of the seed of fenugreek and its admixture with wheat intended for milling. The presence of fenugreek seeds in wheat, owing to the objectionable smell of its essential oil and bitter taste of its resin, renders flour made from such wheat unsuitable for bread-making. Even such a small proportion as ⅛th per cent. of fenugreek seeds can be tasted in the bread.—Constantino **Gorini**: The action of streptococci on milk.

## Official Publications Received.

Department of the Interior: Bureau of Education. Bulletin, 1925, No. 40: Statistics of Public High Schools, 1923-1924. Pp. 38. 5 cents. Bulletin, 1926, No. 1: Educational Directory, 1926. Pp. iii+129. 20 cents. Bulletin, 1924, No. 14: Biennial Survey of Education, 1920-1922. In 2 vols. Vol. 2. Pp. iii+753. (Washington, D.C.: Government Printing Office.)

Imperial Department of Agriculture for the West Indies. Report on the Agricultural Department, St. Lucia, 1924. Pp. iv+30. (Trinidad, B.W.I.) 6d.

Report of the Kodaikanal Observatory for the Year 1925. Pp. 4. (Madras: Government Press, 1926.) 6 annas.

Annual Report of the Council of the Yorkshire Philosophical Society for the Year 1925, presented to the Annual Meeting, February 8th, 1926. Pp. 37+21+7 plates. (York.)

## Diary of Societies.

*SATURDAY*, MAY 15.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. G. C. Simpson: Atmospheric Electricity (1).

*MONDAY*, MAY 17.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Dr. F. Dixey: The Nyasaland Section of the Great Rift Valley.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.

ARISTOTELIAN SOCIETY (at University of London Club), at 8.—Symposium.

EUGENICS EDUCATION SOCIETY (at Royal Society), at 8.30.—W. T. J. Gun: Foundations of Notable Families.

*TUESDAY*, MAY 18.

ROYAL STATISTICAL SOCIETY (at Royal Society of Arts), at 5.15.

ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.30.—M. Terry: Some Little Studied Aborigines Encountered during Travels in North Australia.

*WEDNESDAY*, MAY 19.

CORRELATIVE SCIENCE SOCIETY (at Royal Botanic Society of London), at 3.—Conference on Energy, Kinetic and Potential. The Stupendous Energy of Cosmic Speed; Exploding Suns.

ROYAL METEOROLOGICAL SOCIETY, at 5.—E. S. Player: Meteorological Conditions and Sound Transmission.—Dr. J. Glasspoole: The Wet Summer of 1924 and other Wet Seasons in the British Isles.—C. E. P. Brooks: Pressure Distributions associated with Wet Seasons in the British Isles.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section) (Annual General Meeting), at 5.—W. G. Spencer: Celsus: De Medicina—a Learned and Experienced Practitioner of Medicine, upon what the Art could then accomplish.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Mrs. Jane Longstaff: A Revision of the British Carboniferous Murchisoniidæ, with Notes on their Distribution and Descriptions of some New Species.—T. Neville George: The Carboniferous Limestone (Avonian) Succession of a Portion of the North Crop of the South Wales Coalfield.

INSTITUTION OF ELECTRICAL ENGINEERS (Wireless Section), at 6.—M. Thompson, R. H. Dudderidge, and J. G. A. Sims: Life-Testing of Small Thermionic Valves.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 8.—Prof. H. C. H. Carpenter: Single Metallic Crystals and their Properties (May Lecture).

SOCIETY OF GLASS TECHNOLOGY (in London).

*THURSDAY*, MAY 20.

ROYAL SOCIETY, at 4.30.—Prof. A. V. Hill: The Laws of Muscular Motion (Croonian Lecture).

ROYAL SOCIETY OF MEDICINE (Dermatology Section) (Annual General Meeting), at 5.—Dr. H. C. Semon: Case for Diagnosis.—Dr. Kingston: Premycotic Stage of Mycosis Fungoides.—Dr. H. W. Barber: Reticulated Pigmented Poikiloderma (Civatte).

INSTITUTE OF PATHOLOGY AND RESEARCH (ST. MARY'S HOSPITAL, W.), at 5.—Prof. J. Mellanby: The Mechanism of Pancreatic Secretion.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—N. R. Evans: Corrosion, Tarnishing, and Tinting of Metals (1).

CHEMICAL SOCIETY, at 8.

RÖNTGEN SOCIETY (and Royal Society of Medicine—Electro-Therapeutics Section) (at Royal Society of Medicine), at 8.15.—Dr. A. Dauvillier: The Measurement of X-ray Dosage (Mackenzie Davidson Memorial Lecture).

*FRIDAY*, MAY 21.

ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section) (Annual General Meeting), at 5.30.—Dr. H. Eaton Stewart: Diathermy in Pneumonia.

PHOTOMICROGRAPHIC SOCIETY (at 4 Fetter Lane), at 7.—Annual Exhibition.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. E. Pears, Jr.: Recent Developments in the Art of Fine Measurements.

### PUBLIC LECTURES.

*MONDAY*, MAY 17.

KING'S COLLEGE, at 5.30.—Dr. C. D. Broad: The Present Position of the Logic of Induction.

*WEDNESDAY*, MAY 19.

GRESHAM COLLEGE, at 6.—A. R. Hinks: Astronomy. (Succeeding Lectures on May 20 and 21.)

### CONGRESSES.

MAY 15.

INSTITUTE OF TRANSPORT (at Birmingham).

MAY 22 TO JUNE 2.

ITALIAN NATIONAL CONGRESS OF PURE AND APPLIED CHEMISTRY (at Palermo).

MAY 24, ETC.

INTERNATIONAL GEOLOGICAL CONGRESS (at Madrid).

MAY 24 TO 29.

INTERNATIONAL ORNITHOLOGICAL CONGRESS (at Copenhagen).

MAY 25.

INTERNATIONAL SOCIETY FOR THE PROTECTION OF CHILDHOOD (at Rome).