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## Science and the Empire.

DURING the past few weeks the minds of many electors in Great Britain must have been disturbed by the storms of rhetoric, appeals to occupational interests, and promises of a Golden Age in the near future, which are common characteristics of a general election. We have seen dozens of election addresses, and almost all of them profess the desire to promote industrial development, and thus reduce the burden of unemployment. The solution of this problem is not, however, so simple as it seems on paper, and is not, moreover, solely a matter of adjusting the conflicting claims of capital and labour. The third pillar of the tripod upon which the structure of modern civilisation has been erected is creative science, yet scarcely a candidate referred to it as an essential factor of national stability as well as of progress.

This is perhaps not surprising, as the number of voters engaged in scientific research or familiar with its productive value is negligible in comparison with the electorate in general upon whose suffrages in bulk depends the position of a candidate at the poll. It is also a consequence of the fact that scientific investigators as a body do not in the public Press or on the public platform assert their claims, or pronounce their principles, so vociferously as do advocates of many social changes and reforms of relatively trivial importance. It is true that there is a National Union of Scientific Workers, but it is a Trade Union affiliated, we believe, to the Labour Party, and it exists to secure suitable conditions of work and payment for its members rather than for the extension of natural knowledge. It is therefore concerned with occupational interests alone, and has almost nothing in common with our scientific societies which month by month add more to the store of human knowledge than was gained in a century in some earlier epochs of modern history. Whatever may be thought of the strength of our position in any other respect, it cannot be questioned that as regards output of originality and inventiveness British men of science are in the front rank of the scientific army and often bear the banner in the van of progress.

We have every reason to be proud of our pioneers who to-day, as in the past, are cutting a way through virgin forests into new lands of promise from which others will gather the fruits; yet their names are mostly unknown even to our political leaders, and their works arouse no interest in the market place. Scientific men are usually indifferent whether the public gives attention to their work or no; theirs is the joy of the chase, and others may dispute over the spoils. This unworldly attitude may excite respectful admiration, and we should be sorry to suggest that scientific investigators themselves should seek to get into the limelight or take part in the turmoil of politics. They are much better employed in the laboratory than in Parliament. What are wanted, however, are advocates of science and scientific method—men and women who know the disinterested spirit in which purely scientific inquiries are carried on and desire to introduce into social and political discussions the same impartial attitude towards evidence and fearless judgment upon it. At the present time it is in a large measure the mission of science to rebuild a shattered civilisation, not alone by providing the foundations for material progress, but also by introducing scientific methods and the scientific spirit into all fields where questions of national significance are debated.

To attain these ends there must be a much wider understanding of the service of science than exists at present. Science will not advertise itself, but there is every reason why believers in it should undertake a publicity campaign on its behalf. Dozens of interesting leaflets or short pamphlets might be written showing what science means to progressive industry and modern civilisation, and they should be distributed in thousands both to enlighten and to stimulate. Wireless telephony, for example, is a direct product of purely scientific studies. The tungsten used for the filaments in the thermionic valve and in metallic filament lamps generally, was discovered more than a century ago. It enters into the constitution of all high-speed tool steels and every magneto. Manganese, nickel, titanium, aluminium, and other essential constituents of the alloy steels now used for many engineering purposes were all first discovered in scientific laboratories. So also were the thorium and cerium used in the manufacture of incandescent gas mantles, calcium carbide for the production of acetylene gas, the methods of extracting nitrogen from the air to produce nitrates for explosives and agricultural fertilisers, and hundreds of other substances and processes which are now accepted as part of our daily life without a thought of their origin.

The most remarkable of such developments is that of helium gas discovered by Sir Norman Lockyer in the sun in 1868, found in terrestrial minerals by Sir William Ramsay twenty-six years later, and now being produced in millions of cubic feet from certain oil wells in the United States, where all airships are compelled to use this gas instead of hydrogen. It is quite possible that the practical monopoly of helium which America possesses in its rich sources of supply, may be of great significance both in the arts of peace as well as those of war. At any rate, the United States Government is quietly accumulating vast quantities of the gas compressed in cylinders for whatever needs the future may bring.

It is obvious that valuable national and Imperial service can be performed by a body which has sufficient funds to undertake active propaganda work for the extension of an understanding of the influence of scientific research and its results. The only organisation which is attempting to do this is the British Science Guild, founded in 1905 to convince the people, by means of publications and meetings, of the necessity of applying the methods of science to all branches of human endeavour and thus to further the progress and increase the welfare of the Empire. The Guild is thus not a scientific or technical society but a body of citizens united for the purpose of making the Empire strong and secure through science and the application of scientific method. Its relation to the work done in our laboratories is that of the Navy League to the Royal Navy—to watch and promote progress. Lord Askwith has just accepted the presidency of the Guild in succession to the Marquess of Crewe, who has reluctantly had to withdraw from this office on account of his appointment as British Ambassador at Paris.

Active steps are shortly to be taken by the Guild to secure adequate funds for displaying the fertility of British science not only throughout the Empire but also to the whole world. We possess a great treasure, and in these days cannot afford to let it lie hidden. It is devoutly to be hoped, therefore, that when the British Science Guild makes its appeal for funds and members there will be a rich and ready response to it, so that branches may be established throughout the Empire for the strengthening of the foundations of the knowledge upon which our position among the nations of the world depends. The British Empire Exhibition to be held in 1924 will provide an opportunity for showing what science has accomplished, and we look to a body like the British Science Guild to see that the promoters provide in the Exhibition a Temple of Science which shall be worthy of the great achievements of British genius.

## Wegener's Drifting Continents.

*Die Entstehung der Kontinente und Ozeane.* By Dr. Alfred Wegener. Dritte gänzlich umgearbeitete Auflage. Pp. viii + 144. (Braunschweig: Friedr. Vieweg und Sohn, Akt.-Ges., 1922.) 9*s*.

HOWEVER much conservative instincts may rebel, geologists cannot refuse a hearing to Dr. Alfred Wegener, professor of meteorology in the University of Hamburg. As an oceanographer, he looks out over the boundaries of sea and land; as a meteorologist, he is interested in changes of climate in the past. Like many scientific workers, he feels that a recognition of the Permo-Carboniferous ice-age compels him to put forward an explanation. Like them, he overlooks the fact that a century of speculation as to the causes of the glacial epoch of far more recent times has left us with a score of hypotheses amid which we wander unconvinced. The evidence of the occurrence of ice-ages becomes more and more cogent as observation spreads, and it is highly probable that they have a common cause. Prof. Wegener, in laying stress on the differences between equatorial and polar temperatures at the present day, takes up the position of greatest difficulty, and regards a regional refrigeration as necessarily connected with the poles. He does not look beyond our planet and the atmospheric conditions that now prevail. It is evident that Prof. Spitaler's laborious inquiries as to zonal fluctuations will not content him, though this author believes that he has drawn the Permo-Carboniferous glaciation into his uniformitarian net. Wegener's suggestions are far more heroic; he will shatter the outermost layer of the crust to bits, and remould it, by successive arrangements of the pieces, nearer to his heart's desire. His theme is fascinating, and his style is admirably lucid. His fondness for "hüben und drüben," a phrase, we believe, derived from Goethe, makes us wonder if he treats the globe as lightly as it was treated in the "Hexenküche." For him indeed "sie klingt wie Glas; sie ist von Ton, es giebt Scherben."

As is well known, Wegener has been much impressed by the easterly salient of S. America and the easterly indent of the African coast. If we could assure ourselves that these were at one time, and at the right time, actually in contact, most of the problems of oceanic islands, of palæoclimatology, and of the distribution of land-organisms, would be solved. Would not the instability of S. America in regard to Africa imply a similar instability between N. America and Europe, of which there is (p. 81) some geodetical evidence, accepted by Wegener, but much open to discussion? If the Atlantic is a crustal rift, the other oceans are likely to have had a similar origin. The primary crust, the silica-alumina layer, which Wegener calls *sial* in preference to Suess's less distinctive word *sal*, broke open and gave rise to continental blocks and accessory islands, which float, and even waltz, upon the *sima*, the silica-magnesia layer that underlies them.

There is a concluding figure in many Bantu dances—it survives even in folk-dances at Skansen—where two partners turn back to back, bump, and part again. The possibility of this figure on a continental scale is thrilling and attractive. If Africa once parted from America, she may woo her mate again as years pass by. The hand of the philosopher may be laid on the great land-blocks, and the occurrence of Glossopteris in India or of *Geomalacus maculosus* in Kerry may be explained by a simple process of "Verschiebung." If the fitting is not sufficiently accurate, some plasticity is granted to the sial blocks, and "Umwälzung" is also possible (pp. 35 and 41).

Wegener's conception, however, must not be taken in the spirit of a jest. Experiments on the force of gravity, made over very wide areas, have established the existence of a mass-defect under mountain-ranges and a mass-excess under lower grounds and oceans, and the sea-floor may be justly regarded as consisting of sima in large degree. It has long been recognised that a crumpled crustal mass bulges both upward and downward; it displaces what we now call sima in the depths. On the theory of isostasy, it maintains its elevation above the general surface by the fact that it displaces matter the specific gravity of which is greater than its own. Like ice in water, it floats, with a certain portion unsubmerged.

The analogy with ice is seized on by Prof. Wegener. If icebergs shift their places and "calve" by cracking on their flanks, why should not continents do the same? Let us grant that the level of the sima is reached at a less depth than that of the ocean-floors; the latter must then be composed of sima, and over them the buoyant continents may meet, and waltz, and part again. Of course they may do so; but when we are asked (p. 101) to look for the sima level about 100 fathoms down, or in some rare and dubious cases at 250 fathoms, we find that the rocks familiar to us on the land-surface are held to extend very little beyond the ordinary continental shelves. The chalk and flints dredged from 600 fathoms off western Ireland will require a new explanation. In depth, the continental blocks may go down to 100 km. Their relations to the earth as a whole, on this supposition, are shown on the same longitudinal and vertical scale in an expressive section following a great circle between S. America and Africa. The two continents are seen to be well immersed in sima. Sima (p. 113) behaves under pressure like sealing-wax, and sial like wax. Hence crumpling occurs in the sial blocks when they are pressed against the sima, though the latter in time yields and flows. Higher temperature in the depths assists this flow, and (p. 105) inclusions of sima in the base of sial blocks assist, by their greater fluidity, the yielding of the sial under folding thrusts.

We have now before us Wegener's view of the possibility of great horizontal displacements of the continents. The author points out (p. 6) that H. Wettstein in 1880 regarded the continents as subject to a westward drift; but he viewed the oceanic areas as representing sunken land. This widely accepted notion is rejected by Wegener at the outset.

We may ask why the skin of a contracting globe became too small for the interior, and split along rifts which ultimately widened into oceans. The answer is that our globe is not contracting. It may even be expanding through rise of temperature, and Joly's conclusions are quoted as to the influence of radium in the crust. Wegener thinks that Pickering, when, in 1907, he fitted Africa and S. America together in a retrospect, was wrong in assigning an Archæan age to the great rent. The present separation (p. 7) must have occurred since Cretaceous times, if we are to account for the similarity of structural features in the two continents. That is to say, if we reject the notion that the ocean-floors represent subsided land, and if we find similar successions of strata, and ranges with similar orientations, in two separated continental blocks, these blocks must have drifted apart. We should observe the importance of that first " if "; if we agree with Wegener's hypothesis of the inadequacy of vertical movements of the crust, we are in a fair way towards salvation. " Die Theorie der Kontinentalverschiebungen vermeidet alle diese Schwierigkeiten." Even if contraction is going on below, horizontal contraction of the continental surfaces, by " Zusammenschiebung " and consequent crumpling, goes on faster (p. 11), and this causes a rending of the sial. To Wegener this does not seem to open up a new series of " Schwierigkeiten." It explains so much that it seems to require little explanation. Yet is not this a return to the conception of a Great First Cause? Accept that, and all thereafter will run smoothly.

Here again we may be charged with speaking lightly. Wegener is dealing with possible natural events. Build up an earth on certain lines, endow its parts with certain properties, some of which are suggested by well substantiated experimental work, and certain results are rendered probable.

The great length of geological time can always be appealed to as a factor. We may now ask what causes continental lands to drift and waltz. We learn (p. 132) that there is a tendency for the blocks to move towards the equator, like other bodies capable of sliding over the main curved surface of an oblate and rotating earth, and that a westward drift may also be expected. The island-loops, the garlands, are detached portions left behind; oceanic islands, however much they may be disguised by igneous upwellings, however much they may resemble volcanic cones built up from the depths, are similar fragments stranded on the sima, children that could not keep pace with their parents in the movements of the continental dance.

This is perhaps the boldest stroke of all; but the suggestion is continued on a larger and more serious scale. New Zealand is bereft of a relative that has hurried forward as Australia, Ceylon is cast off from the foot of India, Madagascar from the African flank. Prof. Wegener reads widely, and he uses biological and geological details that suggest analogies and former continuities. He quotes even (p. 40) Lange Koch's recent tracing of the Caledonian folding into Greenland (see NATURE, vol. 110, p. 91), though he fails to recognise the significance of Sigillaria in S. Africa or of Glossopteris in northern Russia (p. 68). Having rejected the probability of land-bridges and sunken regions, the floor of the Indian Ocean becomes for him a sheet of sima, left bare by separation of the continents, and we need no longer look wistfully for the lost forests of Gondwana Land, as the flying fish come on board to tell us of the secrets of the seas.

The trough-valleys that have been traced from Suez to the Shire River, though their origin is still under discussion, are regarded as signs of a rift that threatens Africa. In Fig. 36, p. 117, we have the author's view of what may occur under such a trough; since the walls are separating, room is allowed for a sinking down of fragments from them, while sima is rising under them from below. It is obvious that a melting off of the base of subsiding portions in the sima, such as the author elsewhere contemplates, would allow of a very different representation, and that Wegener's drawing is inspired by his rejection of vertical movements in the sial. Even fjords, despite their barriers of continuous rock, are for him cracks widening by lateral movement as an ice-load presses on the coast.

Wegener's strong case against general movements of subsidence and evatelion lies of course in his discovery (pp. 19-21) that the great majority of ocean-depths lies near 4700 m. below, and of land-heights near 100 m. above, the level of the sea. Attention was directed to this by the reviewer in NATURE (vol. 109, p. 202) of the second edition of Wegener's work. The conception of flotation is thus strongly supported; but it is already part of the doctrine of isostasy. Geological difficulties in Wegener's hypothesis are discussed by Philip Lake in his review of the second edition in the *Geological Magazine* for August 1922. Literature accumulates on the subject, and we have to consider such general papers as those of Harold Jeffreys " On certain geological effects of the cooling of the earth " (Proc. R. Soc., vol. 100, Sect. A, p. 122, 1921), where account is taken of the fracturing of a primitive crust, and such local studies as those of H. A. Brouwer on the garland-isles of the Dutch East Indies (Journ. Washington Acad. Sci., vol. 12, p. 172, 1922). Brouwer regards the garlands as the crests of growing anticlines, based on crumpling masses that have a considerable lateral as well as vertical movement. Meanwhile, Wegener, flinging down his gage, certainly calls on us to justify such faiths as we at present hold. His principal geographic rearrangements are shown in a series of small maps, in one of which the northern lands are rearranged so as to explain the latest glacial epoch. The Permo-Carboniferous glaciation presents difficulties, as was pointed out in a notice of the excellent papers by Du Toit (NATURE, vol. 109, p. 757); but Wegener, when he has clustered his land-masses around the pole, shifts the pole from point to point among them, to suit their special idiosyncrasies. Nothing daunts so bold a champion. The hand of the master presses on the sial blocks or on the polar axis, and all goes well with the hypothesis.

Has the author considered, however, that no re-groupings of the furniture of the earth will account for the simultaneous reduction of ice-masses in all glaciated regions at the present day? Can, moreover, the evidence for general rises of temperature in the past be so lightly set aside? Can—but these questions are endless; those who still hope for simple explanations may well turn their eyes for light and inspiration, with Akhenaten, to the sun.

GRENVILLE A. J. COLE.

## A New Treatise on Chemistry.

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry.* By Dr. J. W. Mellor. Vol. 1. Pp. xvi + 1065. Vol. 2. Pp. viii + 894. (London: Longmans, Green and Co., 1922.) *3l. 3s.* net each vol.

THE writing of a "Comprehensive Treatise on Inorganic Chemistry" presents a problem which becomes more and more difficult with each successive year. The small text-books of a century ago soon required to be expanded into a series of volumes such as were issued by Watts in 1868, and in the English translation of Gmelin, of which 19 volumes were issued between 1848 and 1872. In recent years the growth of the subject has been so rapid that nearly all the more recent successes have been scored by teams of workers, such as those who have collaborated in the production of Thorpe's "Dictionary of Applied Chemistry" in England, and of Moissan's "Traité de chimie minérale" in France, as well as in the more recent German productions. Even so, as Dr. Mellor reminds us in his preface, the seventh edition of Gmelin, begun in 1905, is not yet completed, while three other unfinished compilations date back to 1905, 1900, and 1874 respectively. For every reason it is greatly to be hoped that Dr. Mellor will be able to carry through to completion the series of volumes of which the first two have now been issued.

In reviewing these two volumes (and perhaps paying more attention to the first than to the second), it is necessary in the first place to offer respectful homage to the author for the vast range of accurate information which he has gathered together. Almost every item of fact appears to have been abstracted from the original sources, and by a system which has left very little room for casual errors. It is, moreover, remarkable to find that an author, whose interests have generally been thought to centre themselves in the mathematical and physical aspects of chemistry, should be in a position also to deal in such an able manner with other topics, such as the early history of the science, which occupies a substantial portion of the first volume. In these chapters his references are often more numerous and earlier than those which are given in the more formal histories; thus, included in volume 1 are a number of unexpected references to the history of combustion before Jean Rey, of oxygen before Priestley, and of crystallography before Haüy, while volume 2 contains, on page 419, an amazing quotation from Roger Bacon, from which it might perhaps be supposed that metallic sodium had already been prepared in the thirteenth century! If the historical portion of the volume is dull reading, the major portion of the blame must be ascribed to the infertile character of the science during two of the three periods into which its history is divided by the author, namely, the first or mythological period, and the second or philosophical period, before it finally reached in the seventeenth century the third or scientific era. Certainly the 50 pages which are devoted to these preliminary stages fully justify the policy which has been adopted generally by teachers, even of historical chemistry, of curtailing within the narrowest limits the study of everything prior to about 1600 A.D. A lingering doubt as to whether this early period is quite so dull as it appears has, however, been raised in the mind of the reviewer by the sudden arousal of his interest when, on page 107, a series of quotations are given from a translation of Lucretius instead of a mere second-hand summary of his views on atoms.

The materials for the Treatise have already been used in part in the author's "Modern Inorganic Chemistry"; conversely, the treatise bears evidence that it has been based, in part at least, upon an expansion of the text-book. This hypothesis at any rate serves to account for some features in the arrangement of the treatise which are awkward and perhaps undesirable. Thus, in a text-book, which the student is expected to read consecutively from cover to cover, and in which the assumption is made that the reader may begin with no previous knowledge of the subject, it is a well-known device to alternate the theoretical and the experimental sections; but this method is surely out of place in a treatise which is so extensive that it can be used only as a work of reference. In such a treatise it is merely an annoyance, and a source of unnecessary trouble to the reader, to break up the text in this way. Thus the systematic account of ozone and hydrogen peroxide is sandwiched between unrelated chapters on the kinetic theory and on electrolysis, to the obvious disadvantage both of the theoretical and the descriptive portions of the book. In the same way, and presumably for the same reason, a valuable section on chemical affinity has been buried in a chapter on hydrogen, together with a section on mass action, while sections on catalysis, on consecutive reactions, and even on neutralisation, are hidden away in a chapter on oxygen. In each of these cases the index alone gives the clue as to where the author has concealed his hidden treasures. It is perhaps even more bewildering to discover a long discussion of the indices of refraction of liquids and vapours in a chapter on crystals and crystallisation. In all these cases reference to the theoretical sections is rendered unnecessarily difficult by the way in which certain portions have been detached and redeposited in the systematic chapters of the book.

A similar confusion between the methods which are suitable for an elementary text-book and those which are required in a work of reference is also to be found in some of the figures. For example, it would have been much more satisfactory if facsimile reproductions had been given of the apparatus used by Lavoisier for the decomposition of steam by iron, and by Dumas for determining the composition of water, instead of the simplified and modernised versions of the diagrams which are given on pages 130 and 134 of volume 1; these can be of no possible value except to a student in the first stages of his chemical education, when simplicity rather than detailed accuracy is perhaps necessary. The figures are, however, not a strong feature of the treatise; thus, in volume 1 a figure has been omitted on page 89, while on page 214 a block has been printed upside down. On page 607 a block of Iceland spar with strictly rectangular faces is made to show the double refraction of a black spot on a strip of white paper without producing any refraction at all of the paper which carries the spot; the trigonal axes on page 618 also give the impression of being rectangular, and the rhombohedron of Iceland spar on page 619 does not appear to have been drawn according to any recognisable crystallographic scheme. The diagrams of spectra would also have been of greater value if they had been plotted on a scale of wave-lengths instead of on what appears to be the arbitrary scale of an instrument.

At the head of each section a quotation is given, and many of them are particularly apt and interesting; it is a pity that only the name of the author is given and that the system of references does not enable these quotations to be traced to their source. This difficulty arises also in other cases, *e.g.* on page 83, where half-a-dozen striking examples of the influence of impurities on the properties of metals are given with the name of the author but no reference to the place where the quotations may be found. The author has adopted an ingenious system of numbering separately the references to each section of perhaps half-a-dozen pages, so that no extensive re-numbering is required when additional references are inserted, and each section with its references is complete in itself; but even this excellent system has occasionally failed and most of the minor errors which have been detected in the earlier chapters have arisen in connexion with the misplaced numbering of the references. It is, however, necessary to enter a protest against the way in which, especially in the systematic portion of the book, a score or more of references are included under a single number. In the case of a student who wishes to consult the whole bibliography of a subject, no harm may be done by this system; but in the case of a chemist who wishes to look up quickly the original sources from which data have been quoted, this method of handling the references gives rise to much troublesome delay. To take only one example, on page 84, volume 2, a figure is given of an apparatus by F. P. Worley, and the text corresponding to this figure is close at hand at the foot of the page, but a careful inspection fails to reveal any number or sign with the help of which the reference to this work might be found among the two pages of closely printed references at the end of the section. The numbers which form a guide to the references are in any case not easy to find in a text-book which bristles with the subscript numbers of chemical formulæ and the superscript numbers of mathematical formulæ and equations; and it is necessary to go back to the top of page 83 and forward to page 85 in order to discover the numbers 30 and 31, with the help of which the reference to Worley's work is finally traced among the eleven references quoted under the number 30. If this system of quoting references is to be satisfactory, the reader should at least have the assurance that he will not have to go beyond the limits of a paragraph in order to find the number which will lead him to the reference.

