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Cycles in the Yield of Crops.

NEARLY five-and-twenty years have elapsed since Sir Arthur Schuster, by devising the orderly and comparatively brief process known as the "periodogram method," gave a great stimulus to the investigation of periodicities in natural phenomena. Solar and magnetic phenomena provided the first fields of application, and meteorological data have since been attacked by many investigators. It seems fitting that crops, which are so largely dependent on the weather, should be submitted to the same test.

In the course of last year Prof. H. L. Moore, of Columbia University, published a series of three articles in the American *Quarterly Journal of Economics*, which may be briefly summarised as indicating that, in the periodogram for periods of three to twelve years, there is a marked maximum at eight years in the cycles of a number of crops and corresponding cycles in the production of the raw materials of industry. This periodicity appears to correspond to what is known as the "economic cycle" in trade, and it is suggested that the periodicity in crops is the *generating cycle* of the whole movement—a movement which is very clearly reflected in prices. Prof. Moore's data refer, for the most part, to the years 1882–1918 only, with the exception of Sauerbeck's data for prices in this country, which are available from 1818, and of wheat prices in England, which are utilised for the years 1870–1916. To the latter part of his third article we return briefly below.

In the meantime, in an article published in the British *Economic Journal* for March 1920, Sir William Beveridge suggested, on evidence which, to many readers, did not seem at all adequate, the existence of a period "between 15·2 and 15·4 years." In the same journal for December 1921, a further paper was published in which the original conclusion is completely vindicated. By the aid of overlapping data as to wheat prices in a large number of places in Great Britain, France, Germany, and the Netherlands, an index-number of wheat prices for Western Europe is constructed running from 1500 to 1869. The index-number for each year is then expressed as a percentage of the mean of the thirty-one years surrounding it, and the results are submitted to periodogram analysis over the three centuries 1545–1844, for periods running from two years to thirty-six. Data are also given separately for 1545–1694 and 1695–1844.

For the whole 300 years and for the last 150 years the greatest intensity, taking only integral periods, is at fifteen years, the maximum being well marked; for the earlier 150 years the intensity at 15 (70) is slightly exceeded by the intensity at 11 (76), 13 (80), and 18 (73). Testing fractional periods on the series as a whole, the intensity at 15 (47) is raised to 82 at $15\frac{1}{3}$, and to 80 at $15\frac{1}{2}$. The dominant period appears, therefore, to be fairly closely 15·3.

But, Sir William Beveridge suggests in an interesting analysis that follows, the period thus found is probably not a real one—*i.e.* is not the period that exists in the operative cause, the weather. If a certain cycle exists in the weather tending to give, say, abnormally heavy rain at its maximum, it will nevertheless not have any adverse influence on the harvest unless the maximum and its accompanying deluge fall within the limited period of year during which the crop is growing. Hence what will be observed in the crop is not necessarily the period of the weather cycle, but the period in which its maximum tends to recur during the critical months. We have not space to follow the author's reasoning in detail, but it is suggested that there are at least two weather cycles operating, if not four—(*a*) with a period of approximately 4·37 years (30·6/7), which corresponds to a cycle identified by Sir Arthur Schuster in sunspots; (*b*) with a period of about 5·11 years (30·6/6), which has been found in temperature and rainfall records; and two of less certainty, (*c*) with a period of 2·74 years (30·6/11), and (*d*) with a period of 3·71 years, both of which also appear to have been identified in meteorological or astronomical data.

The period observed, it is argued, arises from a temporary compounding of the effects of these four cycles. All four "are due to return to a maximum phase between February and September 1923," and this may mean an exceptionally bad year for harvests in Europe. "In the excessively improbable event of my arithmetical analysis being complete and accurate in every particular," Sir William Beveridge continues

"1923 is destined to repeat something like the experiences of 1315, the year of the worst and most general harvest failure known in European history." To the crowd, if not to the man of science, the fulfilment of a prophecy always seems to give more adequate support to a theory than any number of agreements with past events, and the year 1923 may be awaited with an interest mingled with anxiety. On the face of it, the evidence seems sound, and the reasoning careful and critical.

Sir William Beveridge does not attempt to trace the physical causation of the observed periodicity further than to show that it may be accounted for by cycles already noted in meteorological or astronomical data. The eight-year period gives only a small maximum in his periodogram with an intensity of 12. Years after 1844 were apparently omitted in part because during the nineteenth century the character of the curve visibly alters, the "credit cycle" acting as a "disturbing influence." It may, however, be questioned, in view of Prof. Moore's work, whether the credit cycle can be treated in this way as an extraneous disturbing cause. An eight-year cycle, as he says, was isolated in the barometric pressure of the United States, and has also been traced in rainfall, and these cycles appear to be congruent with the economic cycle. When Prof. Moore goes beyond this and seeks for a cosmic cycle that may be regarded as the "generating cycle," he lights on an hypothesis for which, we think, a good deal of further evidence will be required before it can win acceptance; it is suggested that the period in question is that between conjunctions of the earth and Venus. No proof, however, is given that the periods coincide with any precision, the periodograms for economic data having been calculated only for integral periods.

Analysis must be carried further before a true consonance of the periods can be predicted with any confidence. The point brought out by Sir William Beveridge, moreover, that the period in the weather may not be that in the yield of the crop, must be borne in mind. If a "maximum" of some kind in the weather is vital to the crop only provided that it occur at some critical period of the year, the determination of this critical period becomes of interest, and we would suggest that such work as that of Mr. R. H. Hooker, of the Ministry of Agriculture, whose presidential address to the Royal Meteorological Society on the correlation in eastern England between yield and the weather in successive months of the year was summarised on p. 193 of NATURE for February 9, might help to elucidate the matter. Crop prediction is a matter of the highest economic importance, and all lines of investigation should be considered together.

A Searchlight on Solids.

Aggregation and Flow of Solids: Being the Records of an Experimental Study of the Micro-structure and Physical Properties of Solids in Various States of Aggregation, 1900–1921. By Sir George Beilby. Pp. xv+256+34 plates. (London: Macmillan and Co., Ltd., 1921.) 20*s.* net.

THIS is a book that will hold a true child of science like any fairy-tale, and it would be difficult to overstate its fascinating interest. In form, in substance, and in all its auspices it is so highly individual. It is a story, a connected story, of the leisure pursuits of one of our leading and most enlightened industrialists, who for many years, and pre-eminently in the stress of war, has rendered great

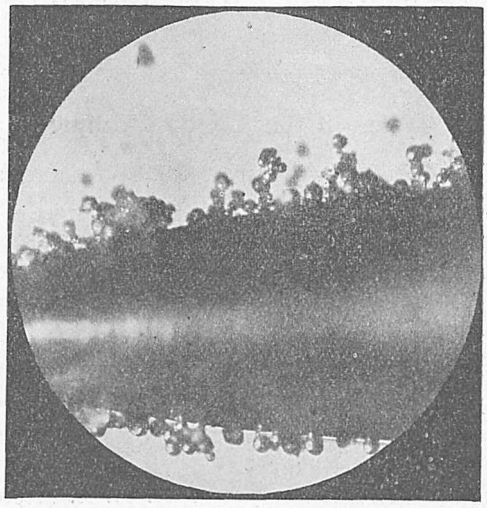

FIG. 1.—Globules of zinc dust picked up on the edges of a thin steel blade (×60). From "Aggregation and Flow of Solids."

services to his country. But it is a record that would adorn a life wholly devoted to the pursuit of science.