A fault which appears for the first time in volume 2 is the introduction of abbreviations into the main portion of the text. These abbreviations may be in place when dealing with tabular matter or in condensed abstracts; but it is very irritating to the reader to be pulled up in a purely narrative section by phrases such as "the liquid is conc. in salt-pans," or "the press. between the surfaces is normal." After such an experience the reader feels an unwonted thrill of gratitude to the Publication Committee of the Chemical Society, which does not even allow these abbreviations in the narrative portions of its abstracts. The saving of space which is achieved in this way is more than lost as the result of inserting the initials of every author even when the same author is mentioned half-a-dozen times in one paragraph. The main idea of quoting the initials of an author is probably correct, even if it appears somewhat superfluous in the case of giants such as Lavoisier and Priestley; but to repeat the initials over and over again, when the text makes it perfectly clear that the same author is being quoted, is a purism which might well be sacrificed, if only in order to find space to print in full the half-finished words which disfigure the second (but not the first) volume of the Treatise.

It will be seen that the criticisms given above refer mainly to the way in which the contents of the Treatise are presented, and not to the contents themselves. The reviewer, who spent some weeks of his vacation in mastering the contents of the two volumes before attempting to criticise them, would therefore like to conclude his comments by again expressing his amazement that a single chemist should have brought together so immense a store of information and have compiled a Treatise which every English chemist will desire to have on his shelves as a masterly guide to the literature of his science. A list of errors is being forwarded to the author.

## Physiology of Respiration.

*Respiration.* By Dr. J. S. Haldane. (Silliman Memorial Lectures.) Pp. xviii+427. (Newhaven: Yale University Press; London: Oxford University Press, 1922.) 28*s.* net.

DR. J. S. HALDANE'S book is nominally a report of his Silliman lectures delivered at Newhaven; in reality it is an account of his life's work in physiology. No one who turns over the pages can be but impressed with the enormous advance which has been made in the physiology of respiration within the last thirty years, and the degree to which that advance has been due to Dr. Haldane's work and to the stimulating influence which he has wielded over the minds of others.

To those who teach physiology, the contents of the book are for the most part familiar ground. To such, the book at its lowest will form a convenient epitome of Dr. Haldane's works within the limits of a single cover, but many will delight in reading it because in it they will find a more perfect picture of the genius of the author than is obtainable from the perusal of his works in a less consecutive form.

One of the interesting points which will probably strike the reader is the extent to which Dr. Haldane's discoveries in the realm of pure science have been the result of problems which have confronted him in the province of industrial or applied physiology.

Of industrial physiology—now so recognised a branch of the subject in America—Dr. Haldane may almost be said to have been the founder in this country. More than thirty years ago the author was much concerned to arrive at some explanation of the fact that man could tolerate a concentration of carbon monoxide in mines which, according to what might be expected on theoretical grounds, should prove fatal. The difficulty so raised led to a complete investigation of the quantitative relations of the blood to oxygen and carbon monoxide respectively, and ultimately to his acceptance of the theory of pulmonary respiration put forward by Bohr, namely, that the pulmonary epithelium was capable of secreting oxygen (see chap. v.). It is not our object to discuss here the correctness or otherwise of these and other extremely controversial points in the book. Our concern is to point out that Dr. Haldane's refusal to leave an important point in the physiology of mines unexplained has led to a great volume of work both by himself and by others which, taken together, has given a quite unusual impulse to physiological research.

From chapters xi., xii., and xiii. it may be gleaned that in the 'nineties of last century and the early part of the present one, Haldane was much occupied with the analysis of mine air, of the air in tunnels, in ships, and in caissons. To the effects of sudden compression and decompression may probably be traced his interest in the effects of altered barometric pressure upon the human frame. The present volume facilitates the taste of the student who would acquaint himself with these problems, for hitherto much of its author's work on them has been hid away in blue books, mining reports, technical journals, and the like, so that it was difficult for the ordinary reader of physiological literature even to become appraised of its existence. In this connexion it is much to be regretted that the book lacks an index. If, as may confidently be expected, the present edition is followed at no great date by another, we hope that this omission will be made good. The book must surely be to a great extent a work of reference, and a book of reference without an index loses much of its usefulness.

The reader cannot scan the pages without observing the large number of persons who have been privileged to collaborate with Dr. Haldane. To that company the book will mean something more than a mere recapitulation of his work or a history of the development and philosophic position, or a commentary on the action and reaction of abstract science on industrial research; it will mean something a little sacred, but something which one of them, at all events, finds some difficulty in putting into words. JOSEPH BARCROFT.

## Our Bookshelf.

*An Introduction to Sedimentary Petrography: With special reference to loose Detrital Deposits and their Correlation by Petrographic Methods.* By Henry B. Milner. Pp. 125. (London: T. Murby and Co., 1922.) 8*s.* 6*d.* net.

THIS attractive little book deals mainly with loose detrital deposits and their correlation by petrographic methods. The first chapter gives an account of sampling, treatment, and methods of examination in about a dozen pages. The next chapter (56 pages) deals with detrital minerals and is illustrated by numerous plates showing the shapes and appearances of loose grains and crystals. Following this are two chapters in which a courageous effort is made to show the value of the evidence provided by detrital minerals as a means of stratigraphical correlation, and as an aid in palæogeographical studies. A useful bibliography, a table showing the distribution of detrital minerals in British strata, and an index are included.

It is not easy to share Mr. Milner's confidence in the inferences he draws from the evidence provided by the mineral composition of sediments. Such evidence is rather unsafe as a basis of stratigraphical correlation, owing to the rarity and local significance of instances in which detrital minerals are derived from what he calls "homogeneous distributive provinces." The difficulty of generalising safely on the genesis of detritus is illustrated very forcefully by Mr. Milner's statement that a garnet-staurolite-kyanite suite suggests derivation from a definite thermo-metamorphic province, while a sphene-apatite-zircon assemblage is indicative of acid or intermediate rock-types as sources of supply, whereas an ilmenite-anatase-rutile-brookite association points to derivation from basic or ultrabasic rock-types.

These are, to say the least, highly controversial statements, but they tend to make the subject interesting and to stimulate further work; for, as Mr. Milner very properly remarks, the aim of science should be not merely to collect facts, but to explain them, and to put them to service in the solution of larger problems. The difficulty in this particular case is that the facts available are as yet scanty and very local in their significance. Much patient fact-collecting remains to be done before it can be ascertained whether any given system or series has definite characteristics as regards the nature and mineral composition of its detritus, and what those characteristics are. Not until this work has been done will it be safe to assert that the evidence provided by detrital minerals is useful in any substantial way as a basis of stratigraphical correlation.

T. C.

*Universal Problems.* By H. Jamyn Brooks. Pp. 123. (Braintree, Essex: The Author, The Limes, Shalford, 1922.)

REVIEW by quotation is not usually desirable, but with books of the class to which Mr. Brooks's belongs it is the only possible method. It will suffice to quote at random three of the eight "hypotheses on which the theories discussed in the work are founded."

"1. Every element, whether it be chemical, physical or mental, is distributed in unbroken unity throughout universal space."

"5. The mode of progression of the physical forces through matter and space is by communicated combustion, as is illustrated by the ignition of a train of gunpowder."

"7. Energy is the force which becomes manifest through expansion and contraction."

At first we are inclined to be amused, but really such books are tragic, not comic. For Mr. Brooks lacks neither intelligence nor enthusiasm. He has read enormously, and he has actually printed with his own hands the little book in which his views are presented. If only that intelligence and enthusiasm had been combined with the desire and the capacity to study science seriously! If only he had given to a few elementary text-books and a short course of laboratory work the time and application he has given to encyclopædia articles and "popular" treatises! Faced with such results as this, we are forced to ask ourselves whether the "popularisation" of science is all or mainly gain. Has Prof. Eddington, for example, —his book is quoted more frequently than any other— done good to science by arousing the interest of untrained readers, or harm by encouraging the delusion that they can really understand? N. R. C.

*Mechanical Testing: A Treatise in Two Volumes.* By R. G. Batson and J. H. Hyde. (Directly-Useful Technical Series.) Vol. 1: *Testing of Materials of Construction.* Pp. xiii+413. (London: Chapman and Hall, Ltd., 1922.) 21*s.* net.

THE contents of this volume deal with the testing of materials of construction; the testing of apparatus, machines, and structures will be included in the second volume. The authors have had extensive experience in the National Physical Laboratory, and this is reflected in their book. A large number of engineers in this country are now alive to the importance of continually testing the materials they employ, and to such the volume will be welcome on account of the information it contains regarding modern methods of testing. The student will also find the book useful, since no college laboratory contains all the apparatus described, and text-books on materials usually have only brief sections on the apparatus employed in testing. The greater part of the volume is devoted to the testing of metals; besides the ordinary simple commercial tests, we find chapters on the repetition of stress, combined stresses, hardness testing, impact testing, and the effects of temperature. The book closes with chapters on the tests of timber, stone, brick, concrete, road materials, limes, and cements. Sufficient information is given regarding the results of methods of testing to enable the experimenter to compare his own results with average values for trustworthy materials.

The book represents a large amount of work, not merely on account of its actual contents but also on account of the number of original papers which had to be consulted. This is evidenced by the copious references at the end of each chapter. The authors are to be congratulated on the success with which they have accomplished their task.

*Artificial Limbs and Amputation Stumps: A Practical Handbook.* By E. Muirhead Little. Pp. vii + 319. (London: H. K. Lewis and Co., Ltd., 1922.) 18*s*. net.

No surgeon who may be called upon to amputate a limb can afford to disregard the problem of fitting a prosthetic appliance to the resulting stump. Mr. Muirhead Little has recorded his conclusions, based on a wide experience in fitting artificial limbs, and his book will undoubtedly take its place as a standard work of reference on the subject in English surgical literature.

The chapter on amputation stumps is of great importance; in it the author describes the characteristics of a good stump, the conditions which prevent or delay the fitting of prostheses, and the best methods of dealing with such conditions. The actual descriptions of artificial limbs are mainly those of the British Official Prostheses, *i.e.* appliances supplied by the Ministry of Pensions. Arms are classified according to the work required to be done, and again according to the amputation region. Lower limbs are grouped corresponding to the site and type of amputation. The book is very well illustrated and is complete in its attention to details outside the actual fitting of the limb, *e.g.* the preservation and repair of the artificial leg, and the re-education of the patient. The appendix contains specifications of artificial limbs, and directions for making certalmid sockets and for fitting the light metal leg.

*Industrial Nitrogen: The Principles and Methods of Nitrogen Fixation and the Industrial Applications of Nitrogen Products in the Manufacture of Explosives, Fertilizers, Dyes, etc.* By P. H. S. Kempton. (Pitman's Technical Primer Series.) Pp. xii + 104. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.

MR. KEMPTON has provided a very brief but readable account of an important industry which has grown up within the last ten years. The descriptions of the processes are necessarily very sketchy, but enough information is given to enable one to form a reasonably accurate picture of the present state of affairs—one which, it may be mentioned, is by no means to the credit of this country. Several minor inaccuracies were noted. The yields of the various arc furnaces given on p. 15 are not the real figures. The Claude process is not the only one largely used for the manufacture of nitrogen (p. 32). Copper formate, not chloride, is used for the purification of hydrogen in the Haber process (p. 45). "Rev. A. Milner, 1871" should be "Rev. I. Milner, 1788" (p. 64). The "Ostwald-Barton system" of ammonia oxidation (p. 67) is quite adequately described by the first of the two names, and the statement that in it "a catalyst of secret composition is used instead of platinum," although it appears to have been spread abroad for the information of the credulous, is wholly without foundation.

*The Beloved Ego: Foundations of the New Study of the Psyche.* By Dr. W. Stekel. Authorised Translation by Rosalie Gabler. Pp. xiv + 237. (London: Kegan Paul, Trench, Trubner and Co., Ltd., 1921.) 6*s*. 6*d*. net.

DIFFERENT aspects of life, such as the fight of the sexes, psychic opium, the fear of joy, the unlucky dog, to select but a few, are some of the topics of the series of essays which constitute this book. Each chapter discusses special symptoms which, in particular cases, reveal that the personality has been thrown out of perspective, and the proffered solution is that love of the self is the fundamental cause of the disturbance. Love at first sight is love of the self as reflected in another, and even the person who is always disproportionately unlucky is so, because his self-love demands that he must be unique in some one direction. The author admits his indebtedness to the work of Freud, and regards it as a step towards a new psychotherapy, but believes that sexuality has been over-emphasised by Freud's followers. He aims at showing the part played by the self. The essays are in popular form and are certainly interesting and embody much sound advice.

*A Textbook of Organic Chemistry.* By Prof. J. S. Chamberlain. Pp. xliii + 959. (London: G. Routledge and Sons, Ltd., 1922.) 16*s*. net.

PROF. CHAMBERLAIN'S textbook follows the usual lines. Only important compounds are described, and attention is directed to the general relationships between groups of compounds. The style is clear and the matter well arranged, so that students beginning the serious study of organic chemistry should find the book of value, especially if supplemented by lectures, as the author intended. The printing and paper are good. From the large number of elementary textbooks on organic chemistry which have appeared recently one might be led to infer that some new methods of teaching the subject had been evolved. This does not seem to be the case.

(1) *Industrial Motor Control: Direct Current.* By A. T. Dover. (Pitman's Technical Primer Series.) Pp. xi + 116. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.
(2) *Switching and Switchgear.* By H. E. Poole. (Pitman's Technical Primer Series.) Pp. ix + 118. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.
(3) *The Testing of Transformers and Alternating Current Machines.* By Dr. C. F. Smith. (Pitman's Technical Primer Series.) Pp. xi + 91. (London: Sir I. Pitman and Sons, Ltd., 1922.) 2*s*. 6*d*. net.

(1) MR. DOVER'S object in his book is to discuss the principles involved in the starting and speed control of direct current motors. The principles are applied subsequently to typical control apparatus. The diagrams are well drawn and the descriptions are clear.

(2) The elementary considerations which have to be taken into account when designing apparatus for the switch-control of electric circuits are well described in Mr. Poole's book. It will form a useful introduction to more technical treatises.

(3) Dr. Smith's book will prove useful to students, and to engineers who want to revise their knowledge.

## Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

### Echinoderm Larvæ and their Bearing on Classification.

IN NATURE of December 22, 1921, Prof. E. W. MacBride, in consequence of Dr. F. A. Bather's review (in NATURE of December 8, 1921) of my work, "Studies of the Development and Larval Forms of Echinoderms," has taken the opportunity of making some remarks which, at least partly, have somewhat the character of a personal attack on me. Being at that time on a scientific expedition to the Malay Archipelago, it was not until the middle of May last that I received the issue of NATURE containing that communication. In spite of Dr. Bather's chivalrous defence on my behalf, I think it desirable to send to NATURE an answer to Prof. MacBride's letter. This could not possibly be done then, however, as out there (at the Kei Islands) I had no access whatever to literature—not even to my own work. I had to wait until my return from the expedition, and therefore it is only now that I am in a position to send a reply to the statements made by Prof. MacBride a year ago.

Prof. MacBride first emphatically objects to the idea that the metamorphosis of Echinoderms might be an alternation of generations. It is not quite clear to me whether this is addressed to the reviewer or to the author, or perhaps to both of us. Dr. Bather has replied for himself to this objection. I may be allowed here to reply to it for my part, and shall do so simply by quoting what I did write.

On p. 124 of my work I state that in *Ophiopluteus opulentus* the postero-lateral arms remain in connexion after the young Ophiuran has been dropped, in the same way as it occurs in the larva of *Ophiothrix fragilis*. In *Ophiopluteus opulentus*, however, it appears that the larva does not perish after a little while, as doubtless happens to the Ophiothrix-larva. Some specimens show that *a new larval body begins to regenerate* from the postero-lateral arms. That we have here to do not simply with abnormal larvæ is evident from the fact that the long postero-lateral arms are perfectly normally developed, which could not be the case in an abnormal larva with the mouth and intestinal organs imperfectly developed, and accordingly unable to feed. Further, on p. 148 is said: "How far the process of regeneration goes cannot be ascertained; but in any case Pl. XX. Fig. 5 shows that it may go on so far as till the formation of a new mouth and œsophagus. It is also evident from the numerous nuclei seen in the anterior part of the new body that a vigorous growth is going on here, so that it would seem most probable that the process may continue the short while, until the new digestive organs are able to assume normal function—and then there seems to be no reason to doubt that a new complete and ultimately metamorphosing larva may be the result. Thus we would here have a *true case of metagenesis*, otherwise totally unknown in Echinoderms." Finally, on p. 149 I have said: "Of course, I do not mean to maintain that definite proof of this astonishing regeneration has been given. But the available material certainly indicates that it does take place. The problem most urgently invites closer investigation."

I think it clear from these quotations that I do not characterise the metamorphosis of Echinoderms as an alternation of generations. On the other hand, if the regenerating larva goes on to metamorphose a second time, even Prof. MacBride certainly will have to regard this as a (of course quite exceptional) case of metagenesis in Echinoderms. The correctness of my observations is not to be doubted—the regenerating larvæ are at the disposal of any one who may wish to control my figures; and my conclusions, which are perfectly logical, I cannot agree to be audacious.

To my statement that since the larvæ of the more primitive Asteroids (the Phanerozonia) are devoid of a Brachiolaria stage, the sucking disk found in the larvæ of Spinulosa and Forcipulata must be a later acquired specialised structure, and accordingly the homology generally supposed to exist between the sucking disk of the Brachiolaria and the Pelmatozoan stalk only apparent, and the great part it has played in phylogenetic speculations unjustified, Prof. MacBride most emphatically objects: "No more rash statement could be made nor one more devoid of foundation. Modern Asteroids are divided into five groups, viz. Forcipulata, Valvata, Velata, Paxillosa, and Spinulosa. Nothing whatever is known of the development of any valvate or velate form, but the fixed stage is found not only in the development of the Forcipulata (which Dr. Mortensen arbitrarily regards as the most specialised forms) but also in the development of the Spinulosa (which all admit to be the most primitive group). In the Paxillosa, which include the British genera Astropecten and Luidia, and which, *mirabile dictu*, Dr. Mortensen appears to regard as primitive forms, the fixed stage is omitted. . . ."

I shall leave the strong expressions to Prof. MacBride and only comment upon his statement that "all admit" the Spinulosa to be the most primitive group of Asteroids.

Prof. MacBride will probably agree that among naturalists now living the following are the first authorities on Asteroids: W. K. Fisher, H. L. Clark, R. Koehler, and L. Döderlein. I have written to all of them, asking them to tell me (1) whether they have ever stated as their opinion that the Spinulosa are the most primitive Asteroids (I did not remember ever having met with such statements in their publications, but I might, of course, have been mistaken); (2) to inform me which group of starfishes they regard as the most primitive. All answered that they had never stated the Spinulosa to be the most primitive Asteroids. Prof. W. K. Fisher writes: "I think that the typical Phanerozonia such as the Astropectinidæ, Odontasteridæ, etc., are decidedly more primitive than the Spinulosa, meaning by that the Asterinidæ, Echinasteridæ, and Solasteridæ, to mention three of the families." Dr. H. L. Clark writes that he agrees perfectly with me "in considering the Asteropectinidæ as essentially primitive, and the Spinulosa specialised." Prof. Koehler writes: "Je crois, comme vous, que les types les plus primitifs doivent être cherchés dans les formes voisines des Astropectinidées, telles que le genre Hudsonaster et d'autres genres très anciens." Prof. Döderlein writes that he regards the family Asterinidæ as "die ursprünglichste aller Seestern-Familien." Among recent authorities on Asteroids, Döderlein thus is the only one who holds a similar view as to the classification of Asteroids as Prof. MacBride; but as he has never stated this opinion in any of his publications, neither Prof. MacBride nor I could possibly know anything thereof.

I may further mention that both Sladen and Ludwig, who, Prof. MacBride will probably agree, must also count as authorities on asteroid classification, likewise regard the Phanerozonia, not the

Spinulosa, as the more primitive. This opinion is also adopted by Hamann in "Bronn" and by Gregory in Ray Lankester's "Treatise on Zoology." Prof. MacBride alone, and, among late specialists in Asteroids, Perrier, have expressed the view that the Spinulosa are the more primitive of Asteroids. Is Prof. MacBride then not perhaps attaching somewhat too much value to his own opinion when he states that "all admit" the Spinulosa to be the most primitive group of Asteroids—with myself alone as an absurd exception?

The question which group of Asteroids is the most primitive may not yet be definitely solved. If, however,—as *nearly* all admit—the Astropectinid forms are the most primitive, the conclusion is inevitably that the Brachiolaria, occurring—so far as evidence goes—only in the more specialised groups, the Spinulosa and Forcipulata, is a specialised larval form and its sucking disk a specialised, later acquired structure. Then this sucking disk is not homologous with the crinoid stalk, and its use in phylogenetic speculations is unjustified.

To Prof. MacBride's suggestion that my views would have some more value if I "had worked out with thoroughness the complete life-history of any Echinoderm," and to his protest against "the idea that those interested in Echinoderms agree with the over-estimate of the importance of trifling peculiarities in the structure of pedicellariæ in which Dr. Mortensen indulges" Dr. Bather has already kindly replied. In order not to make this belated reply too lengthy I shall then not take up these challenges at present. TH. MORTENSEN.

Zoological Museum, Copenhagen.
November 22.

### Rotary Polarisation of Light.

IN the second edition of Dr. Tutton's monumental work on "Crystallography and Practical Crystal Measurement," a question of some interest to crystallographers and physicists is raised in an acute form by a footnote at the bottom of page 1082, which reads:—

"Considerable confusion has been introduced into the subject of optical rotation by the fact that chemists, in their use of the polarimeter for the determination of the rotation of the plane of polarisation by optically active substances (chiefly liquids or solids in solution, but occasionally the solids themselves), have adopted a different convention, as regards the sign of the rotation, to that employed by physicists and crystallographers, who refer to the actual occurrence in the crystal itself. For instance, the right-handed quartz of the crystallographer actually rotates the plane of polarisation of light in the opposite direction to the so-called dextro-camphor of the chemist. The latter regards a rotation as right-handed or dextro when it appears clockwise to the observer looking through the eye-piece of the polarimeter. But the crystallographer regards himself as travelling with the beam of light, that is, as looking along the direction of propagation of the light: if the movement of the light in the crystal is like that of a right-handed screw, clockwise, the crystal is right-handed or dextro-gyratory, and if the light moves in left-handed screw fashion, anti-clockwise, the crystal is lævo-rotatory or left-handed. It is very important that this should be quite clear."

This question as to the precise meaning to be attached to the words "right-handed rotation" has been responsible for a certain amount of misunderstanding and confusion in text-books on mineralogy and physics for nearly a hundred years, and from Dr. Tutton's footnote it would appear that it is still unsettled.

Now the facts are simple. In 1813, the famous physicist Biot read a paper before the Institute of France[1] in which he described a number of experiments that he had made upon plates of rock-crystal cut perpendicularly to the axis of crystallisation. In carrying out this work Biot made the important discovery that there are two kinds of quartz—one in which the plane of polarisation is rotated to the right, while in the other the rotation is to the left. In carrying out these experiments Biot used a table polariscope, and adopting as a standard succession of colours that in which they ascend in Newton's scale, namely, red through yellow and green to blue, he found that a rotation of the analyser from left to right, that is in a clockwise direction, gave the standard succession for one kind of quartz, while an opposite rotation gave it for the other. The first rotation he spoke of as right-handed and the second, consequently, as left-handed. The experiments were subsequently carried out upon a considerable number of liquids and the convention of direction of rotation referred to was applied consistently.

In 1820, that is, seven years after Biot's discovery of right- and left-handed rotation of the plane of polarisation, Herschel read a paper before the Cambridge Philosophical Society[2] in which he announced his discovery that the direction of rotation of the plane of polarisation in quartz is indicated by the disposition of certain crystal faces.

Unfortunately, however, Herschel was not satisfied with Biot's convention, and he proposed to substitute for it one in which the observer was supposed to be looking along the beam of light in the direction in which the light was passing. While Biot, as it were, looked at an internally illuminated clock-face from the outside, Herschel preferred to look at it from the inside. Biot's right-handed thus became Herschel's left-handed rotation. Herschel, however, was consistent. He called the crystal which gave a right-handed rotation according to his convention, a right-hand crystal, and in giving the results of Biot's experiments on liquids, he changed the signs in order to bring them into accordance with his own convention. Thus according to Herschel cane sugar in solution rotates the plane of polarisation to the left.

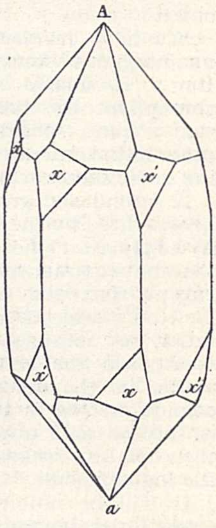

FIG. 1.—A right-hand crystal (Herschel).

Fig. 1 is a reproduction of the figure given in Herschel's original paper and reproduced in the article "Light" in the Encyclopædia Metropolitana (1830). In this article it is stated that the figure "represents a right-hand crystal." It is important to note here that in practically all modern books this figure illustrates a left-hand [twin] crystal. The confusion resulting from Herschel's attempt to substitute his convention for that of Biot was soon apparent.

In 1843 a book entitled "Lectures on Polarised Light delivered before the Pharmaceutical Society of Great Britain" appeared. This admirable little book of some hundred pages was written by Dr. Pereira. Now Dr. Pereira was evidently alive to

[1] "Mémoires de la classe des Sciences mathématiques et physiques de l'Institut Impérial de France (Année 1812)," Pt. I. pp. 263-4.
[2] Trans. Cam. Phil. Soc., vol. i. p. 43 (1821).

the danger of confusion arising from the existence of contradictory conventions such as those of Biot and Herschel, because, on page 86, he writes :—

"There are two varieties or kinds of circularly polarised light which have been respectively distinguished by the names of dextrogyrate or right-handed, and lævogyrate or left-handed.

"In one of these the vibrations are formed in an opposite direction to those in the other. Unfortunately, however, writers are not agreed on the application of these terms ; and thus the polarisation, called, by Biot, right-handed, is termed, by Herschel, left-handed, and vice versa. There is, however, no difference as to the facts, but merely as to their designation. If, on turning the analysing prism or tourmaline *from left to right*, the colours descend in Newton's scale, that is, succeed each other in this order—*red*, *orange*, *yellow*, *green*, *blue*, *indigo*, and *violet*, Biot designates the polarisation as *right-handed*, or +, or ↗; whereas if they descend in the scale by turning the analyser *from right to left*, he terms it *left-handed*, or −, or ↖. Sir John Herschel, on the other hand, supposes the observer to look in the direction of the ray's motion. Let the reader, he observes, 'take a common corkscrew, and holding it *with the head towards him*, let him use it in the usual manner, as if to penetrate a cork. The head will then turn the same way with the plane of polarisation as a ray in its progress *from* the spectator through a *right-handed* crystal may be conceived to do. If the thread of the corkscrew were reversed, or what is termed a *left-handed thread*, then the motion of the head, as the instrument advanced, would represent that of the plane of polarisation in a left-handed specimen of rock-crystal.'

"I shall adopt Biot's nomenclature, and designate the polarisation right-handed or left-handed according as we have to turn the analysing prism to the right or to the left to obtain the colours in the descending order."

We have in these paragraphs a very clear and unambiguous statement of the two conventions. Biot's is finally adopted and used consistently throughout the book. It will be noted, however, that Pereira speaks of colours which succeed each other in the order, red, orange, yellow, etc., as descending in Newton's scale.

A second and greatly enlarged edition of Pereira's book, edited by the Reverend Baden Powell, appeared in 1854, after the author's death. In this edition the above paragraphs remain substantially the same, except that the words "the colours descend in Newton's scale, that is, succeed each other in this order, red, orange, yellow, green, blue, indigo, and violet," in the first edition, are replaced by these words in the second edition (see p. 253)—"The colours *descend* in the order of Newton's scale—that is, succeed each other in the order of the colours of their plates, reckoning from the central black as the highest point."

It will be noticed that the enumeration of the colours, red, orange, yellow, etc., has been replaced by the words "succeed each other in the order of the colours of their plates, reckoning from the central black as the highest point," so that we must seek further for information as to the meaning of the words "descend in the order of Newton's scale" as used in the second edition. And turning to page 256, we read :—

"Thus, suppose we turn the analyser right-handed, that is, as we screw up, the colours succeed each other, with a certain thickness of the crystal, in this order—*red*, *orange*, *yellow*, *green*, *purple*, *red* again, and so on, in the ascending order of Newton's scale, on the colours of thin plates, before given."

So that in the second and first editions, the word "descend" has contradictory and opposite meanings. In the first edition it refers to colours succeeding one another in the order, red, yellow, green, and blue, whereas in the second edition the word "ascending" is used to denote the same order of colours. The result is that while Biot's convention was given clearly and correctly in the first edition, and used consistently, that given as Biot's convention in the second edition is, unfortunately, not Biot's but Herschel's convention, but both are used, with the result that the student gets hopelessly puzzled.

In Dr. Tutton's book, in spite of the warning in the footnote quoted, the first and also the second editions have apparently been written consistently with the Biot convention. In the first edition, for example, at pp. 802-803 and in the second edition at pp. 1082-1083, it is stated that "a slight rotation of the analyser from the position for the violet transition tint, to the right (clockwise) or left (anti-clockwise) according as the crystal is right-handed or left-handed, causes the colour to change to red (first order). On the other hand, a rotation of the analyser contrary to the rotary character of the plates causes the violet transition tint to change to blue or green (second order)." This statement, it will be seen upon consideration, can only be true of the right- and left-handed crystals shown by Figs. 344 and 345

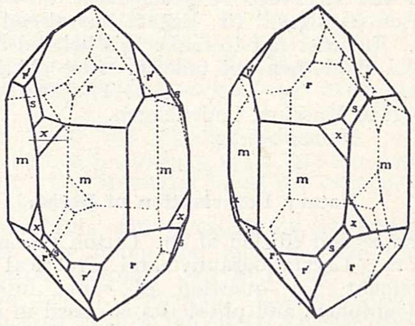

FIG 344.—Left-Handed Crystal of Quartz. FIG. 346.—Right-Handed Crystal of Quartz.

FIG. 2.

of the first edition (here reproduced in Fig. 2) and Figs. 311-312 of the second edition, upon Biot's convention. Upon Herschel's convention the words "right (clockwise)" and "left (anti-clockwise)" should be transposed in the above quotation.

Any attempt to revive Herschel's convention should, I think, be resisted. Simple experimental facts should be capable of description in clear and unambiguous language, and this, as has been shown, is not likely to be achieved so long as two conventions, in such a simple matter, are tolerated. The fact that Herschel himself brought his convention into line with crystallographic nomenclature by calling what is now universally accepted as a right-hand crystal, a left-hand crystal, has been overlooked. The crystallographic conceptions of right- and left-handed crystals are not likely to be changed now, so that the adoption of the Herschel convention by any writer will, or should, necessitate the definite statement that according to this convention a right-hand crystal is made up of left-hand quartz. Dana, it is true, in his "System of Mineralogy" gives Herschel's convention, but he accepts at the same time the usual definition of right- and left-hand crystals, so that a right-hand crystal, according to him, is left-hand optically. It should be remembered, however, that the last edition of Dana appeared thirty years ago. Later writers such as Miers, Johannsen, Duparc, and Pearce, and many others, have not, however, followed Dana—a crystal right-hand crystallographically, is also right-hand optically with them. F. CHESHIRE.

Imperial College of Science,
South Kensington,
October 27.

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I AM much indebted to Prof. Cheshire for stating so clearly the historic incidence of the confusion which has arisen in regard to the designation of the two types of optical rotation, as to which shall be called right-handed and which left-handed, due largely to the reversal of Biot's convention by Sir John Herschel, and to the similar reversion in the second edition of Dr. Pereira's book. Other investigators and experimenters have also adopted the reversal, for instance, Sir William Spottiswoode at the time he was president of the Royal Society, for on pp. 47-48 of his book, "Polarisation of Light," we read: "A right-handed ray is one in which, to a person looking in the direction in which the light is moving, the plane of vibration appears turned in the same sense as the hands of a watch." Moreover, if instead of using the polariscope as a table instrument one projects the phenomena on the screen, the picture there displayed is reversed exactly like a lantern slide, which has to be inverted in the lantern (the two spots in front at the top being brought to the bottom at the back), in order to get an upright picture on the screen. Thus, for example, in the mica-sector experiment of the late Prof. S. P. Thompson (pp. 1103-1104 of the second edition of my "Crystallography and Practical Crystal Measurement"), the black cross moves on the screen one sector to the left for a right-handed quartz crystal and to the right for a left-handed one; whereas on looking through the same instrument used as a table polariscope the movement is to the right for a right-handed crystal, in accordance with the Biot convention.

It is thus important to know the exact conditions of the experiment whenever the question of the correct discrimination of right- or left-handedness in the optical rotation of crystals is being dealt with. Further, the safest course, in the case of quartz, is to cut the section-plate to be used to afford the definite decision from a crystal which is clearly a single individual, and not a twin, showing the little *s* and *x* faces unmistakably, and this course was pursued by me in the preparation of my "Crystallography." As most in accordance with current practice (that of von Groth and Pockels, for example), and in rightful deference to Biot, the discoverer of the two optically active kinds of quartz, Biot's convention was used, in both editions of the book, a course which it is satisfactory to learn meets with the approval of Prof. Cheshire. The apparent opposite, on p. 1101, lines 7-8, is due to this being a projection experiment, the observer looking towards the screen along with the light rays; the direction here, however, really does not matter, as only the colour of the centre of the field is being referred to; even here, perhaps, it would be better in any future edition (they were not present in the first edition) to omit the words "from the point of view of the observer looking in the same direction as the light is being propagated," the text then conforming clearly with the Biot convention. On p. 1083, where a table experiment is being referred to, and the conditions are otherwise similar to those in the centre of the field in the case just referred to, there is no ambiguity, the Biot convention being clearly followed.

It was felt desirable to direct attention to the confusion which has so obviously arisen, and this was done in the footnote to p. 1082. Emphasis was attempted to be laid on the fact that, after all, the phenomena are due to the passage of the ray through the helical structure of the crystal, now so happily confirmed by Sir William Bragg's X-ray analysis of quartz, and that the observer does well to imagine himself travelling with the rays through the screw, in order to appreciate the cause of the rotation of the plane of polarisation or vibration of the light rays. The particular screw type, right- or left-handed, is the same, however, whether we regard the screw from one end of it or the other, whether we look along with or against the light stream; otherwise it would matter which side up the quartz plate were arranged, that is, which side were placed the nearer to any particular one of the nicols. But the optical effect, the rotation of the plane of polarisation or of vibration of the light rays, is, of course, what matters and what is so clearly different for the two different types of quartz helices, and it was my intention to retain and use the Biot convention for its directional (right- or left-handed) designation. The footnote in question is not sufficiently explicit, and must be amended in any future edition. Prof. Cheshire and the writer are, however, quite agreed on the facts, and that this Biot convention shall be the one employed, and I am grateful to Prof. Cheshire and to the editor of NATURE for affording me the opportunity of stating this. A. E. H. TUTTON.

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### Space-Time Geodesics.

IN his letter in NATURE of November 25, replying to mine which appeared in NATURE of October 28, Prof. Piaggio points out that the equations of Space-Time geodesics may be deduced by other methods than those of the calculus of variations, and suggests that, in some such way, it is possible to get over the difficulties to which I directed attention.

My criticism, however, was directed, not merely against the definition of Space-Time geodesics as *minimum lines*, but against all seeming definitions of them which start from ideas of measurement as a fundamental basis.

I must, however, in passing, warn my readers against what at first sight looks like a suggestion, though I have no doubt that it was not so intended by Prof. Piaggio, that Space-Time geodesics might be defined in terms of "*the osculating plane*."

If there were any strict analogy with the case of geodesics on surfaces in ordinary three-dimensional geometry, such an "*osculating plane*" would (apart from a line of intersection) have to lie in some mysterious region outside our Space-Time continuum altogether. Prof. Piaggio, however, I have no doubt, wishes to lay stress upon the equations he obtains.

I was of course aware that the *equations* of Space-Time geodesics could be arrived at by various analytical devices; but how much better off does this leave us? Consider, for example, the simple Space-Time analysis as given by Minkowski and see what it implies.

In the first place, it implies a set of co-ordinate axes $x$, $y$, $z$, and $t$, which are themselves *geodesics*.

How are these particular geodesics to be defined?

They cannot be defined as minimum lines, for they are not minimum lines; and we cannot use our co-ordinate system to define them, since we are now contemplating how the co-ordinate system can be set up.

In the second place, the co-ordinate axes are supposed to be *normal* to one another. How is this *normality* to be defined? It is to be remembered that *normality* in Space-Time theory is a wider conception than normality in ordinary geometry; since in the former we have lines which are "*self-normal*" (or what I have called "optical lines"), in addition to other rather curious features.

In the third place, the co-ordinate axes are supposed (if I may so express it), to be capable of graduation in equal parts. How is this graduation to be theoretically arrived at, and how are we to compare lengths, say along the axis of $x$, with lengths in some other direction?

It thus appears that we are reasoning in a circle if we attempt to give an analytical definition of Space-Time geodesics on such a basis.

The employment of generalised co-ordinates does not free us from difficulties, for, if it gets us out of one difficulty, it brings in another in its place.

Thus, for example, if the "graduations" were made according to arbitrary scales, the expression for the length of a Space-Time interval would contain functions the form of which would depend upon the arbitrary character of the scales employed.[1]

Again, if measurement of intervals be regarded as a fundamental conception, what is one to make of a case where

$$(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2 - (t_1 - t_2)^2 = 0,$$

in which $(x_1, y_1, z_1, t_1)$ and $(x_2, y_2, z_2, t_2)$ are the co-ordinates of two Space-Time points?

It must not be supposed that in raising these objections to the ordinary methods of treating this subject I am concerned only with destructive criticism.

My own answers to these difficulties are to be found in my published work.

In conclusion, I must thank Mr. Rogers for his very interesting letter published in NATURE of November 25; which, however, does not call for any special reply.

ALFRED A. ROBB.

Cambridge, November 27.

[1] This is the same sort of point which would arise, for instance, in thermodynamical theory by using some arbitrary scale of temperature nstead of the thermodynamic scale.

### A New Type of Electrical Condenser.

SINCE an electrical condenser is a device for storing electricity, it follows that a secondary battery is a condenser—obviously of very large capacity as compared with the electrostatic type of condenser. Arguing from this point of view it appeared to the writer that, by a suitable arrangement of pasted lead grids immersed in dilute sulphuric acid and connected in circuit with an alternating current, it should be possible to obtain the characteristic effect of an electrical condenser, namely, a phase advance of the current relatively to the terminal potential difference.

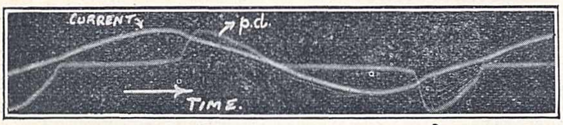


FIG. 1.

A large number of tests have borne out this conclusion and it may be of interest to readers of NATURE to show an oscillogram of the effect (Fig. 1). The oscillogram was taken during a test on a cell consisting of grids pasted with red lead and immersed in dilute sulphuric acid. The temperature of the electrolyte was about 86° C., the frequency of supply was 3·5 cycles per second, the current density about 0·75 amperes per square inch of grid and the r.m.s. value of the terminal pressure was a little more than 2 volts. There was practically no gassing of the cell during the test.

If the fundamental of the potential wave is determined it will be seen that there is a large angle of phase advance of the current on the pressure. There is one other interesting point noticeable in the oscillogram, namely, the potential difference of the grids remains relatively very small during a large portion of the current wave. When the current wave has passed its maximum value the pressure quickly rises to a maximum and then falls to zero at about the same moment as the current reaches its zero value. The process is then repeated during the next half of the current wave.

T. F. WALL.

Edgar Allen Research Laboratory,
The University, Sheffield, November 25.

[AN engineering contributor to whom we have shown Dr. Walls' interesting letter writes: "It has been well known to electricians for the last thirty years that an electrolyte with metal plates in it will act as a condenser. These devices are called electrolytic condensers and are used in everyday work. They generally consist of aluminium plates immersed in an electrolyte, but iron plates in a solution of soda are sometimes used. They are useful for getting currents which lead in phase the supply voltage. Dr. Gunther Schulze carried out an extensive series of tests on electrolytic condensers at the Reichsanstalt in 1909. See *Elektrotechnik und Maschinenbau*, 'Kondensatoren Grober Kapazität' (vol. xxvii. p. 247, 1909)."—EDITOR, NATURE.]

### Sex of Irish Yew Trees.

AFTER extensive inquiry up and down the country, I have so far failed to come across any example of the Irish Yew bearing male flowers. All the trees examined in private gardens and in cemeteries and churchyards have been of the berry-bearing or female sex.

I have now a number of young plants raised from the berries of the Irish Yew (*Taxus fastigiata*) fertilised by pollen from the English variety (*Taxus baccata*). These show a graded series from the spreading English type to the erect Irish form.

Growth is so slow, however, that it will be some years before it will be possible to ascertain the sex of these plants; meanwhile, I should be glad to know through the readers of NATURE any case of a male Irish Yew.

If, as is believed, the Irish Yew trees now growing in England have all been propagated by cuttings from the mutational Irish form, which first appeared in Co. Fermanagh, Ireland, more than a hundred years ago, this would explain the fact that they are all of the female sex. On the other hand, it is desirable to ascertain whether any linkage originally existed between erect habit of growth and female-ness in the mutational Irish variety.

Further, if any male example of the Irish Yew can be discovered it would be desirable to test the effect of fertilising the female Irish Yew by Irish pollen.

C. J. BOND.

Fernshaw, Springfield Road, Leicester,
November 28.

# The Physiography of the Coal-Swamps.[1]

By Prof. PERCY FRY KENDALL, M.Sc., F.G.S.

THE subject of Coal Measures geology has been discussed piecemeal in innumerable papers and memoirs, so that an inquirer may well be appalled at the mass of facts and of often conflicting deductions with which he is confronted. Indeed, it is surprising to discover how fundamental are some differences of opinion which exist.

Among the questions in the answer to which doctors have differed there is, I imagine, none more fundamental than this:

Were coal seams simple aggregations of plant remains swept together by the action of water—a process of accumulation which the learned call allochthony; more simply by drift; or were they formed, like peat, by the growth of vegetable material in its place—the process of autochthony?

I do not intend to labour the answer to this question. Categorical arguments in favour of the growth in place origin of the coal-forming vegetation are on record, and they have never been as categorically answered. Many arguments in favour of the drift theory seem to me clearly to have arisen from confusion between cannel and true coal. This distinction is again fundamental. True coal-seams are characterised by:—

(1) Wide extent.
(2) Uniformity of thickness and character over extensive areas.
(3) Freedom from intermingled detrital mineral matter.
(4) Constant presence of a seat-earth or rootlet bed.
(5) Entire absence of remains of aquatic animals within the seam.

Substitute affirmatives for negatives, and negatives for affirmatives, and the characteristics of cannel are as truly set forth.

## THE ABERRATIONS OF COAL-SEAMS.

Having got our coal-swamp clothed with vegetation, and the coal-forming materials accumulating, let us next consider the various interruptions of continuity and the aberrations to which it is liable. These interferences may be either contemporaneous with the accumulation of the materials, or, as one may say, posthumous.

Prominent in the category of contemporary interferences must be put the phenomena of split-seams. A split-seam is the intercalation into the midst of the coal of a wedge of sandstone, shale, or the like, in such wise that the seam becomes subdivided by intervening strata into two or more seams. The most notable split-seam in Britain is the famous Staffordshire Thick Coal. Jukes showed that this magnificent seam, 40 feet thick at its maximum, is split up into a number of minor seams by wedges of sedimentary strata which aggregate, in a distance of 4½ miles, a thickness of 500 feet. The explanation offered by that sagacious student of coal, Bowman of Manchester, might find here a typical application. Bowman supposed that a local sag occurred in the floor of the coal-swamp, resulting in the drowning of the vegetation and interrupting the formation of peat until the hollow was silted up and a new swamp flora re-established.

I now turn to a form of split-seam of extraordinary interest, which has received comparatively little attention from geologists though mining engineers must surely have a special comminatory formula to express their sentiments thereon. The first example that came under my notice was encountered in the eastern workings of the Middleton Main Seam, at Whitwood Colliery, near Wakefield. Thin intercalations of shale and other sedimentary materials, appearing at different horizons in the seam, were found to thicken gradually to the east concurrently with the gradual dwindling of the lower part of the seam. An exploration was then carried out. The bottom coal was followed, but it was found that though the underclay continued the coal disappeared, and was wholly lost for a short distance before it reappeared. The top coal rose over a steadily thickening shale parting, and disappeared into the roof of the workings, but boreholes proved that it was present above a parting which was, at the maximum, 29 feet thick. At the farther end of the heading the top coal came down and the integrity of the seam was restored. Two other transverse explorations have proved the same general arrangement on the same scale of magnitude and one or both margins have been traced for a long distance, enabling the interruption to be mapped continuously for about 8 or 9 miles and intermittently much further.

My first impression was that this was just a simple case of Bowman's "sag," until I observed that in every traverse the *upper element of the seam was arched while the floor was flat.*

Several analogous cases came under my notice before an explanation of this anomalous arching was reached. The explanation was found to lie essentially in the differential shrinkage undergone by peat-stuff in the process of forming coal, and, on the other hand, by any sand or mud which may have been deposited so as to replace a part of the peat.