All who are seriously concerned with physical or chemical science must know something of the contributions which Sir George Beilby has made to the subject dealt with in this book, but the rush of scientific discovery makes it very difficult to realise the full sweep and significance of much that is going forward. Probably every one knows that Sir George Beilby has demonstrated the existence of a vitreous state in metals and other solids where that state had never been suspected, and to most of us he has become permanently "featured" on the transparent *surface film* of polished solids.

In his papers from time to time he has disclosed in some degree the theoretical accompaniment and the connecting threads of his experimental work, but it is probable that few will have seen the extraordinary breadth and comprehensiveness of the ideas which have developed as the work proceeded, or have realised

the extent of their implication in matters of great scientific and practical importance.

The work under notice now tells the whole tale in a form which leaves nothing to be desired, and adds at least one new chapter. It is not difficult to understand how much it must have cost of resolution and hard labour to bring to its present form the vast amount of material that had accumulated in Sir George Beilby's hands, and we must all be grateful to Sir Herbert Jackson, whose persuasiveness brought Sir George Beilby to the point of setting out on his task, and whose help, along with that of Mr. W. D. Haigh, is very gratefully acknowledged by the author. "I unhesitatingly say," he states, "that without his (Mr. Haigh's) constructive skill and insight the work would not have been accomplished." And we may add that no one more than Sir Herbert Jackson was in a position to appreciate the importance of Sir George Beilby's work.

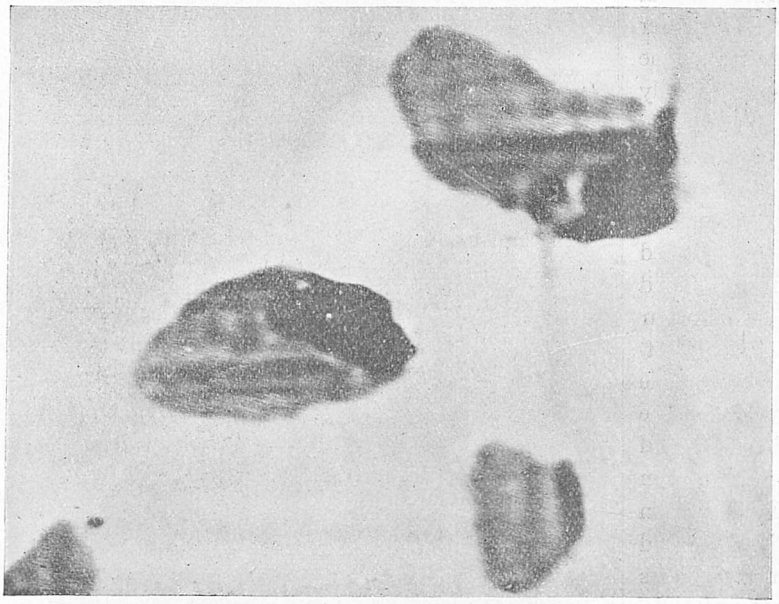

FIG. 2.—Crystalline antimony polished by emery and rouge and etched with potassium cyanide, showing film of flowed metal covering pits. From "Aggregation and Flow of Solids."

The letterpress extends over some 250 pages, clearly printed and in every respect easily readable. The concluding part consists of thirty-four beautiful reproductions of a series of figures, nearly all photographic. Not one of them is uninteresting, and most of them are remarkable. In the letterpress the topics dealt with in sequence are the following: Microscopic methods and measurements; surface tension films in liquids and solids; the varied ways in which aggregation takes place; cohesion among minute solid particles and between these particles and flat surfaces; polish, the result of surface flow; the crystalline and vitreous states in solids; influence of the crystalline and vitreous states on the physical and mechanical properties of ductile metals; influence of the crystalline, mobile, and vitreous states on the flow of rocks and ice; molecular pulsation cells: a tentative hypothesis; extension of Faraday's work on the optical and other characteristics of thin metal leaves; phosphorescence of crystals effected by the change from the crystalline to the vitreous state.

The general nature of Sir George Beilby's work can probably be best understood by thinking of the conditions under which it was carried out. We have to picture a man of scientific taste and talent, whose lot has been cast in the industrial world, eager to devote his leisure to the advancement of fundamental knowledge and compelled to select a topic that can be cultivated experimentally under home conditions, that do not give any very exceptional facilities for experimental work. Under these limits, what better than to take up the study of some topic of micro-chemistry or micro-physical chemistry? Able to provide himself with the best appliances for his purpose, and skilled in the manipulative art of the chemist, he develops a highly special technique, and with all these resources applies himself to particular problems of his subject. The result is a series of refined observations and delicate manipulations which has disclosed many things never seen before and established many new facts about the structure and behaviour of solids.

It is really very difficult to give a summary of what is contained in this book. It would be rather like writing a short paragraph summarising the incidents of an Antarctic explorer's voyage of discovery. No doubt it is possible to say, in a word, that the centre of Sir George Beilby's doctrine is the vitreous film of solids, but the great interest of the book lies in the record of successive experimental steps by which the facts have been established and amplified. To the student of molecular physics, the metallurgist and engineer, the geologist, the fine artificers of glass and metal, the records have something of first-rate importance to say.