Let us imagine a stream being diverted at flood time across a bed of peat and scooping out for itself a hollow channel which subsequently becomes filled with sediments, and afterwards the formation of peat continues, the peat plants creep out, and presently envelop the whole mass of sediments. When the beds consolidate there will obviously be very different contraction between the sands, muds, and the coal-stuff. The sands will scarcely contract at all, the muds will contract a good deal, the coal-stuff will contract very greatly.

Let us now return to the consideration of the plano-convex lens of "dirt" occupying a position between the upper and lower elements of the split-seam at Whitwood. On the sag explanation it should be convex downward, yet in this as in all other cases I have investigated, it is convex upward. The explanation is simple. Let us make our mental picture of the infilled channel in the peat a little more specific in detail. Let us suppose that the peat was 40 feet in thickness when the river commenced to cut its

[1] From the presidential address delivered to Section C (Geology) of the British Association at Hull on Sept. 8.

course across it; the channel we will say was, like most channels, deeper in the middle than at the sides, and in the middle actually cut through to the seat-earth. Then the channel silted up completely, so that a cast of its meandering course in sands or mud reaching 40 feet in thickness at the maximum, but much thinner at the margins, was formed; then the upper bed of peat formed to a further depth of 40 feet. The conversion of the peat into coal would reduce it to two beds, each, let us say, 2 feet in thickness at the maximum, enclosing the sediment with a proportionately smaller thickness in the eroded peat on either margin of the channel. The sedimentary mass would have the transverse section of a plano-convex lens, the convexity being downward, but when the peat under the edges of the sediment is condensed to one-twentieth of its original bulk the base becomes almost flat, and the unconsolidated mass of sediments adjusts itself thereto. Thus the curve, originally at the base of the mass, reproduces itself in the top of the mass, which was originally quite flat and now is curved. The lens of infilling has reversed its curvature.

When a seam is deeply eroded the only too familiar phenomenon of a "wash-out" is formed.

The most common abnormality is the occurrence of belts or patches of "proud coal" in which the seam swells up to twice or thrice its normal thickness—sometimes, though not always, by repetition of the whole seam or of the upper part, either by shearing or by overfolding.

It has been suggested that all the violent displacement and over-ridings are brought about by tectonic agency, and that they are thrust-planes. The localisation to a single stratigraphical plane should suffice to discredit this explanation. An amplification of the same explanation ascribes the displacements to a thrust with a movement from S.E. to N.W. and a common cause to the cleat or cleavage of the coal which is normally directed to the N.W. It suffices to refute this to remark that the wash-outs I have explored in the Yorkshire coalfield are aligned in four principal directions, so that if superposed they would give what may be called the Union Jack pattern, *i.e.* N.E.—S.W., N.W.—S.E., N.—S., and E.—W.

Moreover, if these so-called "wash-outs" are not due to the erosive effects of contemporaneous or sub-contemporaneous streams, but to flat-hading faults, any coal displaced should be presently found again without any loss whatever. That swellings and duplications of the seam occur we have already noticed, and such phenomena have been pointed to as evidence that there is "no loss" of coal in connexion with the so-called wash-outs. But losses and the gains by duplication do not, in fact, balance. A simple and convincing case is a wash-out in a thin seam, in which, by taking measurements of the thickness of coal present and the breadth of the barren area, I have been able to show that a gap with no coal for 210 feet is compensated for by only 35 feet of excess on the margin.

### SEISMIC PHENOMENA IN THE SEAMS.

While the displacements and duplications are totally unlike those produced by faults, there are cases in which the seam appears to have been subjected to a stretching tension and to have broken under the strain. Along the zone of such a stretch great confusion is commonly found. Masses of sedimentary materials, of the coal seam, and slabs and seams of cannel commonly occur, besides a curious argillaceous substance unlike any natural rock with which I am acquainted. In its unstratified structurelessness it suggests a kind of consolidated sludge such as might be produced by violently stirring or shaking a quantity of not too liquid mud. Where the seam abuts against this stuff it presents usually a nearly vertical ragged edge, its bright and dull layers preserving their characteristics quite up to the contact.

The explanation I have offered is that all these disturbances which complicate the already complex features of wash-outs are the effect of the lurching of the soft alluvial materials by earthquake agency. Every predicable subterranean consequence of earthquake action upon unconsolidated alluvial deposits, such as the Coal Measures were, can be seen in the Yorkshire Coalfield. The lurchings, the rolling and heaving of sand-beds, the shaking to pulp of the muddy deposits, the rending and heaving of the peat, cracks in the peat, and cracks infilled with extraneous material passing through the strata; and lastly, though actually the first clue to the explanation, masses of sandstone in the form of inverted cones ("dog's-teeth," "paps," or "drops"), descending on to coal-seams, which I interpret as the deep-seated expression of the sand-blows that are the invariable accompaniments of earthquakes in alluvial tracts.

An earthquake sweeping across an alluvial plain beneath which lay a thick bed of water-charged peat overlain by laminated clay, and that in turn by sand and an upper layer of mud or clay, would throw the peat and its watery contents into a state of severe compression which would result in the bursting of the immediate cover of clay and the injection of water into the sand, and, probably, a large quantity of gas, converting it thus into quicksand. This in turn would eject water in the form of fountains through the upper muddy or silty stratum, producing sand-blows and craters on the surface. When the disturbance subsided sand would run back down the orifice into the funnel above the peat. These are the "drops." They are commonly flanged down the sides, showing that they were formed upon a line of crack. An earthquake not infrequently gives rise to permanent deformations of soft deposits either by the lurching of the surface and the production of permanent wrinkles, or by subterranean migration of quicksand so as to produce, here a sag or hollow, there a ridge or bombement. Mr. Myron Fuller's admirable account of the effects of the New Madrid earthquake of 1816 as observed one hundred years after the event, is full of the most interesting and suggestive observations, not the least so those upon the sand-blows and sand-filled fissures containing lignite—the sand having come up from a bed lying at a depth of not less than 80 feet—the elevated tracts, and the new lakes produced by subsidence.

### THE "CLEAT" OR "SLYNES" OF COAL.

One feature of coal-seams I must discuss before I conclude, though it will not at first appear clear that it can be brought within the title of this address —I allude to the cleavage or cleat or slynes of coal. If we look at a piece of coal this cleavage is very conspicuous, for, lying at right angles with the bedding, it gives the straight sides to the fragment. It is obviously not like the cleavage of slate, *a texture*, but it is a series of well-developed joints.

It is a vital element in the cleat problem that it is as well developed and as definite in direction in a flake of bright coal the $\frac{1}{100}$th of an inch in thickness as in a tree-trunk. While I was preparing this address I procured a slab of shale from the bed underlying the uppermost bed of the Millstone Grit. It bore numerous imprints of goniatites and a leaf of Cordaites, which, in its present condition of bright coal, varies in thickness from about $\frac{1}{50}$th down to $\frac{1}{150}$th of an inch in thickness. It is traversed by an even and regular cleat at intervals of about $\frac{1}{100}$th of an inch, disposed at an angle of about 35° to the length of the leaf. With great care it was possible to replace the slab in its original position and to determine the orientation of the cleat to be N.W.-S.E. This is not nearly the extreme of tenuity reached by well-cleated plant remains. I have specimens that are mere shiny films, and cannot, I should judge, exceed $\frac{1}{500}$th of an inch, yet they show well-defined and regular cleat. Further, it should be noted that the production of cleat was subsequent to the erosion of stream channels as well as to the production of phenomena on the margins of the wash-outs. Every pebble and flake of coal found in the displaced masses in these stream-casts has the cleat well developed, and in strict parallelism with the cleat of the adjacent undisturbed seam.

I have directed attention to the fact that cleat is quite independent of the joints traversing the shales and sandstones of the associated measures; whence I draw the inference that the cleat must have been produced prior to the jointing.

The reason for this early development of a joint system is easily found—the original peat, in passing into lignite, acquired a brittle consistency and a consequent disposition to joint. Indeed, the change of consistency is the effect of chemical change and loss, whereby the peat substance contracts. Hence when our Coal Measures were first laid down they would consist of a series of incoherent sands and muds, and this uncompacted condition may have persisted for a very long period, even surviving considerable tectonic disturbances. The peats, however, would be subject to changes entirely innate: the gradual loss of volatile constituents, or at least the resolution of the carbon compounds into new groupings and the conversion of the mother substance of the coal into lignite. In this condition the coal-substance would be brittle and liable to joint in response to the tensile strains set up by the contractility of the mass.

There are questions of very deep import concerned with the geographical direction of the cleat. The first reference to this interesting topic is, I believe, in a work, close upon a century old, by Edward Mammatt, entitled "Geological Facts to elucidate the Ashby-de-la-Zouch Coalfield," published in 1834. His fourth chapter, headed "On the polarity of the strata and the general law of their arrangement," contains these remarkable passages: "Polarity of the strata is a subject which hitherto has not been much considered. The extraordinary uniformity in the direction of the slynes and of the partings of the rocky strata seems to have been determined by the operation of some law not yet understood. . . . Wherever these slynes appear, their direction is 23° West of North by the compass, whatever way the stratum may incline. The coal between them has an arrangement of lines all parallel to the slynes, by which it may be divided. This is called the *end* of the coal."

In a paper in the *Geological Magazine* I commented on the fact that little had been written on the subject of cleat since Jukes's "Manual of Geology" (1862), in which he quotes a Nottinghamshire miner's remark that the slyne faced "two o'clock sun, like as it does all over the world, as ever I heered on," a generalisation to be remembered.

John Phillips corroborates the statement so far as concerns the coalfields of Northumberland and Durham, where he says it "runs most generally to the north-west (true)." The same direction, he says, prevails in Yorkshire and Derbyshire and also in Lancashire.

I have suggested a reason why coal should acquire a joint system anterior to, and independent of, that of the associated measures, but, while providing a jointing-force, that theory furnishes no explanation of the directional tendency of the cleat. This tendency must have been supplied by some directive strain —not necessarily of great intensity, but continuous in its operation.

In 1914 and since I have collected a great body of data regarding the direction of the cleat in coals and lignites in many parts of the world.

Cleat observations in the Northern Hemisphere show an overwhelming preponderance of a N.W.-S.E. direction in coals and lignites of all ages from Carboniferous to Pleistocene and from regions so remote as Alaska, Spitsbergen, the Oxus, Nigeria, and China. This direction persists through every variety of tectonic relations, but seems most regular in the largest and least disturbed fields.

Jukes's miner's astonishing statement that "the slyne faces two o'clock sun . . . all over the world" involves more than is at first glance apparent, for, as a friend has pointed out, that two o'clock sun must shine from a quite different compass-bearing in the Northern and Southern Hemispheres. Yet the data I have collected confirms generally the miner's declaration in the Southern Hemisphere as well as the North, though exceptions occur that may possess a deep significance.

Many of the southern coals have no definite cleat, but in such as do display a regular system there is a distinct predominance of the N.E.-S.W. direction, which has a curious inverse relationship with the N.W.-S.E. direction of the Northern Hemisphere.

I feel persuaded that the cause will be found in some relation to influences, tidal or other, dependent upon the earth's planetary rôle.

There is a negative aspect of the cleat question which brings it more clearly within the ambit of an inquiry into the physiography of the coal-swamps. I allude to the absence of cleat that characterises anthracite the world over. Upon this absence of cleat are attendant features that have been regarded as indicative of conditions prevailing during the formation of the coal, and hence clearly within my terms of reference.

In the Memoir of the Geological Survey on the Coals of South Wales, it is pointed out that the anthracite condition, instead of being accompanied by a high ash-content—which is what might be expected if the ash ratio were determined simply by the reduction in the non-ash—is shown statistically to bear the reverse relationship. That is, the more anthracitic the coal, the lower the ash. From this it is argued that the anthracites of South Wales were formed of plant-constituents different from those contributing to the steam and house coals. This proposition gains no support from the study of the plants found in the associated measures, nor does it explain why the coals of other fields, composed in their various parts of very diverse constituents, do not exhibit the anthracite phase. But the ash question needs to be approached from another point of view. The ash of coal may, as I have shown elsewhere, be composed of three entirely distinct and chemically different materials. There may be (1) the mineral substances belonging to the plant-tissues; then (2) any detrital mineral substances washed or blown into the area of growing peat; and, finally, the sparry minerals located in the lumen of the cleat.

As to the first, I have long considered that the coal was in large measure deprived by leaching of much of its mineral substances; it is otherwise difficult to account for the almost total absence of potash. The second—detrital matter—is probably present in some though not in all coals; the high percentage of aluminium silicate is probably of this origin. But the third constituent—the sparry matter—may, both on *a priori* grounds and upon direct evidence, be assigned a very important rôle in the production of the ashes in most coals. When a coal with a strongly developed cleat is examined in large masses it is at once seen that the cleat spaces are of quite sensible width, and that they are occupied most commonly by a white crystalline deposit which may consist of either carbonate of iron or carbonate of lime, and there are also in many seams crystals of iron sulphide—either pyrites or marcasite. These sparry veins may be as much as $\frac{1}{10}$th of an inch, or even more, in thickness, and they clearly constitute the principal contributors to the ash. It has been suggested that they are true components of the original peat, a proposition to which no botanist would assent, and it appears certain that the veins consist of material introduced by percolation from the overlying measures, subsequent to the production of the cleat. If that be so, it then will follow that the amount of the material present in coal must be in some direct proportion to the available cleat space, and if there is no cleat neither will there be any vein-stuff to contribute to the ash. It should be pointed out that ordinary bituminous coal broken into minute dice and washed so as to remove any heavy mineral particles is found to contain a percentage of ash quite comparable with that of an average anthracite. It is to be concluded, therefore, that the variations of the ash contents of a coal are no indication of the plant-constituent of the coal.

I have sought to show how the concept of the Coal Measures with their sandstones, shales, and coal-seams accords entirely with what we know of modern swamps and deltas, and that just as each Coal Measure fact finds its illustration in modern conditions, so we may, inverting the method of inquiry, say that no noteworthy features of the modern swamps fail to find their exemplification in the ancient.

Even what may seem the most daring of my propositions—the seismic origin of abnormal "wash-outs"—finds, I cannot doubt, a full justification in what has been *seen* in the Sylhet region by Mr. Oldham, and in the Mississippi valley by Mr. Fuller, or in what can be *inferred* as a necessary subterranean accompaniment of these surface signs of great earthquake convulsions.

## The Royal College of Science for Ireland.

THE scientific public cannot but feel grave concern that the Royal College of Science for Ireland is at present closed, and its students are scattered in temporary accommodation. All interested in applied science will realise that this is a serious state of affairs, both as regards Ireland's industrial prosperity and scientific progress.

The College was founded nearly sixty years ago. It came into existence in 1865 as the result of a Treasury Minute of that year, which converted an existing institution—the Museum of Irish Industry and Government School of Science applied to Mining and the Arts—into the Royal College of Science. Sir Robert Kane—well known as the author of "The Industrial Resources of Ireland"—was appointed its first Dean.

The College was at first housed in premises in St. Stephen's Green, and as early as 1869 it had earned considerable reputation for itself as a school of science. Thus, the Commission on Science and Art in Ireland, of which Huxley and Haughton were members, reported in that year, that—"In the Royal College of Science, Ireland possesses an institution which in the number of its professorships and general course of study is more complete as a pure school of science than anything of the kind existing in England or Scotland."

In its earlier years the College was under the administration of the Department of Science and Art; but in 1900 it was placed under the control of the newly created Department of Agriculture and Technical Instruction, a department which was largely the outcome of what was known as the Recess Committee, of which Sir Horace Plunkett was chairman and Mr. T. P. Gill secretary.

Under the enlightened administration of this Department, the College was greatly developed and extended, particularly in rendering it of more direct service to the industries and needs of the country. In the early days of the College, chief attention was devoted to such subjects as chemistry, physics, mathematics, geology, mining, engineering, and manufactures. Under the Department, however, not only were these activities extended, but also considerable developments were made in connexion with agriculture, which is the staple industry of the country.

With the expansion of the teaching of applied science on so wide a scale, the accommodation in the existing buildings rapidly became wholly inadequate. Accordingly, the provision of new quarters became imperative, and under Act of Parliament in 1903 a government grant was made for this purpose. The magnificent new buildings on the present site in Upper Merrion Street were thus made possible, and the foundation stone was laid by King Edward VII. in 1904. The buildings were opened by King George V. in July 1911, and in October of that year the College began work in its new laboratories.

The buildings (Fig. 1), which were designed by Sir Aston Webb, occupy three sides of a quadrangle, and the numerous laboratories and lecture-rooms are laid out in a manner leaving nothing to be desired. Neither care nor expense has been spared in making the buildings and equipment perfectly suited for the work of the College. Many years have been spent in their completion, and they are among the best in the British Isles at the present time. The laboratories are replete with the most modern appliances and accessories, and the machines and apparatus installed have been chosen for their excellence from the world's markets.

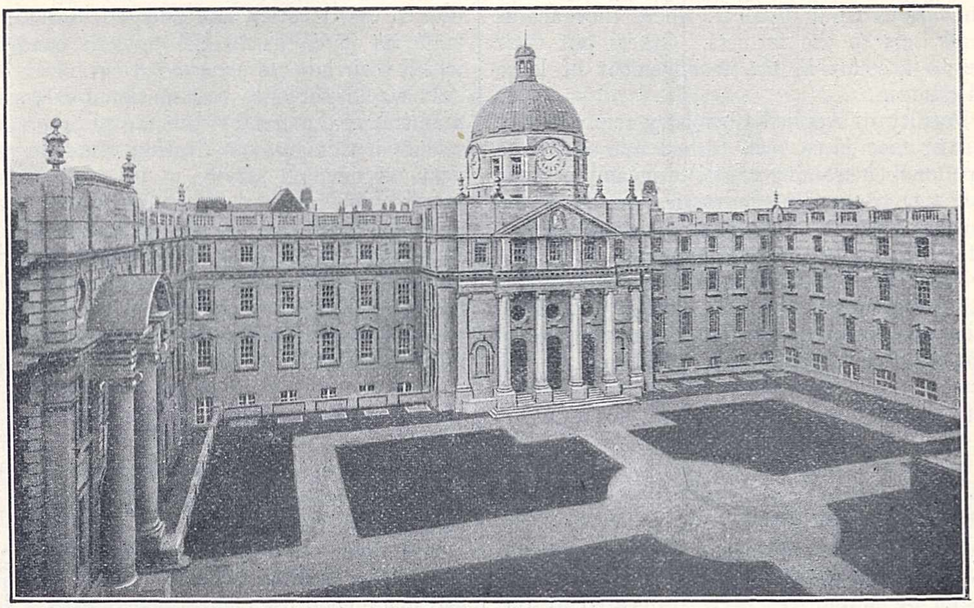

FIG. 1.—Royal College of Science for Ireland.

In short, the College possesses the great advantage that its buildings and equipment in every detail are up-to-date, and both have been thoroughly laid out with the definite object of providing the means necessary for dealing efficiently with the courses of education undertaken. The College buildings also provide laboratory accommodation for the important work of the Plant Diseases and Seed Testing Division, and the Agricultural Analytical Station of the Department of Agriculture.

For some time it had become apparent that the three-year course, which until 1911 had been required of the students taking the associateship, was inadequate to deal satisfactorily with a gradually extending curriculum. Accordingly, shortly after the removal of the College to its new home, all the principal courses were extended to four years, an alteration which has been amply justified in the light of the results which have been attained. Broadly speaking, the curriculum is now arranged so that the first two years are devoted to work mainly of a mathematical and purely scientific character, while towards the end of the second year, and during the third and fourth years, attention is devoted largely to the applications of science, and to the professional aspects of the several subjects of study.

The courses in all cases involve very considerable use of laboratories and workshops, and close co-ordination between tuition in theory and laboratory work has been worked out carefully.

The work of the College is organised in three faculties—those of agriculture, applied chemistry, and engineering. In addition, there are four-year courses of study, in experimental science and in natural science, leading to industrial careers. The College also provides courses in science subjects for students who intend to become teachers in the technical and secondary schools of the country, and it is thus the keystone of the Department's scheme of technical and scientific education throughout Ireland.

Students who have successfully passed through one of the full courses of study are awarded the associateship of the College. Associates of at least three years' standing may proceed to the fellowship of the College, which is awarded for meritorious original scientific research or for contributing otherwise in a marked degree to the advancement of science.

There are professorships in agriculture, botany, chemistry, engineering, forestry, geology, mathematics, physics, and zoology; and lecturerships in agricultural botany, agricultural chemistry, bacteriology, organic chemistry, physical and metallurgical chemistry, engineering, horticulture, mathematics, and physics. Among the past professors are many well-known names, such as — Sir Robert Ball, Sir William Barrett, Sir

William Thiselton Dyer, Dr. A. C. Haddon, Sir Walter Hartley, E. Hull, Dr. G. T. Morgan, T. F. Pigott, and Sir Wyville J. Thomson.

Following upon the establishment of the College in its new buildings, there has been a steady and progressive increase in the number of its students, and its several courses of study are becoming appreciated more and more fully throughout the whole of Ireland. Moreover, the past students have been winning success in the several fields of industry and education for which their courses have fitted them.

In the Faculty of Agriculture the scientific courses given at the College have been the basis of considerable improvement in agricultural practice in the country, for in the majority of cases the young Irishmen who have attended these courses at the College have found their way into the service of the Department of Agriculture as Agricultural Instructors, located in various rural districts, where they act as scientific advisers to the farmers. Others put their knowledge to account in the management of large farms and estates.

In the Faculty of Applied Chemistry many highly trained young men have been turned out and have found scope for their training as assistants and research workers in many chemical industries, such as the manufacture of dyes, explosives, and synthetic drugs.

In the Faculty of Engineering the increase in the number of students following upon the development of the new laboratories has been specially marked, and already the demands for admission are taxing the accommodation to its utmost. The majority of these students find employment with the large engineering concerns in the British Isles; and prior to the present condition of depression, there was a regular demand each year for capable students from some of the leading establishments. The output of the engineering and chemistry departments of the College should be of great and essential service to Ireland, if a policy of industrial reconstruction is undertaken.

The equipment of the College is excellently suited for active research in many directions. Indeed, already after a few years' occupation of the new premises, upwards of one hundred researches were in hand or had been carried out, many of them being on subjects of direct benefit to the industries of Ireland. While research thus holds a high place in its activities, the College is, nevertheless, specially noted for the thorough attention that is devoted to the effective teaching of its students. Its success is due to the devotion and energetic service of its able staff, as much as to the modern conditions under which their labours are carried out.

It would not only be a national calamity but also a matter of the greatest concern to progress in applied science if this great institution, that has taken many years of devoted service of its staff to bring to its present high standard of excellence, should be rendered unavailable for the young men and women of Ireland. It is, therefore, greatly to be hoped that the present difficulty will be but a passing cloud, and that the College will soon be permitted to reopen its doors, and will find its true place in the industrial development of Ireland.

## Obituary.

### Sir Isaac Bayley Balfour, K.B.E., F.R.S.

ISAAC BAYLEY BALFOUR, son of the late Dr. John Hutton Balfour, professor of botany in the University of Edinburgh from 1845 to 1879, was born in Edinburgh on March 31, 1853. Educated at the Edinburgh Academy, then as now one of the foremost of British public schools, young Balfour proceeded to the University, in which he graduated as D.Sc. in the department (not yet a faculty) of physical and natural science. He also matriculated in the faculty of medicine, and while still an undergraduate in that faculty was so fortunate as to be attached to the party which in 1874 visited the island of Rodriguez to observe the transit of Venus.

Resuming his medical studies, Balfour graduated as M.B. with honours in 1877, and thereafter continued his botanical studies in the Universities of Strasbourg and Würzburg. In 1879 he was appointed professor of botany in the University of Glasgow, and in 1880 undertook botanical survey operations in the island of Socotra. In 1883 he obtained the degree of M.D., being awarded a University gold medal for his thesis, and in 1884 he was elected Sherardian professor of botany at Oxford and given charge of the Oxford Botanic Garden, becoming at the same time a fellow of Magdalen. In 1888 he was elected professor of botany in the University of Edinburgh, in succession to the late Dr. Alexander Dickson, and was appointed King's Botanist for Scotland and Regius Keeper of the Royal Botanic Garden. From these posts Balfour retired in March last after having held them, as his father did, for a period of thirty-four years.

If Balfour, as regards youthful environment, was fortunately situated, he showed at an early age that he had made good use of his opportunities. In 1874 Dr. J. D. Hooker, then director of Kew, considered one of Balfour's letters from Rodriguez sufficiently interesting for communication to the Linnean Society. Among the results of this journey we owe to Balfour a finished study of the genus Halophila and an important contribution to the natural history of the difficult genus Pandanus. The elaboration of the material secured during his visit to Socotra involved sustained study for nearly eight years; the result was a work that has already become a floristic classic. But Balfour's systematic interest was equalled by that taken in economic questions, and his Socotran studies enabled him to determine the sources of more than one famous drug of which the geographical provenance was assured though the botanical origin was uncertain. From the outset of his career he realised the importance of historical study in the field of applied botany.

Short though Balfour's tenure of the Sherardian chair was, the success with which he discharged its duties led to results of permanent advantage to Oxford and to botany. Under his care the historic "Physick Garden" regained its old consequence. The part he played in the provision of an English version of De Bary's Fungi, Mycetozoa, and Bacteria earned for him the thanks of English and American students, who owe him besides a debt for his share in the foundation of the *Annals of Botany*; from the outset he served as one of the editors of this successful and important journal.

It was, however, the work accomplished by him as a teacher for a generation at Edinburgh that led Balfour to be regarded, with justice, as one of the foremost of British botanists. His personal charm enabled him to arrest the attention of his students; the lucidity of his discourse ensured the maintenance of that attention. But the reality of his success depended neither upon these natural accidents nor upon the variety and the precision of the knowledge which informed his teaching. It is to be accounted for rather by the wide sympathy which enabled him, as one who was at once an erudite natural historian and an accomplished experimental biologist, to combine all that was valuable in the older training to which he had been subjected in this country and in the newer methods which he had mastered abroad. To a still greater degree, perhaps, he owed his success to that sane outlook which enabled him to induce those he taught to regard botanical investigation and research, in the field, the cabinet, and the laboratory alike, as means to an end rather than as ends in themselves.

Balfour's work as Regius Keeper and as King's Botanist was actuated by the same philosophy. His study of the natural history of the plants under his care, while complying with the highest standard set in ecological and in systematic work, was undertaken with the object of mastering their cultural requirements. The success of his results in the technical field was largely due to the thoroughness of his scientific study.

The long-sustained and critical investigation of the members of the two great genera, Primula and Rhododendron, to which of late years Balfour devoted much of his scanty leisure, has given his name a permanent place in the annals of systematic study. The complexity of the problems he has had to face might almost justify a suspicion that in Balfour's case the difficulty of a subject was an added incentive to its study. However this may be, the fact remains that these arduous labours, though incidentally of extreme taxonomic value, have had as their primary purpose the rendering of assistance to horticulture in dealing with the accessions of new plant-forms during the past two decades from south-western China and the north-eastern Himalaya. It is because the object of his studies was the provision of technical help to the gardener, and not in spite of that fact, that the results attained are of such benefit to students of plant-distribution and plant-association.

Among the extra-official duties undertaken by Balfour were included willing services rendered to the Edinburgh Botanical Society, the Royal Society of Edinburgh, and the Royal Horticultural Society. Elected to the Linnean Society in 1875, he served on the Council during 1884–85; elected to the Royal Society in 1884, he served on the Council during 1892–94. In 1894 he was president of the biology section of the British Association at the Oxford meeting, and in 1901 was president of the botany section at the Glasgow meeting. An invitation to serve as president of the Linnean Society, in succession to Prof. Poulton, in 1916 was declined, and the intimation that his health was such as to preclude acceptance was one of the earliest to cause his friends disquietude.

In 1920 Balfour was created a K.B.E. in recognition of the great public services rendered by him during the war, his devotion to which had undermined his constitution. Among other honours bestowed on Balfour were the Victoria Medal of Honour of the Royal Horticultural Society, received in 1897, and the Linnean Medal—the highest honour the Linnean Society could offer—received in 1919. The wish then expressed by the latter society that Balfour "might long be spared to continue the work that has served its members as an example and an encouragement" has unfortunately not been fulfilled. By his death, which took place at Court Hill, Haslemere, on November 30 last, botanical science has lost a brilliant votary; his friends have lost one whose soundness of judgment was only equalled by his ready kindness and unfailing courtesy.

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### SIR NORMAN MOORE, BT., M.D.

THE medical profession is poorer by the death of Sir Norman Moore on November 30. Born in Manchester seventy-five years ago, he rose without influence and solely by his own exertions to be president of the Royal College of Physicians. He also earned a well-deserved reputation as an historian of British medicine. After a preliminary education at Owens College, he matriculated in the University of Cambridge from St. Catherine's College, whence in due course he graduated in arts and medicine, being afterwards elected an honorary fellow. He entered St. Bartholomew's Hospital in 1879 and remained in close association with it during the whole of the rest of his life. He served first as lecturer on comparative anatomy, later as demonstrator of morbid anatomy, and in due season as lecturer on medicine in the medical school, while in the hospital he filled in succession all the offices from house physician to consulting physician. He also acted for many years as dean of the school and warden of the college, living within the precincts of the hospital, and serving so zealously that for many years the annual entry of students exceeded that of any of the other hospitals in London.

During his years of residence in St. Bartholomew's Hospital, Moore laid the foundations of his renown as an historian of medicine. He wrote as many as 454 articles, dealing chiefly with the lives of medical men, for the "Dictionary of National Biography." He was instrumental in obtaining for the Royal College of Physicians the endowment of the FitzPatrick lectures, and himself gave two courses of the lectures, one on "John Mirfield and Medical Study in London during the Middle Ages," the other on "The History of the Study of Clinical Medicine in the British Isles." His knowledge of the subject and his work in connexion with it made him a worthy successor to Sir William Osler as president of the history section at the Royal Society of Medicine. More than thirty years of such time as he could spare from his other duties were devoted to the preparation of a history of St. Bartholomew's Hospital. The work was delayed by the war, but it appeared in two well-illustrated quarto volumes in 1918, and immediately became a classic.

The age and traditions of the Royal College of

Physicians appealed to Moore in the same way as did those of St. Bartholomew's Hospital. He filled all the usual posts with unfailing punctuality, was Harveian Librarian, and served in the office of president from 1918 to 1921. He was also the representative of the College at the General Medical Council. He had an intimate knowledge of the needs of medical education, and he took a leading part in that recasting of the medical curriculum which began in 1886 and is still in progress.

Moore's love of books and his knowledge of their contents were utilised by the Royal Medical and Chirurgical Society, where he filled the post of honorary librarian for many years. When the society was merged in the present Royal Society of Medicine, Moore, in conjunction with Mr. Stephen Paget, wrote the chronicles of the society from 1805 to 1905, with some account of the presidents.

In 1919 Moore was created a baronet. He was twice married, and is succeeded by his surviving son, Alan Hilary.

## Current Topics and Events.

WHILE the rest of the world has been getting used to filling up the forms required by Customs authorities, and to awaiting with patience the delays involved in the examination by Customs laboratories of imported products that may prove to be dutiable, Great Britain has forgotten the very existence of such things, and their reintroduction, as a consequence of the Safeguarding of Industries Act, is regarded as little less than a revolutionary innovation by importers and their spokesmen in the House of Commons. It is clear from the debate which took place on Sir John Simon's amendment to the motion for an address in reply to the King's Speech, regretting the absence of any reference to the repeal of this Act, that opposition to the Act arises largely from its administration. Almost every speaker admitted the necessity of legislation to prevent the recurrence of the famine in magnetos, drugs, optical glass, dyes, and other essential commodities, which occurred in this country on the outbreak of war, but those who wished the Act repealed failed to mention a scheme by which this end could be achieved, probably because any attempt to do so would split up the apparently solid phalanx of opposition. To those who have the national welfare in mind, the troubles of Sir John Simon's trader, who had a consignment of potassium permanganate held up for two months by the Customs, will make slight appeal, and they would cheerfully see a few traders, who have no direct interest in industry and merely buy and sell, sacrificed, if by that means they could ensure the establishment in this country of highly technical industries in which skilled craftsmen and technical experts could be employed and the safety of the country in war and in peace assured. The difficulties which the operation of the Act places in the way of the importation of chemicals and instruments required by research workers, naturally evoke more sympathy than those of traders; and it is satisfactory that the Government was able to promise a joint inquiry by the Department of Scientific and Industrial Research and the Board of Trade into the progress actually made in the industries with which the Act is concerned. In the course of that inquiry these difficulties will no doubt be fully explored and means of dealing with them evolved.

THE needs of men of science in Russia have been referred to on several occasions in our columns, and we have suggested that the different groups of scientific and technical societies should concern themselves with groups of workers in their own departments. This has, we believe, been done in connexion with the Committee for the Relief of Russian Intellectuals, the president of which is Sir Paul Vinogradoff. There is an Engineers' Section Sub-Committee, with Sir Robert Hadfield as president, and this sub-committee has just made an appeal on behalf of Russian engineers and their families, who, not alone in the famine areas but throughout Russia, are undergoing terrible suffering and distress. If British engineers will help, many lives can be saved and the human energy and knowledge necessary for the reconstruction of Russia can be retained. Assistance is required for the provision of food and clothing. Food parcels may be sent to particular individuals, or names and addresses can be supplied to donors who prefer to send parcels direct. Remittances should be sent to the honorary treasurer, Mr. R. C. Griffith, 8 Victoria Avenue, Bishopsgate, London, E.C.2, who will be glad to give any particulars desired.

A SCIENTIFIC novelties exhibition will be held at King's College, Strand, W.C. (by kind permission of the College delegacy), from December 28 to January 10, in support of the Hospitals of London Combined Appeal. Members of the scientific staffs of the various colleges and schools of the University of London, as well as of university institutions having recognised teachers, are assisting with exhibits or demonstrations, and short lectures with experimental or lantern illustrations will be given by Profs. Bairstow, Sir William Bragg, Cheshire, Winifred Cullis, Flinders Petrie, Garwood, Gordon, Macgregor-Morris, Watts, Wilson, and many others. The exhibition will not be merely a display of objects of interest, but of the character of a conversazione, in which experiments and demonstrations will be going on continuously. It will thus be attractive to both old and young, and we hope it will bring a substantial sum into the fund for which it is being organised.

THE issue of *La Nature* for November 18 contains a summary of the recent International Congress on Combustible Liquids held in Paris under the auspices of the French Society of Chemical Industry. Prior to the opening of the congress, an exhibition was organised in which practically every phase of the petroleum and allied industries received attention. The several stages in the production and refining of crude oil were amply illustrated by an excellent series of exhibits, including not only the various products manufactured, but also the plant and machinery employed both in the field and in the refinery. A special feature was the exhibition of different types of internal combustion engines in actual operation, burning those grades of fuel most suited to particular designs. The congress was opened by Prof. Sabatier, and the business transacted was of a most comprehensive nature, the industry being considered in both its theoretical and practical aspects. Undoubtedly the most important question raised at this congress was that of the necessity of adopting a uniform terminology to cover the enormous variety of combustible liquids now being marketed. At the present time the utmost confusion reigns in many cases where a name for a given product in one country implies a totally different product in another. Further, the varied methods adopted of testing these products for definite commercial purposes are often productive of results which, while suitable for one country, are quite ineffective for another. In order, therefore, to standardise both methods of comparison and the nomenclature universally applicable to definite products for specific purposes, an international commission has been set up, composed of delegates of the several countries represented at the congress. The importance of this work cannot be overestimated, particularly from the point of view of European markets, though it is to be hoped that representatives of the American petroleum industry will take a prominent part in the framing of the ultimate standards adopted.

DR. J. WALTER FEWKES, chief of the Bureau of American Ethnology, Smithsonian Institution, has recently returned to Washington from the season's archæological field-work on the Mesa Verde National Park, Colorado, and reports the unexpected find of an interesting prehistoric ruin to which he has given the name, "Pipe Shrine House." A mound of some magnitude in the neighbourhood of a reservoir called Mummy Lake was investigated, and a rectangular building about 70 feet square and one story high, which is accurately oriented to the cardinal points, and has a circular tower formerly 15 to 20 feet high, like a church steeple, midway in the western wall, was discovered. The tower was probably used for observing the sun as it rises in the east or sets in the west, in order to determine the time for planting and other events. In the middle of the building was found a circular room twenty feet deep and about the same in diameter in which were more than a dozen clay tobacco pipes, numerous stone knives, pottery, idols, and other objects. Pipes of this kind have never before been found on the Mesa Verde National Park; apparently after the rite of smoking they were thrown into the shrine. South of the building, which was evidently specialised for ceremonials, is a square room or shrine dedicated to the mountain lion, a stone image of which was found surrounded by water-worn and other strangely formed stones. A similar shrine in the north-east corner of Pipe Shrine House contains a small iron meteorite and a slab of stone on which is depicted the symbol of the sun.

THE juvenile lectures at the Royal Institution this Christmas will be delivered by Prof. H. H. Turner, whose subject is "Six Steps up the Ladder to the Stars." The first lecture will be given on Thursday, December 28, on "The Distance of the Stars," followed by "The Discovery of the Planet Neptune," "Photographing the Stars," "The Spectroscope and its Revelations," "Two Great Streams of Stars," and "The Size of a Star." The following are the lecture arrangements before Easter: On Tuesday afternoons, commencing January 16, there will be two lectures by Prof. F. G. Donnan on "Semi-Permeable Membranes and Colloid Chemistry," two by Mr. R. D. Oldham on "Earthquakes," two by Prof. A. C. Pearson on "Greek Civilisation and To-day," two by Sir Arthur Shipley on "Life and its Rhythms," and two by Prof. C. G. Seligman on "Rainmakers and Divine Kings of the Nile Valley." On Thursday afternoons, the Hon. J. W. Fortescue will give two historical lectures beginning on January 18, Prof. I. M. Heilbron two on "The Photosynthesis of Plant Products," Prof. B. Melvill Jones two on "Recent Experiments in Aerial Surveying," and Mr. Theodore Stevens two on "Water Power of the Empire." On Saturday afternoons commencing January 20, there will be two lectures by Sir Walford Davies on "Speech Rhythm in Vocal Music," two by Mr. J. C. Squire on "Subject in Poetry," and six by Sir Ernest Rutherford on "Atomic Projectiles and their Properties." The first Friday evening discourse will be delivered by Sir James Dewar on January 19 on "Soap Films as Detectors of Stream Lines, Vortex Motion and Sound." Succeeding discourses will probably be given by Sir Almroth Wright, Mr. C. F. Cross, Sir John Russell, Dr. A. V. Hill, Prof. A. S. Eddington, Dr. G. C. Simpson, Dr. M. R. James, and Sir Ernest Rutherford.

THE Journal of the Textile Institute has now nearly completed its first year under the new arrangement by which its pages are separately arranged and numbered under the three headings of Proceedings, Transactions, and Abstracts. The new form of the Journal should appeal to a wide scientific public, and the attention of biologists interested in the raw materials of plant or animal fibre may be directed to the very wide field covered by the abstractors and to the scientific character of the papers appearing in the Transactions. The Journal is now the medium through which a considerable amount of the scientific work carried on by the research associations of the woollen and worsted, the cotton and the linen industries, first sees the light. These newly formed research associations have naturally been busy surveying their wide fields for future effort, and the result has been that a number of very useful general summaries of the state of our knowledge of the chemistry, physics, and botany of the cotton hair have been published in the Journal by members of the staff of the British Cotton Industry Research Association. Preliminary results of new investigations upon the plant fibre also begin to appear, as, for example, the two papers by C. R. Nodder upon plant fibres, dealing mainly with flax and hemp.

ACCORDING to the last monthly circular of the British Cast Iron Research Association, the new director of research, Dr. P. Longmuir, is now formulating a scheme for the active prosecution of research work in several directions. Among the subjects now in hand are: iron suitable for moulds for glass bottles, these moulds being at present largely imported from abroad; and the magnetic properties of cast iron. The high silicon irons now found so useful in chemical industry on account of their high resistance to mineral acids are also to be investigated. Together with the American Testing Society, the question of the standardisation of cast-iron test bars is being examined, and it is hoped that an international specification can be devised. The Association is strengthening its library and reference facilities, and should appeal to a wider circle of ironfounders than its present rather limited membership, in view of the importance of cast iron to the national industries.

IN the Proceedings of the Royal Society of Edinburgh (June 1922) the general secretary—the late Dr. C. G. Knott—gives some interesting notes of a correspondence between the Royal Society of Edinburgh and the French Academy of Sciences about the priority of the discovery of the pilot cable (*câble guide*) for guiding ships into harbour in foggy weather. In 1921 the French Academy awarded a medal and a prize to W. A. Loth for various devices in connexion with navigation, and among these was the *câble guide*. The principle of this device, the Edinburgh Society states, is essentially that of the pilot cable invented by C. A. Stevenson and described by him in the Journal of the Society in 1893. Mr. Stevenson's invention consists in laying a wire or wires along the bed of the sea or of a river. Intermittent currents are sent along these wires, and suitable devices can be used on board ship to detect their proximity, and thus receive a warning of dangerous coasts, shoals, and so on. Stevenson's patent proves that the rough general principle was known so early as 1891, but this does not detract from the credit due to Loth for perfecting the system. The principle of the method is identical with that used by electricians in London prior to 1890 for locating the position of an underground cable.

A CHADWICK public lecture on "Relative Values in Public Health" was delivered by Sir Arthur Newsholme, on December 7. In the course of his lecture, which is one of a course, Sir Arthur Newsholme, after deprecating the undiscriminating call for retrenchment in public health expenditure, stated that it is necessary to adopt every practicable measure for educating the public, and the first step is to educate people as to the causes of evils. Historically, panic —fear of cholera and "fever"—had facilitated sanitation. In Sir Arthur's opinion, the appointment of paid inspectorates, thus introducing a new element into the implements of government, is necessary. Inspection has increased, extending from things and conditions of work and housing of persons, until we have now in view the ideal of hygiene advice and warning available for every member of the community. The inspections have educational value even more than in securing reform. Surveys are extended and systematised inspections, and are of value in arousing the community conscience and in securing the driving power needed for reform.

SIR WILLIAM H. BRAGG, Quain professor of physics in the University of London, has been elected a corresponding member of the Paris Academy of Sciences in the section of physics.

THE library of the Chemical Society will be closed for the Christmas Holidays at 1 P.M. on Friday, December 22, and will reopen at 10 A.M. on Thursday, December 28.

THE Indian Botanical Society took over ownership and control of the *Journal of Indian Botany* in October (1922). Prof. P. F. Fyson, who started the *Journal* in 1919 as a private enterprise, will continue as editor.

PROF. H. N. RUSSELL, of Princeton University, was presented with the Draper gold medal of the National Academy of Sciences of the United States of America at a dinner held in connexion with the New York meeting of the academy on November 15.

AT the meeting of the Royal Geographical Society on December 11, at the Æolian Hall, the French Ambassador, on behalf of the Société de Géographie of Paris, presented a gold medal to Prof. J. W. Gregory for his geographical work in East Africa. Prof. Gregory afterwards read a paper, the substance of which will be found on p. 826, on the results of his recent journey in the mountains of Chinese Tibet.

THE Swiney lectures on geology, in connexion with the British Museum (Natural History), are being delivered at 5.30 P.M. on Tuesdays, Thursdays, and Fridays, at the Royal College of Science, South Kensington, by Prof. T. J. Jehu, who has chosen as his subject "Fossils and what they Teach." Admission to the lectures, twelve in number, is free.

A STATUE of Prof. Adolf von Baeyer, presented by the Interessengemeinschaft der Farbenfabriken, was unveiled in the Botanic Garden of the University of Munich on October 20. Prof. Willstätter spoke on behalf of the University, and Dr. Duisberg on behalf of the Interessengemeinschaft, Prof. Seeliger for the Bavarian Academy of Sciences, and Dr. Lepsius for the German Chemical Society.

A COMMITTEE "to inquire and to report as to the method of charging for gas on a thermal basis" has been appointed by the Board of Trade. The members of the committee are as follows: Sir Clarendon Golding Hyde (*Chairman*), Mr. Arthur Balfour, Sir James Martin, Mr. A. A. Pugh, and Mr. W. J. U. Woolcock. Mr. W. H. L. Patterson, of the Board of Trade, will act as secretary to the committee.

IN a communication to the *Revue Scientifique* of October 28, Profs. Béhal, Haller, and Moureu urge the necessity of establishing some kind of protective measure to prevent German chemicals entering France. They point out that such measures have been established in the United States, England, Italy, and Japan, and they believe that prompt action of a similar kind is necessary if French chemical factories are to remain in operation and French chemists in employment.

THE Bibliographic Institute for Auxiliary Scientific Work (1a Longridge Road, London, S.W. 5), established in 1917, affords assistance in the work of scientific research by supplying bibliographies upon subjects of any kind. The cost of such bibliographies depends entirely upon the range of work comprised in the special subject stated. Further information can be obtained from the English representative of the Institute at the above address.

A MEMORIAL window in Westminster Abbey in remembrance of Sir J. W. Wolfe Barry, past president of the Institution of Civil Engineers, was dedicated on December 7 by the Dean of Westminster. The window, which is in the nave, contains the figures of two angels holding tablets on which are inscribed the words "In Memory of John Wolfe Barry, K.C.B., F.R.S., Civil Engineer. Born 1836. Died 1918." Below the tablets are shields showing, among others, the arms of the Institution of Civil Engineers, of the University of London, and Sir John Wolfe Barry's personal arms.