The present writer is probably not singular in having felt surprise on first learning that the final perfect polish of glass or metal was produced by the use of an abrading agent. One could understand the finer and finer scratches of grinding giving a greater and greater smoothness, and it was possible in the

mind to conceive the *ad infinitum* refining of scratches to the attainment of a perfect sheen. But in actual practice, with a last abrasive even so fine as particles of rouge, it seemed as if there must somehow be a jump at the end between these earthy scratches and the perfect polish of speculum or plate glass. The practical attainment of such a polish seemed much

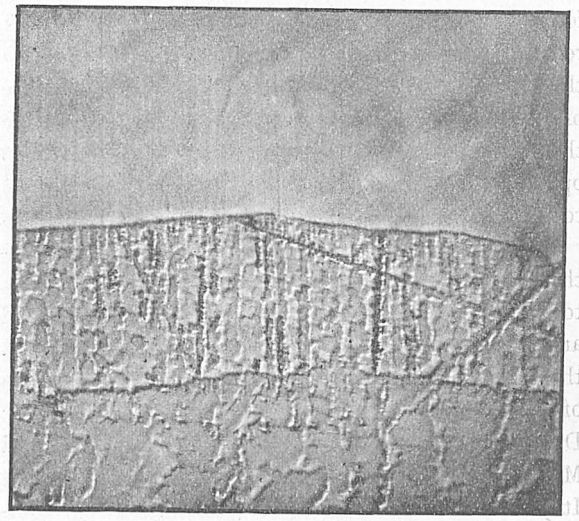

FIG. 3.—Etched calcite surface showing the untouched skin and the under surface at 500 and 1000 $\mu\mu$. From "Aggregation and Flow of Solids."

more easily understood when a custodian of some of the finest old silver at Cambridge, on being asked how the brilliance was produced, simply exhibited the flesh side of an ample thumb, with a gesture and mien indicative of a *flattening* pressure exerted steadily through the ages. Sir George Beilby now tells us, and it is a relief to know it, that the microscopically differentiable particles of rouge are smaller than we thought, that they are also much harder, and that when they are spread over a leather they present a layer such that when the leather is passed over the glass or metal surface, this is *seized* as a whole, the mobility of a liquid is temporarily produced, and when the leather has passed, a film is left with all the qualities of matter that has set like melted glass. Not only so, but "whilst to produce 'mass flow' in the hardened steel of which a razor is made a differential pressure of hundreds of tons per square inch would be required, yet the 'surface flow' necessary to keep the edge of the razor in perfect cutting condition can be effected by lightly stropping the blade on the bare hand a few times daily, before and after use!"

These examples are perhaps sufficient to indicate why and how this work on the surface leads to a study of the hard and soft state in metals, the flow of rocks and ice, the phosphorescence and triboluminescence of solids, and many other things besides.

A word must be said about the magnitudes dealt with in the investigations. The study of a calcite surface will suffice as an illustration:—

"When a condensed beam of sunlight was used to give oblique illumination of the surface, it was possible to detect the effect of a drop of acid which contained only 0·000125 per cent of HCl. The depth of the layer removed did not exceed 0·62 $\mu\mu$. . . . If it is correct to assume that the solvent effect of the acid was uniformly distributed over the whole surface of the pit, then it follows that a roughening of the surface not more than two molecules in depth has been detected." Again, "the mechanical disturbance caused [on calcite] by the polishing agent penetrates to a depth of 500 to 1000 $\mu\mu$."

The frame of reference of Sir George Beilby's thinking has been almost wholly that which preceded subatomism. In a short chapter he sketches his tentative working hypothesis of molecular "pulsation cells." Of this it must suffice to say that it has clearly served its purpose, for it has worked—it has led to a solid output of new knowledge. "Cohesion" is isolated in the old way as a force *sui generis*, and a fine picture is made of cohesion holding matter together in a dead world until there comes the advent of heat "like the first breath of approaching spring into the sleeping buds." Sir George Beilby has brought his rich gift of facts up to the frontiers of the newer physical

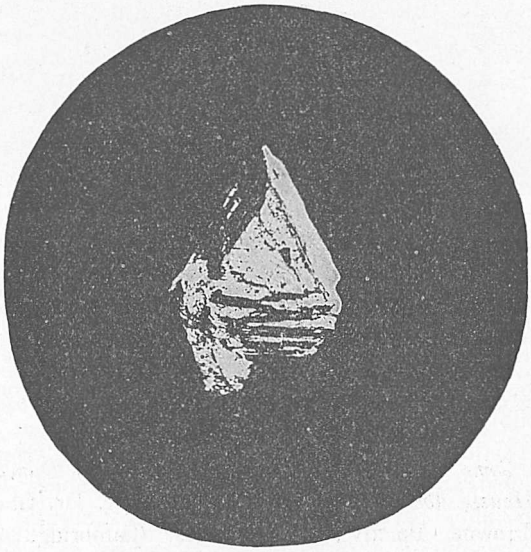

FIG. 4.—Microscopic crystal of antimony. From "Aggregation and Flow of Solids."

science. It must obviously engage the interest of those on the other side. There are especially to be mentioned the Braggs, the work and views of Langmuir, and the new light on lubrication coming from W. B. Hardy's experiments. But whatever may be added, the facts remain as a remarkable addition to scientific knowledge.

In conclusion, one or two suggestions may be made.

As to faults, there is need of revision at the beginning of the book in reference to the characteristic of the boiling-point. There is no index, and though one can see the peculiar difficulty of indexing this book, the omission is an inconvenience. It seems worth considering whether enlarged copies of the beautiful photographs which illustrate the book might not be

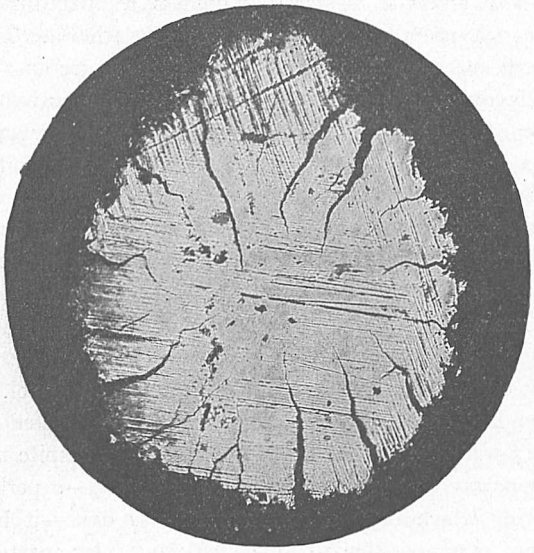

FIG. 5.—The crystal of Fig. 4 flattened by a single blow from a small drop-hammer; the thin plate was in a highly strained condition and the cracks developed in 24 hours. From "Aggregation and Flow of Solids."

issued so that they could be framed and hung on class-room walls.

A last suggestion, offered to teachers, is that this book should be freely prescribed to students of physical science. It seems very important in times with so strong an atmosphere of relativity and with *quanta* to some of us almost more than *suff.*, that students should see how much may still be accomplished by a faithful, indefatigable experimenter, who, with full knowledge, yet without prejudice, will scrupulously examine what lies positively and immediately in front of him. A. SMITHELLS.

Pictish Stone Circles.

On Some Antiquities in the Neighbourhood of Dunecht House, Aberdeenshire. By the Rt. Rev. Dr. G. F. Browne. Pp. xiv + 170 + 63 plates. (Cambridge: At the University Press, 1921.) 63*s.* net.

DUNECHT HOUSE, Aberdeenshire, became known to science by the researches of Drs. Copeland and Lohse at an observatory established there by the Earl of Crawford. The district so thoroughly examined by the distinguished author of this superb book is that of Lady Cowdray's Scottish estate and the immediate surroundings, a district known as "'twixt Don and Dee."