THE annual meeting of the Mathematical Association will be held on Monday, January 1, and Tuesday, January 2, at the London Day Training College, Southampton Row. At the Monday meeting, which is to be at 5.30, Dr. S. Brodetsky will read a paper on "Gliding." On Tuesday there will be two sessions, one at 10 and the other at 2.30. At the first, a statement respecting the forthcoming report of the Sub-committee on the Teaching of Geometry will be made by Prof. E. H. Neville, and the following communications will be read: "The Uses of Non-Euclidean Geometry to Teachers," W. C. Fletcher; "Simple Geometrical and Kinematical Illustrations of the Plane Complex," Prof. R. W. Genese; and "A Certain Dissection Problem," J. Brill. At the afternoon meeting Sir Thomas L. Heath will deliver his presidential address, taking as his subject "Greek Geometry, with Special Reference to Infinitesimals"; and Prof. A. Lodge will read a paper on "Differentials as the Basis for Teaching the Calculus."

A USEFUL Catalogue (New Series, No. 5) of second-hand books on sale by Messrs. Wheldon and Wesley, Ltd., 2 Arthur Street, W.C.2, has just been issued. It contains upwards of 1200 titles of works dealing with geology, mineralogy, mining, coal gas, water, building materials, metal manufactures, etc.

MESSRS. DULAU AND CO., LTD., 34 Margaret Street, W.1, have just circulated a short, but choice, catalogue (No. 98) of Early Botanical Books. It is arranged under the headings "Herbals and Materia Medica," and "Early Agriculture and Gardening: Flora, Fungi, Orchids, Serial Publications, etc." Among the 356 works listed many are scarce.

THE Institute of Metals, 36 Victoria Street, London, S.W.1, has issued a name and subject index of the Journal of Institute (vols. i.-xxv.). The volume contains more than 20,000 entries and covers metallurgical work done during the period 1909–21. Copies can be obtained through booksellers or direct from the Institute of Metals.

## Our Astronomical Column.

THE REPORTED NOVA IN LYRA.—In this column last week reference was made to the announcement of the appearance of a new star near the constellation of Lyra. The weather conditions for observing the object were not favourable, in this country at least, until the night of December 6, when observations were made at Greenwich, the Norman Lockyer Observatory in Devon, and at Armagh. All the observers reported that no bright star existed in the region of the supposed nova; in fact, photographs of the spectra of stars in that region down to the sixth magnitude, taken at the Norman Lockyer Observatory, did not reveal the presence of any star giving the characteristic spectrum of a new star. That a star of the first magnitude should dim so quickly in such a short period of time would be quite unique in the records of novæ, so it must be assumed that the observer was mistaken or the announcement incorrect.

Dr. A. C. D. Crommelin writes: "Widespread cloud prevented the announcement of the discovery of a Nova in Lyra from being tested at once, and it was thought advisable to circulate it with a caution, so that advantage might be taken of any clear intervals to search for it. December 6 was fairly clear at Greenwich, and it was quickly found that there was no strange orb visible to the naked eye in the neighbourhood of the given spot. Telescopic comparison was made with the B.D. chart for an area of 4 square degrees round the position without success. This search was conclusive, at least down to magnitude 7. Dr. Lockyer, Mr. Ellison (Armagh), Prof. Strömgren, and Dr. W. H. Steavenson also searched without success. The *Daily Mail* cabled to Bucharest and learnt that the Astronomical Society there knew nothing of the discovery. There is therefore practically no doubt that the announcement was the result of some mistake, the exact nature of which it is useless to conjecture."

LARGE FIREBALLS.—Mr. W. F. Denning writes:—"A large fireball appeared on November 24 at 6.40 P.M. which was seen from London, Manchester, and other places. It caused considerable flare in the sky for several seconds, and threw off a train of sparks at the later period of its flight. Comparing the various observations the radiant point is indicated at 87° +34° and the meteor fell from a height of 71 to 26 miles. Its length of path was about 124 miles, and velocity 25 miles per second. It passed over the earth from the region about 12 miles west of Grimsby to Shrewsbury. The radiant point near Theta Aurigae is a fairly well-known centre of a minor shower observed during the last half of November."

Another great fireball appeared at about midnight on December 6 and caused a surprising illumination in the region of north Lincolnshire. A noise like thunder was heard two minutes after the disappearance of the meteor. The flight of the meteor was from east to west, but details of an exact nature are lacking.

## Research Items.

WATER-SUPPLY IN CENTRAL AUSTRALIA.—Recent investigations in the heart of Australia have given it a more promising aspect than it had of old. In *Discovery* for December, Mr. O. H. T. Rishbeth, in discussing the economic possibilities of Central Australia, points out that a considerable area, about 150,000 sq. miles, has an average elevation of some 2000 ft. and rises to 5000 ft. in the Macdonnell and Musgrove ranges. But even in this more elevated part of the far interior the rainfall seems to be less than 10 in. a year and very uncertain in its occurrence. The future of Central Australia depends on the possibility of securing a satisfactory water-supply. A great deal could be done by the conservation of surface waters by means of dams, etc., but subterranean water must be the chief source. Many quite shallow wells seem to run freely with good water, but these can scarcely be looked on as inexhaustible. Artesian wells are promising and the water, though highly mineralised, is valuable for pastoral purposes. When the water-supply is assured and railway communications established, Mr. Rishbeth thinks this region has a future as a pastoral area. The carrying capacity and suitability of different parts for various animals must be tested; rabbits and dingoes must be systematically attacked, and stock routes with permanent wells opened up. Gold, mica, and wolfram are also known to occur, but difficulties of transport as well as lack of water have delayed mining.

WATER IN THE KENT COALFIELD.—The Kent coalfield was revealed by a borehole near Dover in 1890; since then no fewer than forty boreholes, comprising upwards of 90,000 feet of boring, have extended our knowledge of its area and depth. At present the Coal Measures have been penetrated by shafts at only four points; at no place have they been proved at a less depth than 800 feet below ordnance datum, yet the only important natural difficulty in their exploitation is the presence of large quantities of water in the overlying rocks. In a paper recently submitted to the Institution of Civil Engineers on "Underground Waters in the Kent Coalfield and their Incidence in Mining Development," Mr. E. O. Forster Brown has brought together many interesting facts concerning the quantity, quality, and local pressure of the water met with at different horizons, and has made suggestions, based on the results of his observations, which should prove of value in the development of mining and underground water supply in Kent. In descending order the water-bearing strata overlying the Coal Measures are, the Eocene, Chalk, Lower Greensand, Hastings beds, and estuarine sands of the Great or Inferior Oolite. During the last nine or ten years, 2 to 2½ million gallons of water per day have been pumped from Tilmanstone and Snowdown pits from the water-bearing beds below the Chalk. This water is allowed to run off at the surface. The author points out that the main faulting and fissuring follow the direction of the major tectonic folds, and that the water in the Oolite sands is divided into independent blocks by post-Jurassic faulting; he indicates the importance of a knowledge of this faulting in mining development. The water in the Oolite sands and in the Carboniferous Limestone below the Coal Measures probably comes from the French side of the Channel where these rocks are exposed in the Boulonnais.

ANTS IN RELATION TO PLANTS.—Myrmecophytism is dominated by the feeding habits of ants and their offspring. Until these are fully understood, it is scarcely possible to grasp the true ecological significance, and the origin of the extreme cases of apparent or true symbiosis, between certain ants and certain species of plants. In a recent and very readable publication ("Ants in their Diverse Relations to the Plant World," Bull. Amer. Mus. Nat. Hist. xlv., 1922, pp. 333-583: extracted from "Ants of the American Congo Expedition," pt. 4), J. Bequaert has brought together the varied and disconnected links of existing knowledge, and a perusal of this work only emphasises how necessary the close co-operation of entomologists and botanists is for the proper interpretation of many of the problems. The dispersal of seeds by ants is evidently an important factor in plant distribution. In Europe a great many grasses and herbaceous plants rely almost exclusively, or at least to a large extent, on certain species of ants for the successful dissemination of their seed. The cultivation of fungi by ants is one of the curiosities of biology, but we know that when the female of *Atta sexdens* starts a new colony, she carries in her infrabuccal pouch a pellet containing fungal hyphæ, with which to start fungus cultivation. She manures the mycelium until it attains a sufficiently luxurious growth to feed to the larvæ. The fungal parasites of ants, and the intracellular bacteria of these insects, also come in for discussion. A large part of the paper is devoted to a review of the myrmecophytes of Africa, and there is also included a bibliography of more than 1100 references dealing with ants in relation to plants.

RESEARCHES ON ORTHOPTERA AND DERMAPTERA.—Part 3 of the "Faune de France" has recently come to hand and is devoted to a description of the Orthoptera and Dermaptera of that country. M. Chopard, the author of this fascicule, is a well-known authority on these insects. In a compass of a little more than 200 pages he has provided a useful and profusely illustrated systematic handbook on the rich fauna inhabiting France. Mr. Morgan Hebard (Occasional Papers of the Bernice Pauahi Bishop Museum, vol. vii., pp. 305-376, pls. xxvi.-xxvii.) revises the species of the same orders of insects inhabiting Hawaii. It appears that the Gryllidæ are the richest in species of any family and number 30 kinds, of which 24 are probably native and 6 "adventive." There are no Phasmidæ, no native species of Acrididæ, and of 16 species of Blattidæ only 2 are native. Of the Dermaptera there are 12 species, one half of which are native. In the Annals of the Transvaal Museum (vol. 9, 1922, pp. 1-99, 4 plates), Mr. J. A. G. Rehn describes the Dermaptera and Blattidæ of the Transvaal and Natal. In the first-mentioned group only 9 species are recorded and none are new: among the Blattidæ there are 73 species of which 24 are new. In the *Bulletin of Entomological Research*, vol. xiii., part 2, 1922, Mr. B. P. Uvarov contributes a study of the grasshoppers of the genus Hieroglyphus and their nearest allies. They are well known in India as pests of rice and sugar-cane, but hitherto only one species, *H. banian*, has been considered noxious. It appears, however, that several species are probably injurious, and this article is written with the view of aiding in their discrimination and recognition.

SOME INDIAN LEECHES.—In his notes on some leeches in the Indian Museum (Rec. Ind. Mus., xxii. pp. 689-727, December 1921) T. Kaburaki deals with twenty-seven species and makes three new genera. In the single example of Foraminobdella, a new genus of the Herpobdellidæ, found in a stream in the Nilgiri District, Madras, the digestive tract opens to the exterior not only at the mouth and anus but also by a pore in the mid-dorsal line of the fourteenth somite. The gut of Trematobdella, as described by Blanchard, also opens by a pore in the mid-dorsal line, and in Horst's *Nephelis dubia* there are two slender passages from the gut to the ventral surface where they open to the exterior.

PHILIPPINE CATTLE ROUND-WORM.—B. Schwartz records (*Philippine Journ. Sci.* xx. No. 6, 1922) observations on the life-history of *Ascaris vitolorum*, a parasite of cattle and of water-buffaloes in the Philippine Islands. The eggs develop rapidly—but if exposed to the heat of the tropical sun are quickly destroyed—and contain larvæ after about twelve days. Such eggs hatch in the intestine and the larvæ migrate *via* the liver and lungs back to the alimentary canal, as in the common round-worm of man, *Ascaris lumbricoides*, but appear to have a greater tendency than in the latter species to linger in the liver.

DISTRIBUTION OF OLIGOCHÆTA IN THE ANTARCTIC.—Two further parts of vol. vi. of the Australian Antarctic Expedition are contributed by Prof. W. B. Benham—Part 4 on the Oligochæta of Macquarie Island and Part 5 on the Unarmed Gephyrea. In the former four oligochætes are recorded—two species of Marionina, one Lumbricillus, and one Microscolex (Notiodrilus). In connexion with this last, Prof. Benham discusses the views that have been advanced to account for the present distribution of Oligochæta on the sub-Antarctic islands and concludes that this cannot be accounted for by polyphyly, floating rafts, carriage by birds, or by drifting seaweeds, and he is led back to the view, first put forward by Beddard in 1891, that the various islands and southern lands were once connected by land bridges. He believes that the former occurrence of chains of islands would suffice to explain the distribution of oligochætes, for the cocoons of these worms might then have been distributed on the feet of birds, and the pelagic larvæ of some of the littoral animals might have been able to survive for the short time necessary to pass across the intervening seas. He puts the origin of the Oligochæta "somewhere in the early Mesozoic epoch."

FUNGAL DISEASES OF RICE.—In the annual report of the Department of Agriculture of the Uganda Protectorate special attention is directed to local fungal diseases of rice. Early failures in the rice crop used to be attributed to unsuitable environmental conditions, but it is noteworthy that the symptoms of "blast" disease resemble the effect of drought and poor soil. This well-known disease, caused by *Piricularia oryzæ*, is reported for the first time in Africa. The disease appears to be widespread, not one of the plots examined being completely free. Both leaves and stems are affected, and when the latter are attacked at both nodes and internodes the plants may break down and the whole plot collapse entirely in bad cases. The ears are sometimes normal, but if attacked the grains are empty or only half filled. At no time has any diseased condition of the roots been observed. "Blast" appears to be the only major disease of rice in Uganda, but in one instance *Gibberella saubinetii*, a fungus with a bad record, has occurred. The supposed conidial stage of this fungus, a species of Fusarium, has not been proved to be connected with the Gibberella, and it is not pathogenic to wheat, rice or maize, on all of which it was found in the country.

PRAIRIE VEGETATION IN ILLINOIS.—A paper by Homer C. Sampson under this title, published as Article 16, in vol. 13 of the Natural History Survey of the State of Illinois, illustrates how American ecologists are attempting to record their main natural vegetation features before these are too much modified by man's activities. Sampson recognises the great importance of climate in determining the "centre of distribution" of the great prairie formation, which coincides roughly in its distribution with the area where the ratio of rainfall to evaporation lies between 60 and 80 per cent. As the prairie is met with farther from its natural centre of distribution, its stability becomes increasingly less so that it disappears before various edaphic and biotic influences. Sampson describes the origin of the prairie from the swamps and drier upland regions left at the close of the last glacial period. On these two soil types two different series of plant associations have followed, hydrophyte and xerophyte respectively in character, but both have ended in the prairie zone in the same association, dominated by *Andropogon furcatum*, the tall blue stem grass. Very striking must have been the appearance of the wide-rolling plains, clothed with this grass growing to a height of 10-12 feet, so that the earlier settlers could follow the movements of their cattle only by climbing to elevated ground and noting the agitation in the vast plains of grass. The author is to be congratulated on one unusual feature which terminates a memoir which is throughout admirably clear and concise. This is the bold attempt made to summarise the chief features of prairie vegetation in non-technical language so that the general public may learn the results of the study of one of the great natural assets of the state. This public should be interested in the author's statements as to the relative want of success that attends efforts to bring natural forest under cultivation as compared with the results of cultivation of prairie land which is normally richer in humus and less leached of its inorganic constituents.

WEATHER IN THE WEST INDIES.—Monthly and annual reports of the West Indies and Caribbean Weather Service have reached us for 1921 and a large part of 1922. The publication is carried out by Mr. Oliver L. Fassig, meteorologist in charge, at San Juan, Porto Rico, the service being in co-operation with the governments of the islands of the West Indies and of the adjacent coasts of Central and South America, under the controlling influence of the U.S. Weather Bureau. Daily rainfall returns are given from about 350 stations throughout the year 1921, and from more than 400 stations in the early months of 1922. In the latter year monthly mean and extreme temperatures are added. For each month the mean rainfall for the entire section is given based upon the reports from all stations observing, and usually a comparison is made with the normal. In 1921 the mean precipitation for the entire area was lightest during the month of April with a mean of 2·11 in. and a mean frequency of 8 days; the month of heaviest rainfall was October with 7·57 in. which fell on 16 days. The mean annual fall for the entire area was 54·32 in., and the mean number of days with rain was 144. In Jamaica the annual extremes at different stations ranged from 26 in. to 199 in., and in Trinidad from 60 in. to 156 in., the annual totals differing greatly, due to the varying topography. Observations are recorded of evaporation, water temperature, and earthquakes. The occurrence and movements of tropical storms are stated, warning of each storm being given by the U.S. Weather Bureau. Considerable development of the reports is evident, and the value of the data will in this way be further enhanced.

## Physiological Aspects of Physical Measurement.[1]

By Sir JOHN HERBERT PARSONS, C.B.E., F.R.S.

PHYSICISTS too often forget that the basis of physical measurements is biological, for the so-called "outer world" only exists for us by virtue of the sensations it arouses in our bodies. Physical measurements are open to the errors of all human observations, and these vary in degree according to the type of observation. In all cases the observation is the formation of a judgment, based on the sensations derived from the stimulation of a sensory organ. Physiological experiments show that stimulation of some sensory organs gives more sharply defined responses than others. Thus, the responses to smell and taste are crude and vague; those to moderate cutaneous stimuli—touch and temperature—much better defined; those to auditory stimuli, still better, and those to visual best of all.

But even among the varieties of a given type of sensation various degrees of definition are met. Thus pain, though cutaneous, is crude like smell and taste; in vision, form sense is much more accurately defined than colour sense. Definition, indeed, varies as the biological differentiation of the sense organ.

Now, the most highly differentiated sensory organ is the eye, and the fovea is its most highly differentiated part. Experiments show that the greatest discrimination is met with in foveal stimuli. The highest degree of sensory discrimination is the appreciation of continuity or lack of exact continuity in two straight lines set end to end, as in the vernier. This may be called *linear identity*, and it is noteworthy that it has been adopted empirically by physicists in the vernier, balance, and other instruments. Physicists have been very ingenious in applying this criterion to otherwise apparently unsuitable measurements, as, for example, the measurement of temperature. But there are many physical measurements to which it cannot be applied, or at any rate has not been applied. Photometry is an example. Here we are measuring the brightness of two lights. By various devices the principle of identity or equality of sensations is made use of—thus utilising the only accurate psychological comparison—but the quality of the sensation to be adjudicated upon does not admit of the accuracy of linear identity. Even in homochromatic photometry we are comparing the brightnesses of two illuminated areas. As is well known, these areas react upon each other physiologically—by the process of induction or simultaneous contrast. Moreover, the judgment is affected by the previous stimulation of the retinal areas concerned (successive contrast). It is further vitiated by variations in adaptation.

Still more open to error are the comparisons of brightness of different coloured lights, heterochromatic photometry. Here the difference in colour acts as a very disturbing element. Yet by practice it is possible to attain almost as accurate results as in homochromatic photometry. But how can we judge of the accuracy of these determinations? In this particular instance we can have recourse to the fact that the critical frequency of flicker depends upon brightness and follows a definite mathematical law. The eye is extremely sensitive to flicker, so that the disappearance of flicker affords a very sensitive criterion. It has been found that the results obtained by the flicker photometer confirm the results obtained by the best so-called "equality of brightness" observations.

No matter how delicate the criterion there are still errors of observation due to imperfections of a biological nature common to all human observers and also to the so-called "personal equation" of the given observer. How are these to be eliminated? Recourse is had to mathematical theory. The basis of the theory of error, which is a branch of the theory of probability, is that small errors will be more frequent than large ones, very large ones will be practically absent, and the mean is the result of the mutual destruction or compensation of many small sources of error acting in opposite directions.

The kinetic theory of gases is built entirely upon this statistical foundation, and its success in explaining the physical properties of gases is strong evidence in favour of the statistical theory. There are several mathematical "averages or means," and much depends upon the choice of the suitable "means," which itself depends upon the frequency distribution of the observations. Graphic methods of eliminating errors are constantly used by physicists. One of the commonest is the method of interpolation, and the smoothing of the curves.

An interesting example of the opposite aspect of averages is the modern view of atomic weights. These are some of the most accurate physical measurements ever made and have been corrected by the best statistical methods. Many of them approximate nearly to whole numbers and there are many theoretical reasons for believing that they are whole numbers. Recent investigations, chiefly by Aston, have shown that the atomic weights hitherto obtained are themselves averages: that there are many so-called "isotopes," having almost if not quite identical chemical properties, but differing from each other in the number of their electrons and also in their true atomic weights, which are invariably integers.

I hope that this philosophical parenthesis suffices to show that even in the matter of physical measurements the physiological aspects of the subject must perforce be taken into account. But in dealing with illumination we are dealing not only with foveal vision, but also with peripheral vision and alterations of sensitiveness of the eye under different conditions of stimulation. It is well known that the foveal region of all parts of the field of vision alters least in sensitiveness under different intensities of illumination. It is, therefore, relatively stable, and observations founded on criteria derived from central vision are proportionately trustworthy. It is quite otherwise with the other parts of the field of vision. Here the sensitiveness of the retina increases enormously with diminution of the intensity of stimulation. This function of retinal adaptation, which is of such tremendous practical importance in the life of the individual and indeed of the species, interferes very seriously with the accuracy of scientific investigations. Physicists have been led astray by ignoring it, as, for example, in the so-called "deviations from Newton's law of colour mixtures" described by König.

Physicists, indeed, are so accustomed to deal with measurements of the highest order of accuracy, founded upon what I have called "linear identity" observations, that they succumb to two errors: (1) that of regarding these observations as of the supreme validity of mathematical abstractions; (2) that of regarding other observations, to which the "linear identity" criterion is inapplicable, as of far greater accuracy than is in fact the case. When the mistakes arising from these errors are too patent to be ignored, physicists are apt to exhibit an unwarranted impatience with the shifting sands of

[1] From the presidential address to the Illuminating Engineering Society, delivered on May 25.

biological science. The fact must, however, be faced that in all cases the observing instrument is a living organ and is, therefore, in a perpetual state of change. The rate of change is relatively slight in the most favourable cases, but rapid and complex in the less favourable. Physicists have been notoriously successful in so reducing the physical complications of experiments to a minimum that the problem nearly approximates to a mathematical abstraction, and, therefore, the highest degree of accuracy. Further advance is to be sought by greater attention to the biological complexities in order that they, too, may be subject to more complete control.

A mass of evidence has of recent years accumulated to show that in peripheral vision two mechanisms are simultaneously at work. Of these, one is chiefly concerned with vision under low intensities of light—what I have called scotopic vision. The end organ of this mechanism is the rods of the retinal neuro-epithelium. Photopic vision, or what may be called daylight vision, is chiefly carried out by the cones. The duplicity theory is so well established that it has even found its way into the writings of the physicists. The explanation and our knowledge of retinal adaptation depends upon these physiological facts. Since retinal adaptation plays a preponderant part in simultaneous and successive contrast its importance in photometry will be readily realised.

## The Design of Railway Bridges.

A SUBJECT of great importance to the general public is the safety of the thousands of bridges by means of which our railways cross roads, rivers, and other railways. Probably it occurs to few railway travellers to consider the complexity of the design of each bridge they cross and the organisation required to inspect, test, and maintain every bridge in a condition suited not only to the traffic for which it was originally designed, but also to the increased weights and speeds which have since been introduced. It is but natural that differences of opinion should arise between the railway companies which have to pay for their erection and maintenance, and the Board of Trade which has to satisfy itself that they are safe.