Confining my remarks to the subject which is given the largest space in the book, there is in the district of Dunecht a "large number of stone circles unique in type" (p. 1), the characteristic feature being a tangential alignment, generally in the south-west quadrant, made by a recumbent stone and its upright flankers. Of these circles Sir Norman Lockyer examined twenty-nine, and in fifteen instances he found a clock-star alignment at right angles to the recumbent stone. He discovered, in fact, the key to this unique type of circle. In my opinion, the glory of Dr. Browne's work on the Dunecht circles shines in the fact that in it the typical Pictish temple thrown open by Sir Norman Lockyer may now be inspected to the smallest detail.

A happy inspiration led the author to appeal to the Principal of the University of Aberdeen for a survey to be made of three circles, using the recumbent stone and flankers as a tangential base line, and measuring the alignment made by each stone with the middle of the recumbent stone. The survey was made by Drs. Fyvie and Geddes, and the circles were those of Midmar, Castle Fraser, and Sin Hinny (Sunhoney). It is most fitting that the three plans form Plate I.

Realising the importance of Dr. Browne's contribution to science, I have examined the seven plans of circles given in the book, and find that the alignments of the other four are also to be interpreted from the recumbent stone, the evidence being alignments in pairs at right angles to each other.

The whole truth, partly discovered by Sir Norman Lockyer, seems to be this: In the Pictish type of circle all alignments must have been originally made in pairs at right angles to each other. Finding this first, or fundamental, principle of circle-building fully established in each of the seven cases examined, I have applied that principle to test the present condition of each circle. By such a test six circles are found to be defective, and I think it is quite possible, theoretically, to restore the defective parts.

It is most fortunate that one circle is perfect according to the revealed Pictish standard, and that is Auchquhorthies (p. 69). It consists of a recumbent stone and flankers and nine other stones (the three stones on the inner side of the recumbent stone had probably some supplementary use). The outer sides of the flankers are aligned with the recumbent stone, but on their inner sides they have separate alignments which rank in the rectangular scheme of the circle and, with those of the nine out-lying stones, have a common base at the middle of the recumbent stone. The twelve separate alignments made by the twelve stones of the circle proper present six pairs of complementary measures. To obtain this result it is necessary

to measure the angular width of each stone from the observational base, and both the side measures and the average measures thus obtained should be studied. The following are averaged measures :—

1.	N.W. 72° S.E. (base line) . .	N. 19° E.
2.	East point	N. 2° E.
3.	N. 74° E.	N. 13° W.
4.	N. 63° 15′ E.	N. 28° W.
5.	N. 48° 45′ E.	N. 42° W.
6.	N. 33° 45′ E.	N. 57° W.

The average angle for the series is about 89° 30′. In two instances, side alignments form perfect right angles. In other instances it seems highly probable that the angular width of a stone was utilised for two alignments. Thus, of the side measures averaged as N. 42° W., the one on the north side of the stone is 38° and the one on the south side is 46°. By the table of solstitial azimuths for lat. 57° N. given on page 381 of "Stonehenge" (sec. ed.), 46° would be sunset at the summer solstice with a horizon of 2° high, and 38° would be sunrise at the winter solstice with the horizon a trifle higher.

It is a great thing to know that the position of each stone in a Pictish circle is, or was intended to be, at right angles to some other position. If the observational base of other types of circles could be discovered it is extremely likely that the same fundamental principle would be found applied. Given a number of rectangular alignments, with horizon measures, it is practically certain that for each circle a star cast, like that of actors in a drama, could be made out, making the determination of the period involved comparatively easy.

Without horizon measures, the solar alignments of the Dunecht circles are easily recognisable. Judging by the one complete circle described, we are warranted in assuming that both the May-year and the solstitial year are provided for. Regarding the base line as of first importance, we have May-year, solstitial, and stellar circles of one and the same cultural type. For an explanation of this variety in unity we need, for one thing, a new survey of all the Pictish circles on the plan suggested by Dr. Browne. JOHN GRIFFITH.

Thorpe's Dictionary.

A Dictionary of Applied Chemistry. By Sir Edward Thorpe. Assisted by Eminent Contributors. Vol. 2: *Calculi to Explosion.* Revised and enlarged edition. Pp. viii + 717. (London: Longmans, Green and Co., 1921.) 60*s.* net.

THE "Dictionary of Applied Chemistry" has now become so indispensable to workers in pure as well as in applied chemistry that it can be stated without fear of contradiction that no library either in the university or in the works can be regarded as complete without it. The appearance of the second volume of the new edition following so closely on that of the first will therefore be welcomed, and will be taken as an indication that the remaining volumes will be published with equal rapidity. The first feature which is noticeable in the new volume is the decrease in size and the increased handiness compared with the corresponding volume of the last edition. This result has been attained by reducing the number of pages by about eighty and by using a thinner paper, the general effect being to produce a volume which can be held in the hand readily without fatigue. It follows, although it is not specifically stated, that the publishers intend to issue the dictionary in six or more volumes instead of the five which have hitherto sufficed.

The subject-matter in the volume under review therefore comprises part of that issued in vol. 1 of the last edition and part of that which appeared in vol. 2. The last edition of the dictionary was reprinted in 1917 from the revised edition of 1912, but despite the comparatively short time which has elapsed—a period during which little scientific work was done—it has been found possible to introduce much new matter; this is shown by the fact that the subjects dealt with in the present volume occupy 717 pages, whereas in the last edition they filled 547 pages only.

On the whole there is little call for criticism. The article on carbohydrates—one would like to see this name abandoned because, obviously, the sugars of the rhamnose group, $C_6H_{12}O_5$, are not carbohydrates—by E. F. A. is altogether admirable and stands out by itself as an illustration of what can be done by a master of his subject to make a highly complex chapter in organic chemistry interesting to expert and lay-reader alike. On the other hand, the article on camphor is very disappointing. It is difficult to understand what useful purpose can be served by publishing an article on the chemistry of this substance which does not contain one single graphic formula. Had this edition been published thirty years ago there might have been some justification for the inclusion of this article. The articles on carbolic acid and cellulose remain practically unaltered; it is doubtless too soon to expect to find a full description of the many important uses to which these substances and their derivatives were put during the war.

The article on chlorine has been entirely rewritten by H. B., and is an exhaustive account of this element. It contains a vigorous reference to the use of poisonous substances by the Germans during the war, and gives a list of some of those employed. One would like to have seen, however, an article on chemical

warfare (it is not too late, because it can still come under Warfare) in which this important subject would receive full treatment and in which the activities of British chemists would obtain recognition. It is a curious fact that the need for such an article was emphasised by Sir Edward Thorpe himself in the review he wrote on the book published recently by Prof. Moureu in which this distinguished French chemist describes the activities of his own countrymen. In the next edition the article on chemical warfare might well follow that on chemical affinity.

One is glad to note that the old article on vegeto-alkaloids is to be abandoned, and the different subjects are to be treated under their own heads; thus there is an excellent article on cinchona alkaloids by B. F. H. and O. C., which gives a full account of these important substances. The articles on the natural colouring matters and allied substances by A. G. P. are especially noteworthy, as are those on certain drugs, which fall within this section, by G. B. It is articles such as these which render the dictionary indispensable to the research worker, because they give in a clear and concise manner all the essential details of the chemistry of the substances dealt with and do not confuse the issue by a mass of irrelevant data. It is usually difficult to find information of this kind elsewhere.

Of the longer articles on subjects of general interest, those on carbon, coke manufacture, and recovery of by-products by W. A. B. and E. R., copper cyanides by T. E., distillation by S. Y., and gaseous explosion by W. A. B. and R. V. W., have been brought up to date but otherwise retain the features which have rendered them so useful in previous editions.

There are some completely new articles, and, of these, that on colour and chemical constitution by E. R. W. is particularly interesting. Most chemists will be familiar with the book on this subject which the same author contributed to the series of monographs on industrial chemistry edited by Sir Edward Thorpe, and although they may not all agree with many of the views expressed therein, they cannot but acknowledge that the account given is a fair and clear description of our present position in regard to this very complex question. The present article may be described as a *précis* of the book, and is well worth perusal. Another new article is that by J. N. F. on the corrosion of metals. This is a subject which this chemist has made his own, and there are few who can write on it with greater authority. It is well written, and presents the subject from a point of view which cannot fail to be interesting. The article on dyeing remains much the same as in former editions. One wonders if the tables for detecting colours on the fibre, which occupy fifteen pages, are really worth the space. It may be noted in passing that although the excellent article on cholesterol is signed I. S. M., the name of this distinguished lady does not appear among those of the eminent contributors at the commencement of the volume.

J. F. T.

A New View of Fertility.

The Law of Births and Deaths: Being a Study of the Variation in the Degree of Animal Fertility under the Influence of the Environment. By C. E. Pell. Pp. 192. (London: T. Fisher Unwin, Ltd., 1921.) 12*s.* 6*d.* net.

IN the issue of NATURE for September 22, 1921, p. 105, appeared an article on "Causes of Fluctuation of the Birth-rate," the statements and speculations in which are usefully supplemented in the present volume, which is a valuable contribution to the discussion of this important problem. The main thesis of the book is that the decline of the birth-rate is not explicable on the hypothesis that it is due to the deliberate evasion of child-bearing, but that it can be explained as the result of a natural law the function of which is to adjust the degree of fertility to suit approximately the needs of the race. Much ingenuity is displayed in arriving at the conclusion that the response to the action of the environment in the degree of fertility bears an inverse proportion "to the intensity of the nervous charge," and that the principle involved is a law governing the union of sperm cell and ovum. Unlike Doubleday, whose theory was that a plethoric condition of the organism is unfavourable to fertility, Mr. Pell regards food as only one factor and thinks there is good reason for believing that cerebral development and mental activity are far more important than the supply of food. In this respect his theories approximate to the well-known views of Herbert Spencer as to the inverse relationship between ability to maintain individual life and the ability to multiply.

The arguments by which the above propositions are supported are ingenious and suggestive, although occasionally weak and doubtful points are presented with as great confidence as strong arguments. Thus the author argues from very imperfect data that the sale of contraceptive articles does not take place on a scale large enough to account for the lowered birth-rate, and he assumes the accuracy of the limited data available as to sterility and small families in circles where contraceptive methods are or are not practised. Such data would need to be corrected for age distribution of the married couples under comparison and for the duration of marriage before valid inferences could be drawn. Even then it would scarcely be practicable

to correct for the varying prevalence of gonorrhœa, a chief cause of sterility, and of syphilis, a chief cause of still-births and miscarriages.

On the other hand, the author makes valuable use of illustrations given by Darwin and others of the varying fertility of animals under domesticated conditions. It is evident that there is in this direction a line of valuable investigation into the laws governing fertility which has hitherto scarcely been explored. The evidence is none the less valuable because throughout this book it is pressed into service in support of the author's hypothesis that increasing nervous energy, high feeding, and diminished physical labour reduce fertility, whether in mankind or in the highly bred racehorse.

Travel and Exploration.

(1) *Hints to Travellers. Scientific and General.* Tenth edition. Revised and corrected from the ninth edition, edited for the council of the Royal Geographical Society. By E. A. Reeves. Vol. 1, *Surveying and Practical Astronomy.* Pp. xv+470. Vol. 2, *Meteorology, Photography, Geology, Natural History, Anthropology, Industry and Commerce, Archaeology, Medical, etc.* Pp. vii+318. (London: The Royal Geographical Society, 1921.) 21*s.* net (two vols.).

(2) *Camping and Woodcraft: A Handbook for Vacation Campers and for Travellers in the Wilderness.* By H. Kephart. New edition, two volumes in one. Pp. 405+479. (New York: The Macmillan Company; London: Macmillan and Co., Ltd., 1921.) 16*s.* net.

BOTH these books are written for the traveller, but they look upon his needs from different points of view. In their scope and appeal, no less than in their style, they differ widely. The first may be said to minister to the intellectual needs of the traveller, the second to his material wants.

(1) "Hints to Travellers," which now reaches its tenth edition, has been known for many years as an almost indispensable volume for the traveller who aims at doing any useful scientific work. Mr. Reeves's volume on surveying and practical astronomy must have found its way into more remote corners of the world than any other book except the *Nautical Almanac.* The present edition has been revised, particularly as regards the second volume, but the general plan of the book remains unchanged. The addition of a few pages devoted to marine invertebrates would not be amiss in the natural history section, and might help to direct attention to an aspect of collecting which many travellers are prone to overlook.

(2) Mr. H. Kephart's aim is to teach the traveller how to live rather than to take observations and record facts. The two volumes, which are bound together, deal respectively with camping and woodcraft. They have grown from an earlier single volume which was published in 1906 and was devoted entirely to travel in the wilds. The author now appeals to a wider public, and devotes much attention to the growing class of holiday-makers who camp, not from necessity, but by choice. For the benefit of the latter there are chapters on fixed camps and camp furniture. The chapter on camp cookery is most elaborate. Mr. Kephart expects campers to live well—his dishes and recipes take us far from the simplicity of oatmeal, bacon, and tea, which are so often the staples of camp life—but evidently the amateur camper in America does not risk any hardship or privation. The chapters on tents, bivouacs, clothing, camp-fires, packs, and cave exploration, to mention only a few, are full of useful hints, even if some of them are too obvious to merit inclusion. There are useful remarks on axemanship, and well-illustrated notes on knots and hitches. The notes on accidents and emergencies are most practical. Altogether Mr. Kephart's book makes fascinating reading, and, even if primarily designed for life in the forests of North America, it should prove useful to campers all the world over, and should certainly find a place in every boy scout library.