The Ministry of Transport has recently carried out a series of tests on actual bridges, and has issued a report containing suggestions which appear to foreshadow regulations requiring railway bridges to be heavier and therefore more expensive. This report has naturally aroused great interest and caused no small concern among the bridge engineers of the leading railway companies. At the meeting of the British Association at Hull, the Engineering Section devoted a morning to a discussion of the problem. Unfortunately no representative of the Ministry of Transport took part in the discussion, but the railway companies were well represented and the speakers included the bridge engineers of the Great Western, North Eastern, and Great Central companies. Taken together the papers constitute a concise but fairly complete review of the present situation.

Mr. J. S. Wilson, who opened the discussion with a general review of the questions involved, showed that the difference of opinion between the companies and the Board of Trade is nearly as old as the railways themselves. In 1849 Torksey Bridge across the Trent was tested by the representative of the railway commissioners preparatory to the opening of the Retford and Lincoln line. The deflection of $1\frac{1}{4}$ inches with four locomotives and tenders on the centre of a span was considered excessive and permission to open the line was refused. The bridge had been designed by John Fowler who, with Sir Benjamin Baker, was responsible later for the Forth Bridge. He had followed the rules laid down by Fairbairn, and he suggested to the commissioners that some mistake had been made, but after further tests the latter persisted in their view that the stresses in the bridge were excessive. Finally, however, Fowler succeeded in convincing the commissioners that the girders, being continuous over the middle pier, were not stressed so highly as would otherwise be the case, and on his offering to reduce the weight of ballast on the bridge, the line was finally opened after a delay of three or four months. The subsequent history of the bridge is of interest. The bridge is still there; for forty-six years it was unaltered and carried all traffic satisfactorily; in 1896 it was strengthened by the addition of a longitudinal girder. These old iron bridges designed by Fairbairn and Fowler, which have stood the test of seventy years' wear and tear and are still in good condition, are powerful arguments in favour of the view that bridges built on the same assumptions will be perfectly safe.

There are many difficulties, however, in the calculations and assumptions involved in the design, in allowing for the effect of impact due to the fact that the load is a live one, that is, not a stationary load, and in allowing for the effect of sleepers, rails, and ballast in strengthening the structure, distributing the load, and damping out the effects of impact. It is here that some doubt arises as to whether the intentions of the Ministry are correctly interpreted by the railway companies; it is useless to specify a factor of safety or a working stress unless one also specifies how the stress or factor is to be calculated or determined. The bridge designer may employ what appears to be a low factor of safety because he knows that the actual stresses are less than those calculated by the simple conventional methods usually adopted and that his actual factor of safety is consequently much greater. If a high factor of safety is specified, then it is open to the engineer to modify not his design but his methods of calculation so as to take account of the various strengthening factors usually neglected, and thus obtain a lower calculated stress and a higher factor of safety than would be given by the usual semi-empirical method.

One speaker in the discussion advocated making full-scale tests on old bridges which were being replaced; these could be re-erected and thoroughly tested, if necessary to destruction. All the speakers deprecated the premature promulgation of rules which would lead to heavier and therefore more expensive bridges, but urged that present practice should be followed until systematic research has been carried out and far more knowledge of the subject obtained than that on which the Ministry of Transport are proposing to act.

In their attitude towards riveted structures of iron and steel, engineers may be divided into pessimists and optimists, and Mr. Wilson's experience showed that the greatest optimists have been those most closely associated with the maintenance or actual construction, who would certainly be the first to detect any indication that the bridges were showing signs of weakness.

An engineering student is always taught that the stress produced by a live load is double that produced by the same load when steadily applied. This assumes, however, that the live load is suddenly applied. If the time taken to apply the load is comparable with the period of vibration of the bridge, this is no longer true, and however fast a train is travelling the time taken to apply the load is considerable, and it is not surprising that actual measurements of deflection show that the stresses due to a moving train are in many cases but little greater than those due to the same load when at rest.

One speaker in the discussion at Hull emphasised the importance of minimising corrosion and looked forward to the possible use of stainless steel for bridges; in the meanwhile he had great hopes of the cement gun, by means of which a thin coating of cement is applied to the iron work.

A paper by Mr. J. S. Wilson and Prof. B. P. Haigh dealt very fully with the influence of rivet holes, not only in bridges but in steel structures in general. This is of importance in the present controversy because of the uncertainty of the allowance to be made for the rivet holes in calculating the stress due to any given load. Calculation indicates that very high stresses should occur in the neighbourhood of rivet holes, but from a large number of experiments the authors came to the conclusion that "the metals used in practice have a ductility and other qualities which render them able to eliminate or accommodate these high stresses."

The various papers read and the remarks made by the speakers in the discussion all tended to show that the actual stresses occurring in bridge work are considerably lower than those usually calculated, and that past and present practice allows an ample factor of safety.

## The Alps of Chinese Tibet and their Geographical Relations.[1]

By Prof. J. W. GREGORY, F.R.S., and J. C. GREGORY.

SOUTH-EASTERN Asia is a region of interesting geographical enigmas which deal with the contrast between south-eastern and south-western Asia, the eastern prolongation of the Himalaya, the place of the mountains of south-western China in the mountain system of Asia, and the remarkable arrangement of the rivers of south-eastern Tibet, which has been described as one of the most extraordinary features of the earth's land surface. These problems are intimately connected with the formation of the basin of the Indian Ocean.

"Seek knowledge," said Mohammet, "even if it is found in China," and in accordance with that injunction of the Prophet the authors landed at Bhamo on the upper Irawadi, 50 miles from the Chinese frontier. This port of departure was selected in obedience to the principle of the Burmese proverb that an old road is a fast road; for the road from Bhamo to the Treaty Port of Tengyueh in south-western China is one of the trade routes of Asia which has been used since prehistoric times. At Tengyueh the Indians who had accompanied the expedition over the frontier mountains were sent back, a Chinese staff being engaged; permission was obtained to proceed to Likiang, the administrative headquarters near the borders of Chinese Tibet. As part of this road was across unsurveyed country in which brigandage was rife, the authorities insisted on the money of the expedition being sent on either by draft or along the main road.

The expedition arrived at Likiang before its money, and a further check was threatened by the refusal of the magistrate to allow the expedition to proceed further north. This decision was found to be in obedience to instructions from the provincial capital, but the magistrate of Likiang ultimately agreed to let the expedition proceed, provided he had no further instructions from the capital, on the receipt of a letter stating that the travellers were going on in spite of his warning and entirely at their own risk. Meanwhile a Chinese merchant in the city had agreed to advance half the amount of the draft, and as soon as this was paid the expedition hurried northward into Chinese Tibet to get beyond recall.

The path taken descended from the plateau into the valley of the Yangtze-kiang where, though 2400 miles from the sea, it is still a great river, and was then in high flood owing to the melting of the Tibetan snows. The structure of this valley and of its two parallel neighbours, the Mekong and Salween, was studied in a series of journeys along these rivers and over the mountains between them. The inhabited districts along the Salween were smitten with famine owing to the failure of the previous harvest, and work there was impossible. The range of Kagurpu with its pyramidal snow-clad peaks and its great glaciers was inaccessible, as its crest is the forbidden frontier between Chinese and autonomous Tibet. Hence for a study of the mountain structure of this region the expedition turned eastward to the peaks and glaciers between the Mekong and the Yangtze-kiang, crossing passes from 16,000 to 18,000 ft. in height. Bad weather frustrated the attempt to explore the glaciers of Peima-shan and heavy floods hampered the return march to Likiang. Wide tracts of country around Tali-fu, the former Muslim capital which had withstood a siege of eighteen years during the Civil War of 1855–73, were flooded owing to the abnormally heavy rains. The caravan had to enter the city by climbing over the city wall, as the north gate was closed to keep out the mischievous spirits from the north which had brought the excessive rains that were threatening the country with famine. From Tali the expedition returned by the main road across Yunnan to the Irawadi in Burma.

The observations made during the journey show that the geography of Chinese Tibet is the result of mountain formation at two distinct periods. The deep valleys with their intermediate ranges, which are the most conspicuous topographic features, are the result of mountain movements of the age of the Coal Measures. These ancient movements gave the country a geographical grain trending north and south, and the Indo-Malayan mountains have been formed by the excavation of valleys along the weaker layers of the grain. Mountains belonging to a relatively modern date have been formed contemporary with the upheaval of the Alps and Himalaya. The high peaks of Chinese Tibet rising over 24,000 ft. in height are due to these later uplifts. The main axis of the Himalaya passes through Chinese Tibet and is probably continued through the Nan-shan of southern China to the Pacific. The Burmese and Malay mountain arcs, which are the same age as the Himalaya, represent a loop to the south of the main mountain axis like the Persian loop in south-western Asia and the Apennine loop in Europe. The great rises on the floor of the Pacific, which reach the surface in the Hawaiian Islands and the coral islands of Polynesia, are probably the continuation of these two mountain lines, being like them due to the pressure interacting between the northern cap of the world and the tropical or sub-tropical zone.

[1] Substance of a paper read before the Royal Geographical Society on December 11.

The enigma of the three parallel rivers is explained as due to their valleys having been worn out along clefts through which the drainage from south-eastern Tibet was enabled to escape through the mountain rim of Chinese Tibet. This rim had been formed by the Himalayan movements which were due to the intense compression of the crust; on the relief from that pressure the mountain ranges were broken by transverse clefts, and large blocks sank between a network of fractures. The basins formed by these subsidences gave the rivers great powers of enlarging their channels and thus of excavating the deep steep-sided valleys which are now the most conspicuous features in the topography of south-western China.

## The Present Position of the Whaling Industry.[1]

WHALING has been practised as an industry for some centuries. The pursuit of the Atlantic right whale was carried on in the Bay of Biscay at an early date, and was active at least so long ago as the twelfth century. The Greenland right whale was hunted in three areas, at successive periods, at first off Spitsbergen from about 1610, when few Atlantic right whales were left, then in Davis Straits from about 1719, and finally in the North Pacific and Bering Sea from about 1840. The sperm whale, which occurred in the whole of the tropical belt, though by no means restricted to this area, was hunted from about 1712.

The successful introduction of the modern harpoon-gun, with a harpoon carrying an explosive charge, dates from 1865, and has revolutionised whaling, by making it possible to capture the large and swift rorquals or fin whales. Modern whaling is concerned mainly with the humpback whale, the fin whale, and the blue whale, all of which are widely distributed in nearly all seas, although it is not certain whether each of these whalers' names indicates the same species in all parts of the world. After rorquals had been hunted in such localities as the Varanger Fjord, Newfoundland, Iceland, the British and Norwegian coasts, and elsewhere, whaling on an unprecedented scale commenced off the edge of the Antarctic Continent in 1905, and is still being conducted energetically. The total catch in this area has exceeded 10,000 in a single year.

The principal whale-products of economic importance are: train-oil, sperm-oil, spermaceti, baleen, ambergris, whale meat, and the various forms of whale-meal or "guano." In a well-conducted factory all parts of the carcass are utilised.

With the exception of the Antarctic whaling, which has had a career of less than twenty years, whaling has been carried on consistently to an excessive amount, leading to the most serious reduction of the number of whales. The Atlantic and Greenland right whales were decimated almost to the point of extermination, the sperm whale industry has practically disappeared, and little remains now but the Antarctic whaling grounds. The efforts of all lovers of Nature should be directed to the restriction of whaling to an amount which is not inconsistent with the permanent preservation of these magnificent marine mammals and of the industry which they are so unfortunate as to support.

[1] Substance of a paper read before the Association of Economic Biologists by Sir Sidney F. Harmer, F.R.S., on November 10.

## Biometric Studies.

IN the current issue of *Biometrika* (vol. xiv. pts. i. and ii.) Dr. Kirstine Smith discusses the standard deviation of a coefficient of correlation computed from data derived from classes, members of which are mutually correlated, with special reference to the case of fraternal and parental correlations calculated from entries of siblings. She finds, *inter alia*, that the best determination of a fraternal correlation from a given number of observations is obtained by taking $(1+1/r)$ offspring individuals from each family, where $r$ is the fraternal correlation.

Mr. Egon S. Pearson contributes an important memoir on variations in personal equation. The experimental basis of the research was a series of five sets of measurements of different type; the form of sessional change, *i.e.* the resultant of factors operative within each series, is separated from the secular, or long period, change effective from one session to another; appropriate forms for the expression of each are discussed. It is evident that in the determination of the precise value of the correlation between successive judgments in a series, one has to reckon not only with physiological or psychological common factors, the organic basis of the correlation, but also with accidental errors which blur the record—the observational errors of some writers—and reduce the numerical value of the correlation. It is found that the correlations between successive judgments decrease approximately in geometrical progression with the number of intervals, a finding consistent with the assumption that there is little or no partial correlation between the observers' true estimates at intervals greater than one. The chief practical outcome of the work is to show that although "experience and accuracy may be gained by practice, it does not follow that the correlation between successive judgments will disappear."

The memoir is not only of practical interest to all experimenters, but also contains several contributions to statistical algebra. In connexion with the work on pp. 37 *et seq.*, a reference to the memoir of Anderson (*Biometrika*, x. 269) would have been in place, but no doubt Mr. Pearson will deal more fully with the literature of the subject in a sequel. He is to be congratulated on his first appearance in a field where one bearing his name must be judged by the highest possible standard.

Dr. Ernest Warren's paper concludes the account of work partly described in 1917 concerning inheritance in the foxglove. Dr. Warren holds that "the evidence of the present investigation is therefore definitely against any general application of the theory of pure lines and of genotypes of any appreciable magnitude, and further it indicates that selective breeding within self-fertilised generations of a homogeneous race is capable of modifying that race to a marked degree."

Prof. Karl Pearson and Mr. Egon Pearson show how to find a general polychoric coefficient of correlation, *i.e.* to fit the "best" normal surface to data subject to the limitation that the marginal totals are exactly reproduced. The arithmetical work is heavy, and the suggestion is that a determination of the correlation ratio from the array means—not a laborious task—will usually suffice.

Mr. James Henderson discusses the expansion of a function in tetrachoric functions, a matter of some importance to those who use the frequency systems favoured by Scandinavian mathematical statisticians.

It will be obvious that the fourteenth volume of *Biometrika* is as valuable to statisticians as its predecessors.

## University and Educational Intelligence.

BELFAST.—The trustees of the late Mr. Henry Musgrave have just paid to the Queen's University the sum of 57,000*l*. Of this sum the income of 7000*l*. is to be applied towards paying an additional Reader in connexion with the chair of physics. The income of 20,000*l*. is to be applied in founding and maintaining studentships of not less than 150*l*. per annum for the encouragement of research in pathology, physiology, biology and chemistry. The disposal of the remaining 30,000*l*. is left to the discretion of the Senate.

CAMBRIDGE.—The Very Reverend W. R. Inge, Dean of St. Paul's, and Sir Sidney F. Harmer, Director of the Natural History Departments of the British Museum, have been elected honorary fellows of King's College.

K. P. Chatterji, Fitzwilliam Hall, has been elected to the Anthony Wilkin Studentship in ethnology and archæology.

The Raymond Horton-Smith prize has been awarded to Dr. A. B. Appleton, Downing College, for an essay on "Morphogenesis of Bone," and to Dr. H. W. K. Vines, Christ's College, for an essay on "Certain Physiological Functions of Calcium Salts."

The Gordon Wigan prize in chemistry has been awarded to R. G. W. Norrish, Emmanuel College, for an investigation on "The Photochemistry of Potassium Permanganate."

It is proposed to appoint a University lecturer in embryology.

OXFORD.—An important collection of early scientific instruments has been offered as a gift to the University by Mr. Lewis Evans, a condition attached to the gift being that a suitable place should be provided for showing it, this to be approved by Mr. Evans. The collection is at present exhibited in the Picture Gallery of the Bodleian Library, where it will be allowed to remain until the end of the summer of 1924. In the meantime it will be necessary to fix on a permanent lodging for the collection, and a proposal by Mr. R. T. Gunther, Fellow of Magdalen College, to allot for this purpose the upper rooms of the historic Ashmolean Museum has the support of the heads of all the scientific departments concerned, of the Board of the Faculty of Natural Science, and of many other resident members of the University. As stated in NATURE of December 9, p. 783, the collection is especially rich in instruments for the determination of time. There is a series of astrolabes, sixty-three in number. There is also a large array of dials, both stationary and portable; the former includes Wolsey's sundial, which was probably designed by Nicolas Kratzer, the first Oxford professor of astronomy; while among the latter can be seen a fine Elizabethan finger ring dial, and a Roman portable dial of the second or third century A.D., stated to be the only perfect example known of this particular type of timepiece.

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DR. KATIE BARRATT, lecturer in the department of biology at the Imperial College of Science, South Kensington, has been appointed principal of the Horticultural College, Swanley, Kent.

THE British Association Committee on Training in Citizenship has produced three valuable reports, each of which is available separately for a few pence, and at reduced prices if purchased in dozens or hundreds. The first report, presented at the Cardiff meeting in 1920, contains a syllabus of a course in civics and notes on regional surveys; the second, presented at Edinburgh in 1921, surveys the position of the subject and summarises views of leading teachers upon its scope and purpose; and the third, presented at the Hull meeting in September last, contains a full bibliography of civics. Prices and other particulars may be obtained from the honorary secretary of the committee, Lady Shaw, 10 Moreton Gardens, London, S.W.5.

WE have received from the University of Hong-Kong a pamphlet describing its aims and needs, with special reference to an offer by the Rockefeller Foundation of New York of an endowment of half a million dollars for chairs of medicine and surgery, conditional only upon the Faculty being brought into harmony in other respects with modern standards of efficiency. This will cost at least 400,000 dollars. The university holds a position unique among British universities in that its policies are to a large extent dominated by its nearness to and relations with a foreign country. Its charter of incorporation declares that its objects include ". . . the development and formation of the character of students of all races, nationalities, and creeds, and the maintenance of good understanding with the neighbouring country of China," and its general aim has been defined as "the provision of facilities and especially of the atmosphere of a residential British university with such modifications . . . as the national and intellectual outlook of the Chinese student may call for." One of its chief merits in the eyes of Chinese parents is that its students get the benefit of a British university education without becoming denationalised. It was opened only two years before the outbreak of the Great War and until 1920–21 its progress was slow. During the past two years, however, the number of students has rapidly increased, and there are now about 250, nearly all of whom reside in university or recognised (mission) hostels. Of students who have graduated from the several faculties (medicine, engineering, and arts) the greatest number—77—took degrees in engineering.

PROF. L. NATANSON sends us the following information summarising the growth and progress of university education in Poland. In the last completed year (1921–22) Poland had five State-endowed universities (Cracow, Warsaw, Lwów, Poznan, Wilno), two high technical schools (Warsaw, Lwów), two "free" or private universities (Lublin, Warsaw), and seven other special colleges of university rank. In these institutions, 1926 persons were engaged in teaching during the session under review, namely: 833 full or "ordinary" professors, 176 assistant or "extraordinary" professors, and 917 lecturers and provisionally appointed teachers. The total number of students enrolled for the same period was 34,708, of whom 8015 were women. The University of Warsaw had the largest number of students in attendance, namely, 7518; the Technical High School of Warsaw had 4112 students. Polish universities contain faculties of theology, jurisprudence, medicine, physical and natural science, philosophy, history and philology; in addition to these, sub-faculties or special departments exist in several universities, devoted to agriculture, pharmacy, veterinary science, and so on. As to the specialty of their study, the students may be divided as follows: theology 1 per cent., jurisprudence 29·1, medical science 13·2, pharmacy 0·9, veterinary science 1·1, stomatology 1·5, philosophy, philology, history and pedagogical science 26·4, agriculture 5·9, commercial science 2·1, chemistry 2·8, mining 0·8, other technical studies 14·4 per cent. The following information is also available relating to the mother-tongue of students in the University of Warsaw: Polish language 89·0 per cent., Russian 2·0, German 0·25, Hebrew 4·25, Jewish 3·25, other languages 1·25 per cent. About 74 per cent. of the number of students were trained in secondary schools chiefly of classical and literary type; the rest, about 26 per cent., had received preparation in schools in which experimental and practical science was the basis of instruction.

## Calendar of Industrial Pioneers.

**December 18, 1888. Joseph James Coleman died.**—One of the pioneers of the cold storage industry, Coleman was first a teacher of chemistry and then chemical engineer to Young's Paraffin Works, Bathgate, Glasgow, where he devised means of liquifying gases, and with Bell introduced the Bell-Coleman dry-air refrigerating system which revolutionised the meat-carrying trade.

**December 19, 1877. Heinrich Daniel Ruhmkorff died.**—Ruhmkorff was born in Hanover in 1803 and in 1819 went to Paris as assistant in a laboratory. There he started in business for himself and became a successful electrical instrument maker. In 1844 he invented a thermo-electric battery, and in 1851 brought out the Ruhmkorff coil for which he afterwards received a prize of 50,000 francs at the French Exhibition of Electrical Apparatus.

**December 20, 1904. Sir Isaac Lowthian Bell died.**—The son of an engineer of Newcastle, Bell studied at Edinburgh and at the Sorbonne, and in 1854, with his brothers, founded the Clarence Iron Works on the Tees, the firm ultimately employing some 6000 men. Bell was distinguished as an investigator and writer on metallurgy, and as a man of affairs assisted to found the Iron and Steel Institute, of which he served as president in 1873–75. He was also the first recipient of the Bessemer Gold Medal.

**December 21, 1909. Charles B. Dudley died.**—From 1875 to 1909 Dudley was chemist to the Pennsylvania Railroad Company, in which situation he carried out a number of important researches on the properties of materials and other matters connected with railways. He was president of the American Chemical Society, and at the time of his death, president of the International Association for Testing Materials.

**December 22, 1867. Jean Victor Poncelet died.**—A distinguished French engineer and mathematician, Poncelet passed through the École Polytechnique, served in the army, was taken prisoner on the retreat from Moscow, and during his confinement began writing his "Traité des propriétés projectives des figures." He rose to high military rank, held a chair of mechanical physics in Paris, published a treatise on practical mechanics, improved the water wheel, and invented a turbine.

**December 23, 1895. Sir Edward James Harland died.**—The founder of the great shipbuilding firm of Harland and Wolff, of Belfast, Harland was born in 1831 at Scarborough, served an apprenticeship under Robert Stephenson at Newcastle, and became draughtsman to J. and J. Thomson, Glasgow. In 1854 he removed to Ireland, becoming the owner of a small shipbuilding concern, in which he was joined by Wolff in 1860. Among the most notable vessels he constructed was the Atlantic liner *Teutonic*, which, built in 1889, was the first mercantile vessel to be fully armed and equipped as an auxiliary cruiser. She was 560 feet long, displaced 16,740 tons, and with 17,500 horsepower attained a speed of twenty knots.