R. N. R. B.

Our Bookshelf.

Introduction to Textile Chemistry. By H. Harper. (Life and Work Series.) Pp. ix+189. (London: Macmillan and Co., Ltd., 1921.) 3*s.* 6*d.*

LARGE extensions in the work of elementary education, provided in the Education Act of 1918, have given rise to the necessity for providing books of a new type. Whether the increased facilities for education offered by the Act are ever to materialise cannot yet be stated, but the series in preparation by Messrs. Macmillan and Co., three volumes of which have been issued, seems to provide a type of book which should have a very beneficial influence on education beyond the elementary-school standard. One of the arguments against education is that it unfits the "worker" to perform his daily routine. Even the least intelligent critic would probably admit that a workman is not less useful when he knows something about the material he handles and the machinery which manipulates it. The "Life and Work Series" will assist education which, without being narrowly utilitarian, takes as a basis the life and work of man—a wide enough scope for any educator.

The present volume is evidently the work of an experienced teacher. The reviewer has taught students of a textile centre on similar lines, and he is of opinion that the book should be most successful. Wool has, no doubt on account of the locality of the author's school, a more prominent place than cotton, which will make

the book less useful in Lancashire. In the reviewer's opinion it would be better to have a separate book dealing with cotton in more detail. The paper, printing, and illustrations are excellent.

Ancient Tales from Many Lands: A Collection of Folk Stories. By R. N. Fleming. Pp. 193+ix plates. (London: Benn Bros., Ltd., 1922.) 10*s.* 6*d.* net.

IN bringing together this collection of tales Miss Fleming has cast her net wide. Japan, China, India, North America, Egypt, Mesopotamia, ancient Greece, and the British Isles, to name only some of the sources, have contributed to a whole which, viewed merely as a collection of folk-tales, is charming both in subject-matter and in style. The author has, however, had more in view than to provide a pleasant pastime for an idle hour. Her aim has been to present in these traditional stories, in which the spirit of the original is preserved as nearly as possible, a picture of the culture and modes of thought of primitive and early historic peoples in a form that can be utilised and interpreted by the teacher, whether of history or social geography, and at the same time appreciated by the child. Miss Fleming adds in an appendix three essays in which she expounds her philosophy of the use of the folk-tale in education and the principles of selection. If any further indication were needed of the thought, wide reading, and experience which have been laid under contribution in the making of this book, it would be afforded by these essays.

Confectioners' Raw Materials: Their Sources, Modes of Preparation, Chemical Composition, the Chief Impurities and Adulterations, their More Important Uses, and Other Points of Interest. By J. Grant. Pp. viii+173. (London: Edward Arnold and Co., 1921.) 8*s.* 6*d.* net.

THE author of this little volume set himself no light task in attempting to provide a handbook suited to the needs of students taking organised courses of instruction in the principles governing confectionery practice. These students usually possess little or no knowledge of elementary science, while, on the other hand, their subject enters many and varied fields of scientific inquiry with which it is by no means easy to deal in simple language. In our opinion the author has skilfully compressed into a small volume and in a readable form a mass of information, hitherto available only in a scattered and relatively difficult literature, which should be of much assistance to the students concerned. A useful introduction is followed by chapters on alcoholic beverages used as flavouring agents, carbohydrates, fruits, essential oils, eggs, and egg products; there is also a useful outline of the methods employed in the analysis of raw materials. The book is by no means without imperfections. The sections dealing with botanical subjects need revision by a botanist, whose recommendations would certainly include suggestions for alternatives to some of the illustrations on p. 101. Again, a bibliography which gives as consecutive entries "Bolton and Revis—*Fatty Foods*," and "Britannica—*Encyclopaedia*," clearly needs drastic revision. Further, the sub-title could easily be improved.

Cocoa. By Edith A. Browne. (Peeps at Industries.) Pp. viii+88. (London: A. and C. Black, Ltd., 1920.) 2*s.* 6*d.* net.

WE have had much pleasure in reading this well-illustrated little book, which is a notable addition to a useful series. Miss Browne, who has first-hand knowledge of the Gold Coast, takes her readers on a personally conducted tour through the cocoa-growing districts of the Gold Coast Colony and Ashanti, which, as most people know, now form the premier cocoa-growing region of the world. The information conveyed in this interesting fashion is complete, accurate, and well arranged, and is supplemented with admirable glimpses of West African life. Balance is given to the book by an account of cocoa-growing in other countries, followed by a description of the manufacture of cocoa products in two well-known English factories. Miss Browne finds opportunity to warn the West African cocoa industry of the potentialities of South American cocoa-growing countries now deprived of their former pride of place. The warning is well timed and merited, not solely on the grounds mentioned by the author.

A Star Atlas and Telescopic Handbook (*Epoch* 1920) *for Students and Amateurs.* By A. P. Norton. Pp. 34+16 maps. (London: Gall and Inglis, 1921.) 10*s.* 6*d.* net.

A NEW edition of this useful atlas and astronomical handbook has been published. The maps are clearly printed on a scale of 8° to the inch, and they include stars down to the sixth magnitude, with many fainter objects of interest. The letterpress contains an explanation of all ordinary astronomical terms and much information on both the solar and the stellar systems, together with hints on the use and care of the telescope. There is a clear lunar map, with the names of the principal formations.

A few errata may be noted: on p. 6, along the circles of 6h. and 18h. R.A. declination and latitude have the same direction; on p. 10 the annual P.M. of Groom. 1830 is 7″, not 17″; the magnitude of the Barnard star in Ophiuchus is 10, not 13; and on p. 11 the object entered in the nova list at the date A.D. 389 was certainly a comet and never went near the constellation Aquila. The information given, however, is full and accurate with very few exceptions.

A. C. D. C.

The Practical Electrician's Pocket-book for 1922. Twenty-fourth annual issue. Edited by H. T. Crewe. Pp. lxxxiii+558+54. (London: S. Rentell and Co., Ltd., 1922.) 3*s.* net.

WE can recommend this pocket-book to all who are practically engaged in any of the industries in which electricity is used. This edition has been revised and contains new sections dealing with tungar rectifiers, railway signalling and current limiters. The latter are devices which either cause the consumer's lamps to flicker in an intolerable way or to become dim if he tries to take more than his permissible current.

The Age of Power: A First Book of Energy, its Sources, Transformations, and Uses. By J. Riley. Pp. viii+248. (London: Sidgwick and Jackson, Ltd., 1921.) 4*s.* net.

DESIGNED originally for use in continuation schools,

this book will be found equally suitable for the middle forms of secondary schools. Containing, as it does, excellent descriptions of the mode of working in windmills, the steam engine, the internal combustion engine, hydraulic, steam, and internal combustion turbines, etc., it cannot fail to interest boys and to increase their interest in their physical studies. There is enough, but not too much, speculative matter included to stimulate the thoughtful reader. We can thoroughly recommend the volume as providing a useful addition to the ordinary school course.