**December 23, 1865. Alan Stevenson died.**—The eldest son of Robert Stevenson (1772–1850), whom he succeeded as engineer to the Scottish Lighthouse Commissioners, Stevenson erected ten lighthouses, among them being that at Skerryvore, "the finest example for mass combined with elegance of outline of any extant rock tower." This lighthouse, which was built between 1838 and 1843, is 138 feet high and weighs 4300 tons. E. C. S.

## Societies and Academies.

LONDON.

**Royal Microscopical Society,** November 15.—Prof. F. J. Cheshire, president, in the chair.—C. **Singer**: The earliest drawings made by means of the microscope. These drawings, probably the earliest made, were prepared in 1625, 3 years before the birth of Malpighi and 8 years before the birth of Leeuwenhoek. They represent the anatomy of a bee, of which the mouth parts are particularly accurately rendered. The drawings are to be found on the fly-leaf of an excessively rare book, the "Melissographia" of Federigo Cesi, Duke of Aquasparta. The only specimen of this book known to exist is in the Lanuvian library at Rome. The drawings were made under the supervision of Cesi himself and of his colleague in the first "Academy of the Lynx," Francesco Stelluti. A mechanical microtome was constructed by the instrument maker Cummings in 1770 and described by the notorious Sir John Hill.

**Physical Society,** November 24.—Dr. Alexander Russell, president, in the chair.—E. G. **Richardson**: The theory of the singing flame. Lord Rayleigh's theory of the action of the singing flame fits the results most closely, in that (1) heat is given by the flame to the air in the tube at each condensation, and (2) stationary waves are formed in the gas as well as in the air-tube. But the lengths of gas-tube unfavourable to the "singing" cover a more restricted range than Lord Rayleigh surmised.—Miss Alice **Everett**: Unit surfaces of Cooke and Tessar photographic lenses. A number of rays in an axial plane (and a few general rays) are traced through the lens systems by exact methods, and on each ray the positions of the conjugate points for unit magnification are found by Mr. T. Smith's formulæ. For general rays the loci of these "unit points" are three-dimensional. They are surfaces only when the chief rays are bound by some condition such as passing through a fixed point of the object. Within the region for which the lenses are designed, the curvature of both object and image unit-point loci is positive (convex to the light source) and the image locus is more curved than the object locus.—R. Ll. **Jones**: Vibration galvanometers with asymmetric moving systems. The theory of vibrations of a system with two degrees of freedom is given, expressions for the amplitudes of the forced vibrations are deduced, and the conditions for resonance ascertained. The results are applied to a galvanometer in which the moving system is asymmetrically hung on a laterally yielding axis, and it is found that the formula for the amplitude is capable of reproducing with fair accuracy the sensitivity curve of the galvanometer, which shows multiple resonance. Asymmetry always lowers the sensitivity of the resonance.—Paul **Schilowsky**: Some applications of the gyroscope. To stabilise a system in unstable equilibrium a reaction must be set up between the system and the gyrostat of such a character as to *help* the precession of the gyrostat during the return of the system to normal. To check the oscillations of a stable system, the reaction must be such as to *oppose* such precession. The gyrostat must be power-driven to neutralise friction. A collection of apparatus for teaching purposes, comprising, *inter alia*, models illustrating the precession of the earth, a method of optically projecting an image of a spinning top, and small mono-rail models, was exhibited. To prevent rocking in a model ship a gyrostatic fly-wheel is mounted with its axle vertical in a frame, which can both rock about and slide along an axis transverse to the ship. In an aeroplane the problem of combining automatic stability with mobility while avoiding dangerous stresses was discussed. Angular velocity of the aeroplane about a vertical axis causes a tendency to precess in a gyroscope rotating about an horizontal axis. This is balanced by a gravity control, and the angle moved through in attaining a balance affords a measure of the required angular velocity. In models of mono-rail gyrostatic apparatus the fly-wheel is mounted with its axle vertical in a frame which can tilt in a fore-and-aft plane and also slide sideways under gravity. The frame is mounted by a pinion co-axial with and geared down from the fly-wheel; the pinion lies between, but normally clear of, two parallel fixed racks mounted on the carriage, and having their lengths in a fore-and-aft direction. In practice the gyrostatic apparatus would form from 3 per cent. to 5 per cent. of the load of a ship, and from 5 per cent. to 10 per cent. of the load of a mono-rail carriage.—P. **Ditisheim**: A new balance for compensating the temperature error of watches and chronometers. Elinvar, an alloy invented by Dr. Ch. Ed. Guillaume, the elasticity of which is not affected by changes of temperature, is used for the hair-spring. Satisfactory timing can thus be obtained up to certain limits with a plain solid uncut balance. To apply the elinvar spring to higher-grade watches a new compensation balance has been designed. It is made from a plain monometallic uncut ring into which two very small symmetrical bimetallic blades are inserted. The latter will enable small corrections to be made in order to obtain very fine rates.

**Aristotelian Society**, November 27.—Prof. A. N. Whitehead, president, in the chair.—R. F. A. **Hoernlé**: Notes on the treatment of "Existence" in recent philosophical literature. The ontological argument is treated in current philosophical literature (*a*) in a *restricted* form, in which it applies only to the unique case of God, and (*b*) in a *generalised* form, in which it is one with the problem of the validity (or "reference to reality") of thought in general. Prof. A. E. Taylor's criticisms of the restricted argument, in his article on "Theism" in the "Encyclopedia of Religion and Ethics," are mutually contradictory, but they contain the valuable suggestion that the validity of the argument depends on the meaning of the term "God," or of the terms defining "God." What these terms *mean* can be decided only by asking what they *express*, and this requires that we should not divorce the language of the argument from the religious experience (=Anselm's *fides*) which underlies it. Thus, the restricted argument appears as but a special case of the generalised argument which depends on the principle that experience, as the union of "that" and "what," "existence" and "essence," supplies the missing existential premise for all meanings which are well-founded. The generalised argument depends on maintaining consistently the "epistemic" against the "formal-logic" point of view. In formal logic, no definition, as such, can imply the existence of the thing defined; no class-concept can imply that the class has members. But, if instead of beginning with definitions, concepts, suppositions (*Annahmen*), we take the *epistemic* point of view and ask what the terms of the definition, etc., mean, *i.e.* what they express, or what we are asked to think *with*, we are driven back to concrete experience in which meanings are *realised*, and in which, therefore, essence is not divorced from, but is one with, existence.

**Linnean Society**, November 30.—Dr. A. Smith Woodward, president, in the chair.—R. J. **Tillyard**: The wing-venation of the order Plectoptera or May-flies.—D. S. M. **Watson** and E. L. **Gill**: The structure of certain palæozoic Dipnoi (fishes).—J. Duncan **Peirce**: The Giant Trees of Victoria. The tallest trees grow in gullies between ridges, the greater moisture and abundance of leaf-mould conducing to their height; the highest tree measured was 326 ft. 1 in.

CAMBRIDGE.

**Philosophical Society**, November 13.—Mr. C. T. Heycock, president, in the chair.—A. Smith **Woodward**: The skulls of palæolithic men.—W. M. H. **Greaves**: On a system of differential equations which appear in the theory of Saturn's rings.—C. G. **Darwin** and R. H. **Fowler**: Fluctuations in an assembly in statistical equilibrium.

SHEFFIELD.

**Society of Glass Technology**, November 22.—W. E. S. **Turner**: The glass industry and methods of manufacture in Czecho-Slovakia. The technical side of the glass industry has not in recent years made anything like the progress that it has in this country. The Bohemian glass industry is living largely on its old tradition and the existing store of knowledge. Machinery scarcely exists for the manufacture of glassware. A great deal of money was made in the industry in the boom years of 1919 and 1920, but very little was put into the industry to improve it. In many methods, from a technical point of view, Great Britain leads the Continent at the present time.—A. **Cousen**: Selenium in the production of colourless glass. A large number of experimental melts were made to determine the effect of various batch materials on the decolourising power of selenium and the effect of the duration of melting on the colour developed.

DUBLIN.

**Royal Dublin Society**, November 28.—Mr. G. Fletcher in the chair.—J. **Wilson**: On the variation of milk-yield with the cow's age and the length of the lactation period. Ten years ago, working on data, from the cows exhibited at the London Dairy Shows, it was found that, if cows' yields at eight years old be set down as 100, the yields at earlier ages work out at about 67 for 3-year-olds; 81 for 4-year-olds; 90 for 5-year-olds; 95 for 6-year-olds; and 98 for 7-year-olds. Recently Dr. Raymond Pearl of Washington and Dr. Tocher of Aberdeen, working with data collected by the Ayrshire Cattle Milk Records Committee, have found yields for the younger ages to be considerably higher, but the Ayrshire records cannot be used to find how yield increases with age, because the breed has been out of equilibrium since about twenty years ago; the records are loaded in favour of those of the younger ages. If twelve months from calf to calf be taken as the normal lactation period, the annual yield is reduced by about 20 gallons in an eleven months lactation, and increased by about 35, 65, and 90 gallons in thirteen, fourteen, and fifteen months lactation periods.—H. H. **Poole**: On the detonating action of α-particles. Experiments show that the probability of detonation of a specimen of iodide of nitrogen by α-particles is proportional to the concentration of the particles, and not to the square, or a higher power, of the concentration. Hence, detonation is caused by a single α-particle, and not by the joint effect of two or more particles, and it is reasonable to assume that detonation is caused by the collision of the particle with a nitrogen or a hydrogen nucleus. Fulminate of mercury, silver azide, and several other explosives were not detonated by exposures to α-particles which would have caused several thousand detonations of iodide of nitrogen. Probably only a very sensitive body, such as the iodide, can be detonated in this way, and the risk of such an effect with detonators or explosives in common use is negligible.—T. G. Mason: Note on the growth and the transport of organic substances in bitter cassava (*Manihot utilissima*). Weekly measurements of 20 plants were made over a period of 27 weeks; alternate plants were ringed close to the ground. The rate of growth of the stems of the ringed plants was not affected by the operation for about 3 weeks; it then commenced to lag behind that of the unringed plants. The weight of the tuberous roots formed by the ringed plants was about one quarter of that formed by the unringed; the weight of the stem was more than 1·2 times as much. Probably the activity of the cells of the apical meristem is not controlled by the available supply of organic substances, but is determined by autogenous changes within the growing point. No evidence was obtained of the presence of a factor correlating the activity of the apical meristem and the growth of the tuberous roots. The results are in accord with the view that the rate of growth of the stem is conditioned by the catalytic activity of the cells of the apical meristem.

### PARIS.

Academy of Sciences, November 20.—M. Emile Bertin in the chair.—The president announced the death of M. G. Lemoine.—Marcel Brillouin: Einstein and Newtonian gravitation. Remarks on a recent note by M. Le Roux. The criticisms of M. Le Roux are regarded as unfounded.—Pierre Termier: The structure of the eastern Alps.—L. Joubin: The geographical distribution of some deep-sea corals in western European seas. In consequence of the increase in the size and power of steam trawlers, trawling is now carried out at much greater depths than formerly. As a result, the quantities of coral brought up in the nets causes great inconvenience. As a guide to fishermen, a chart is given showing the distribution of the most objectionable corals (Lophohelia, Amphihelia, Dendrophyllia), so that the trawlers can avoid these localities.—E. Mathias, C. A. Crommelin, and H. Kamerlingh Onnes: The rectilinear diameter of neon. The purification of the neon used in these experiments is described in detail, and its purity was confirmed of observations of the critical phenomena. Neon obeys the law of the rectilinear diameter. Like other gases, the diameter shows a deviation in the neighbourhood of the critical point. In the case of hydrogen the deviations are distributed irregularly, but with neon they are systematic: at low temperatures the diameter is slightly convex to the temperature axis, and at higher temperatures slightly concave. Argon, nitrogen, and carbon dioxide behave similarly. —M. Charles Camichel was elected Correspondant for the section of mechanics.—S. Bays: Steiner's cyclic systems of triplets.—A. Myller: Remarkable ruled surfaces passing through a given curve.—Paul Mentré: Complexes which present projective singularities of the second infinitesimal order.—H. Roussilhe: Results obtained in 1921 and 1922 by the application of aerial photography to precision plans on the large scale. The mean errors of plans derived from aerial photographs are less than those of a topographical plan taken with every precaution; the area covered by a given staff is also greater when the photographic method is employed.—C. Raveau: Fresnel's law of the entanglement of the æther.—Emmanuel Dubois: The minimum potential of electric discharge in gases at low pressures. Some anomalies described in an earlier communication have been now shown to be due to the presence of saline substances on the electrodes.—L. Bouchet: An absolute plane-cylinder electrometer. A cylinder is mounted on a balance beam and the attraction between the cylinder and a plane surface measured. The theory of the instrument is developed. The limits between which the formula holds have been determined by experiment. —Georges Déjardin: The production of the spectrum of mercury. The influence of helium. A study of the spectrum emitted by mercury vapour traversed by electrons of variable velocity. The lines are those of the arc spectrum. For potentials below 20·4 volts a mixture of helium and mercury vapour gives the same arc spectrum as that observed in the absence of helium. Above 20·4 volts the mercury spectrum undergoes modification, and at the same time the helium spectrum appears.—Pierre Lafon: Anomalies in the expansion of glass.—A. Portevin: The reduction and disappearance of internal strains in steels by reheating followed by slow cooling.—André Kling and D. Florentin: The spontaneous formation of sulphate on limestone in urban centres. Chemical analyses of various limestone structures, showing the serious attack by the sulphuric acid in town atmospheres.— MM. Tiffeneau and Orékhoff: The semipinacolic transposition of the alkylhydrobenzoins: the influence of the alkylradicles.—Raymond Delaby: The alkylglycerols. The preparation of vinylalkylcarbinols.— E. Grandmougin: The acyl-aminoanthraquinones as vat dyes.—Paul Gaubert: The action of heat on spherolites.—H. Joly: Preliminary note on the general direction and age of the folds of the Celtiberic Chain (Spain).—M. Teilhard: A fauna of mammals found in northern China.—V. Van Straelen: The decapod crustaceans of the Callovian of Voulte-sur-Rhône (Ardèche).—Lucien Daniel: Hyperbioses of the sunflower and artichoke.—Maurice Lenoir: The nucleoles during the prophase of kinesis II. of the embryonic sac of *Fritillaria imperialis*.—M. Mascré: The stamen of the Boraginaceæ.—Mlle. Marie Braecke: The presence of aucubine and of melampyrite (dulcite) in several species of Melampyrum. Aucubine was isolated from *Melampyrum pratense*, *M. nemorosum*, and *M. cristatum*: dulcite (Hünefield's melampyrite) was also extracted in the pure state from the two latter species.—Pierre Lesage: The comparative action of sylvinite and its components on the first development of plants. Sylvinite proved more favourable to the development of seedlings than its constituents (chlorides of sodium, potassium, magnesium, and calcium sulphate) taken separately, or even when mixed in the proportions present in the mineral employed. —J. Stoklasa: The respiration of the roots. Experiments are described confirming the conclusion published by the author in an earlier communication, that no acid, organic or inorganic, other than carbonic acid is secreted by growing roots. The respiration of the roots is more intense in the presence of air containing radium emanation.—A. Goris and P. Costy: Urease and urea in fungi.—L. Léger and A. Ch. Hollande: Coccidia of the intestine of the eel.—L. M. Betances: Some refinements on the morphogenesis of the hæmatic cell.

### CAPE TOWN.

Royal Society of South Africa, September 27.—Dr. J. D. F. Gilchrist, president, in the chair.—H. B. Fantham: Some Protozoa found in soils in South Africa. Protozoa belonging to the Sarcodina, Mastigophora, and Ciliata have been found. As regards actual numbers of organisms, flagellates are the most numerous. There is daily variation in the numbers of a Protozoon in a given quantity of culture. Dark, heavy soils containing much humus yielded more kinds of Protozoa than sandy ones. Samples of soil taken relatively near the surface, say six or eight inches down, usually yielded more Protozoa than deeper samples. Cultivated soils yielded more species of Protozoa, especially of Ciliata, than uncultivated ones. Owing to partial sterilisation of South African soils by solar heat and drought, the number of Protozoa in a given area of soil seems to be less than in soils from England or the northern United States. The ingestion of bacteria by soil Protozoa has, so far, not been often observed naturally in South African soils.—J. A. **Gilmore**: Note on elasticity of Dwyka Tillite. Investigation of Dwyka Tillite from Matjesfontein, Cape Province, shows that for an absorption of water of less than 1/400 gm. per gm., Young's Modulus decreases by about 12 per cent., whereas for an absorption of order 1/800 gm. per gm. the crushing strength increases by about 50 per cent. or more.—H. O. **Mönnig**: On some new South African parasitic nematodes.—Sir Thomas **Muir**: Note on the co-evanescence of the primary minors of an axisymmetric determinant.—T. J. **Mackie**: The serum constituents responsible for the Sachs-Georgi and the Wassermann reactions. Sera were fractioned by Liefman's carbon-dioxide method; the carbonic-acid-insoluble globulin was inactive and inhibitory in the flocculation test. The carbonic-acid-soluble fraction was further fractioned into pseudo-globulin and albumin components and flocculation was found to be due almost entirely to the former. In the Wassermann reaction, the most active fraction is the carbonic-acid-insoluble globulin.—J. R. **Sutton**: Note on the propagation of heat in water. Harmonic analysis of hourly observations of the temperature of water in a brick cistern, 7 feet square and 30 in. deep, shows that the whole body of water is heated nearly simultaneously (chiefly by the sun's rays) and that the surface temperature is propagated downward as a wave of about 7 in. per hour.

**Royal Society of South Africa**, October 18.—Dr. J. D. F. Gilchrist, president, in the chair.—Miss A. V. **Duthie**: The cones, spores, and gametophytes of *Selaginella pumila*.—F. G. **Cawston**: South African larval trematodes and the intermediary hosts. The commoner species of fresh-water mollusc found in certain rivers of South Africa, as well as some lagoon inhabitants which are occasionally found in quite fresh water, together with the commoner larval trematodes of these localities, are described.—J. **Moir**: Colour and chemical constitution, Pt. XVIII.: Colourless substances in concentrated sulphuric acid solution (halochromy). Observations on coloured solutions in sulphuric acid of 25 simple substances, mostly colourless *per se*, are recorded, and a scheme for calculating colour from chemical constitution is put forward.—J. **Stuart Thomson**: African Alcyonaria with a statement of some of the problems of their dispersal.

## Official Publications Received.

Straits Settlements. Annual Report on the Raffles Museum and Library for the Year 1921. By Major J. C. Moulton. Pp. 16. (Singapore.)

The Royal Technical College, Glasgow. Annual Report on the One Hundred and Twenty-sixth Session adopted at the Annual Meeting of Governors, held on the 17th October 1922. Pp. 71. (Glasgow.)

County Borough of Warrington: Museum Committee. Report of the Keeper of the Museum for the Two Years ending 30th June 1922, with a List of the Principal Additions to the Museum Collections. Pp. 18. (Warrington.)

Department of the Interior: Bureau of Education. Bulletin, 1922, No. 20: State Laws relating to Education enacted in 1920 and 1921. Compiled by Wm. R. Hood. Pp. iv+269. (Washington: Government Printing Office.) 25 cents.

Department of Fisheries, Bengal. Bulletin No. 19: Statistics of Fish imported into Calcutta for the Year ending 31st March 1922. Pp. 14. (Calcutta: Bengal Secretariat Book Depot.) 8 annas.

## Diary of Societies.

### *SATURDAY*, DECEMBER 16.

BRITISH ECOLOGICAL SOCIETY (Annual Meeting) (at University College), at 10.30 A.M.—Dr. R. Lloyd Praeger: Dispersal and Distribution (Presidential Address).—Dr. Cockayne's Work on the Tussock Grassland of New Zealand (Lantern and Specimens).—J. Ramsbottom: The Mycology of the Soil.—W. H. Pearsall: Plant Distribution and Basic Ratios.

BRITISH PSYCHOLOGICAL SOCIETY (Annual General Meeting) (at University College), at 3.—S. J. F. Philpott: The Analysis of the Work Curve.—H. Gordon: Hand and Ear Tests.

### *MONDAY*, DECEMBER 18.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge, Kensington Gore), at 5.—Col. Sir Gerald Lenox-Conyngham: The Proposed Determination of Primary Longitudes by International Co-operation.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. E. Sharp and others: Discussion of Time Switches.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 7.—A. J. Gould: Warships.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—A. N. C. Shelley: The Law of Building outside London.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street), at 8.—Prof. R. W. Sellars: Body and Mind.

CHEMICAL INDUSTRY CLUB (at 2 Whitehall Court), at 8.—Dr. W. R. Ormandy: Paper.

### *TUESDAY*, DECEMBER 19.

ROYAL SOCIETY OF MEDICINE, at 5.—General Meeting.

ROYAL STATISTICAL SOCIETY, at 5.15.—T. T. S. de Jastrzebski: Changes in the Birth Rate and in Legitimate Fertility in London Boroughs, 1911–1921.

INSTITUTION OF CIVIL ENGINEERS, at 6.—F. M. G. Du-Plat-Taylor: Extensions at Tilbury Docks, 1912–1917.

INSTITUTE OF MARINE ENGINEERS, INC., at 6.30.—Film illustrating Industrial Works—Messrs. Hadfields.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7.—H. T. G. Meredith: Gravure.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—Dr. C. Fox: The Distribution of Population in the Cambridge Region in Early Times, with special reference to the Bronze Age.

### *WEDNESDAY*, DECEMBER 20.

ROYAL SOCIETY OF MEDICINE (History of Medicine Section), at 5.—Dr. Nixon: The Debt of Medicine to the Fine Arts.

ROYAL METEOROLOGICAL SOCIETY, at 5.—C. J. P. Cave and R. A. Watson Watt: The Study of Radiotelegraphic Atmospherics in Relation to Meteorology.—C. J. P. Cave: Winter Thunderstorms in the British Islands.—D. E. Row: Forecasting Sky Types.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. A. Richardson: A Micrometric Study of the St. Austell Granite (Cornwall).—W. G. Shannon: The Petrography and Correlation of the Igneous Rocks of the Torquay Promontory.—Prof. O. T. Jones: Demonstration of the Crystallisation of a Doubly-Refracting Liquid.

ROYAL MICROSCOPICAL SOCIETY, at 8.—J. E. Barnard: Sub-Bacteria.

### *THURSDAY*, DECEMBER 21.

ROYAL SOCIETY OF MEDICINE (Dermatology Section), at 5.

INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.—F. White: Notes on the Correction required to Aneroid Readings for Altitude to counteract the Effect produced by the Diurnal Barometric Wave.—P. C. Whitehead: Some Notes on the Secondary Sulphide Enrichment exhibited by certain Auriferous Veins.

CHEMICAL SOCIETY, at 8.

#### PUBLIC LECTURES.

### *SATURDAY*, DECEMBER 16.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: Animals without Teeth.

### *THURSDAY*, DECEMBER 21.

CITY OF LONDON Y.M.C.A. (186 Aldersgate Street), at 6.—Sir John N. Jordan: Some Chinese Problems.