An Introduction to the Physics and Chemistry of Colloids. By E. Hatschek. (Text-Books of Chemical Research and Engineering.) Fourth edition, entirely rewritten and enlarged. Pp. xiv+172. (London: J. and A. Churchill, 1922.) 7*s.* 6*d.* net.

MR. HATSCHEK'S book is one of the best introductory text-books on the subject in any language, and is widely appreciated. The present edition has been rewritten and enlarged, and embodies much of the recent work on the subject. It should be in the hands of all students of chemistry, and for this reason it is much to be regretted that the price is not lower.

The Manufacture and Uses of Explosives, with Notes on their Characteristics and Testing. By Dr. R. C. Farmer. (Pitman's Technical Primer Series.) Pp. xii+116. (London: Sir I. Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

ALTHOUGH interest in the military applications of explosives has probably waned to a considerable extent in most countries, it is perhaps not generally realised what an important part these products of chemical invention play in the arts of peace. The name of the author of this small book is sufficient to guarantee the accuracy of the information contained in it, and it is only necessary to state that Dr. Farmer has compressed into about a hundred small pages a surprising amount of up-to-date material. The style is easy, but the treatment is such that the book is far from being merely a "popular" account of the subject: it is a small encyclopaedia, which may be read with advantage by all students of chemistry as well as by those more directly interested in the manufacture and uses of explosives. The very important source of sulphur at Louisiana should have been mentioned on p. 37.

Directive Wireless Telegraphy: Direction and Position Finding, etc. By L. H. Walter. (Pitman's Technical Primer Series.) Pp. xii+124. (London: Sir I. Pitman and Sons, Ltd., 1921.) 2*s.* 6*d.* net.

IT is now thirteen years since Bellini and Tosi read their paper on "A Directive System of Wireless Telegraphy" to the Physical Society of London. Although Marconi and Fleming had previously done good work on directive radio-telegraphy, it was this paper that first showed British physicists how directive signalling could be obtained by using a fixed aerial and only rotating a small coil of wire. The method, however, lay almost dormant until the war proved its great practical utility. Mr. Walter was one of the pioneers of the Bellini and Tosi system, and in the volume under notice a *résumé* is given of most of the useful practical information available. The author has utilised much of the theory recently published by the Bureau of Standards and by the Signal Corps of the United States War Department. The mathematics given is of the most elementary description, and will be readily understood by every physicist and engineer. We can commend this book.

Fuel and Lubricating Oils for Diesel Engines. By W. Schenker. Pp. xii+114. (London: Constable and Co., Ltd., 1921.) 15*s.*

THE title of this book is apt to convey a wrong impression, as its contents in the main are of a general character, and not specially devoted to Diesel engines. There are three sections, the first of which deals with the origin and preparation of various kinds of fuel oils, with special reference to the varieties which may be used for Diesel engines; the second section treats very briefly of lubricating oils; whilst the third consists of a description of the commercial tests applied to these oils. The book would have been of greater service to British consumers of oil had the author included a fuller account of the methods of testing and forms of specification used in this country instead of confining himself to Continental practice in these particulars. Thus Redwood's viscometer, the British standard instrument, is dismissed in a dozen lines, and Abel's flash-point apparatus is not mentioned. Descriptions of other appliances are sometimes too meagre, the bomb calorimeter being given only eleven lines, whilst a purifying apparatus, illustrated on p. 66, is entirely undescribed in the text. In spite of these drawbacks, however, the book contains much useful information of a practical kind. C. R. D.

The Wonder Book of Science. By J. H. Fabre. Pp. 287. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THE object of Fabre in writing the series of essays under notice was to impart general knowledge about things that are familiar to the eyes, though not necessarily to the understanding. The first seven essays deal with insect-life, and these are followed by a number on birds, on some of the facts of plant-life, on the various forms of water and the application of steam, on the elementary phenomena of electricity, etc. These essays, which touch on so many subjects, illustrate Fabre's method of arousing the interest of young people in the phenomena around them. In all, forty-eight essays are reproduced, but the name of the translator does not appear.

More Hunting Wasps. By J. H. Fabre. Translated by A. T. de Mattos. Pp. viii+376. (London: Hodder and Stoughton, Ltd., n.d.) 8*s.* 6*d.* net.

THROUGH the energies of the late Alexander de Mattos a number of Fabre's most interesting studies in insect-life have been rendered accessible to the general reader in this country. The present volume consists of fourteen chapters, which complete the essays in the "Souvenirs Entomologiques" devoted to wasps. The remainder have already been translated in two earlier volumes entitled "The Hunting Wasps" and "The Mason Wasps." Two of the essays in this book, which form chaps. 2 and 10, have already appeared in previous translations, while the remainder are rendered in English for the first time. Most admirers of the writings of the French *savant* will welcome the appearance of this book and revel in the fascinating

stories of insect behaviour that are recorded in its pages. Fabre is admittedly a difficult writer to translate, and the charm of his diction only too readily escapes if too much freedom be exercised. Mr. de Mattos's task, therefore, has not been an easy one, but he has carried it out conscientiously and with evident care for accuracy.

A First Book of Applied Electricity. By S. R. Roget. (First Books of Science.) Pp. viii + 143. (London: Macmillan and Co., Ltd., 1921.) 2*s*. 6*d*.

THE author has made a very successful attempt to give the elementary principles which underlie the useful applications of electricity and magnetism without worrying the reader with academical definitions and difficulties. The book has what we think is a great merit—namely, that it is entirely independent of the requirements of examinations. It is therefore more interesting than the ordinary treatise, and covers a much wider field.

It can be recommended to the general reader anxious to get an easily acquired, accurate, and useful knowledge of electrical matters. The ordinary student reading for examinations will also find it a useful introduction to more advanced treatises.

Perfumes, Essential Oils and Fruit Essences used for Soap and other Toilet Articles. By Dr. G. Martin. (Manuals of Chemical Technology.—X.) Pp. vii + 138. (London: Crosby Lockwood and Son, 1921.) 12*s*. 6*d*. net.

DR. MARTIN'S book is of a severely practical character; it contains much information in a very condensed form, and should be useful as a work of reference to those interested in the manufacture of the class of materials of which it treats. A large number of practical recipes is given. The section on analysis, occupying only four pages, is too brief to be of real value. No references to the literature are given beyond the mention of a few patents and a list of ten books on the subjects treated.

"*Power's*" *Practical Refrigeration*. Compiled by the Editorial Staff of *Power*. Pp. viii + 283. (New York and London: McGraw-Hill Book Co., Ltd., 1921.) 10*s*. net.

THE practice of ammonia refrigeration, including a simple account of the theory and tables of useful constants, is discussed in this volume. A number of practical hints for users of refrigeration plant, written in a colloquial style, forms about half the book, which should be useful to persons in charge of such plant.

Chemistry of Pulp and Paper Making. By E. Sutermeister. Pp. vii + 479 + 31 plates. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 36*s*. net.

THE chemical aspects of paper-making are dealt with in the volume under notice, the mechanical processes being described only in so far as they are necessary for an understanding of the chemistry. Although concerned chiefly with American practice, and less complete than the standard English treatises, the volume should be of service to chemists in paper-works laboratories. It is clearly written and well illustrated.

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.*]

The Directive Tendency of Elongated Bodies.

THIS letter deals with several topics, perhaps somewhat remotely related to one another, but all suggested by previous letters on the same general subject in NATURE of October 20, November 24, December 1, and December 22, 1921.

In my letter of December 22 it was suggested that Mr. Reeves's results might be explained by the peculiarities of the gravity field at the place where the experiments were made. The letter was written before Mr. Reeves's letter appeared and while I was under the impression that his experiments were all made at one place. The suggestion might be plausible as regards any one place, at least until measurements had been made there with an Eötvös balance, but would be highly improbable when applied to every one of the widely scattered places where Mr. Reeves made his tests.

Col. Grove-Hills in his latter in NATURE of November 24 directs attention to an important difference between the turning effect of the earth's field on an elongated body supported at its centre of gravity and the turning effect on a similar body when supported by flotation. He attributes quite undeserved credit to me, however, in stating that this matter is fully treated in my article in the September (1921) issue of the *American Journal of Science*. Only a very special case of the turning effect on a floating body is there treated, and that case is scarcely analogous to the one considered in recent issues of NATURE.

There are two kinds of forces acting on a floating body, namely, the force arising from the earth's gravity field, which is a body force, and the normal pressure of the fluid on the wetted surface. By well-known theorems concerning the transformation of surface integrals into volume integrals it may be proved that the effect of the fluid pressure may be replaced by the body force arising from the earth's field reversed and applied to a solid bounded by the wetted surface and by the free surface of the fluid extended in imagination into the floating body, the density of this solid being the same as that of the fluid. This theorem is proved in very elementary fashion in the ordinary theory, in which gravity is assumed to be constant in intensity and direction, but is equally true when gravity varies in intensity and direction from one part of the region considered to another.

In dealing with the turning effect on a floating body of the earth's field and of the fluid pressure, it is necessary to make some assumption regarding the depth to which the body is submerged; a natural assumption is that the body is submerged to such a depth that the downward pull of the earth's field is just balanced by the upward thrust of the fluid pressure or of the equivalent body force. Let us consider the case of an elongated body symmetrical about a vertical axis through the centre of mass of the body, and let us suppose the earth's field to be also symmetrical about the same axis; there is then no moment tending to turn the body about any horizontal axis. Several terms disappear from the general expression for the earth's field on account of the assumed symmetry, but those remaining represent the component of a force that turns the suspended elongated body about into the prime vertical for a normal field

of force, or in any case into the vertical plane where the curvature of the equipotential surfaces is a minimum. The turning moment of the direct effect of the earth's field about a vertical axis is precisely the same for the floating body as for a like body when suspended. For the total effect of the floating body we must consider also the turning moment of the fluid pressure, or of the equivalent body force, and this, in general, opposes the direct turning effect of the earth's field.

For a body like an elongated right cylinder the two turning effects practically cancel each other, so that the resultant is an infinitesimal of higher order, so to speak, than either turning effect by itself. It is possible, however, by varying the shape of the elongated body to make one or the other tendency prevail. If the body overhangs the fluid considerably, like the bow of a racing yacht, the direct effect of the earth's field has the advantage of position in producing a turning moment, and in the normal case the tendency of the body is to turn into the prime vertical, just as for the suspended body. If the body has its extreme end submerged, thus resembling the mirror images of the ends of the overhanging body, then the contrary tendency will prevail, and in the normal case the body will tend to set itself in the meridian. This tendency to seek the meridian would not, however, be true of all elongated floating bodies of dimensions comparable with those of the Eötvös balance, as Col. Grove-Hills would seem to imply.

My own interest in the effect of the earth's gravity field on floating bodies was due originally to an attempt to account for certain hypothetical displacements of each continental mass as a whole towards the equator. These displacements are believed by a well-known geologist—who for the present, however, does not wish to be quoted by name—to be established almost beyond question. His ideas differ somewhat from those of Prof. Alfred Wegener, of Marburg, who has published much regarding supposed continental displacements. The problem of the equilibrium of the mass of self-attracting gravitating fluid rotating about an axis, with a mass of lighter matter floating in the fluid and projecting out of it, is apparently one of considerable difficulty, especially if we consider the gravitational effects of the floating body on the field of force. Considerations of symmetry would lead us to suppose, however, that the floating body would not be in stable equilibrium at any random point on the surface of the body; the equator of the rotating fluid seems a natural place for stability, and a calculation of the forces acting shows that there is, in fact, a tendency for a floating body to move towards the equator—a tendency stronger, in general, the higher the body floats above the free surface of the fluid.

The difficulty with this equatorward tendency as an explanation of the supposed movements of the continental masses is that the movements appear to have occurred after the earth's crust was well consolidated and there could be no longer any question of floating continental blocks. There is, to be sure, a region of weaker and softer crust around the edge of each continental block, where a sort of syncline dips into the warmer regions nearer the centre of the earth. (All this geology is at second hand, or worse, and should be accepted only with appropriate reservations.) There would be also the weakness underneath the continental mass due to the heat there. In a way this condition resembles that of a floating body, and if for any reason the continental mass should move, the region of weakness around its edges would move with it. However, it does not seem especially probable that the weak gravitational field that tends to move a floating body towards the equator could accomplish very much in moving a continent that forms part of a fairly well consolidated crust.

Even though the equatorward force on a floating body may not be manifest in the displacement of continents, it may perhaps be discernible in the motions of much smaller floating bodies, namely, icebergs. The higher the iceberg the stronger this force. The acceleration may be written approximately for the normal case as

$$\frac{d}{a}\Delta g \sin 2\phi,$$

where d is the distance between the centre of gravity of the floating body and its centre of buoyancy, Δg the difference between the acceleration of gravity at pole and equator, ϕ the latitude, and a the radius of the earth. An iceberg 200 metres in height is rather exceptional for Arctic latitudes, but in Antarctic waters a height of 500 metres (1700 ft.) has been reported (see "The Seaman's Handbook of Meteorology," published by H.M. Stationery Office for the Meteorological Committee, third edition, pp. 132-35). If we suppose the icebergs to be plateaux with wall-sides and to have only one-eighth of their masses above the water, the values of d corresponding to visible heights of 200 and 500 metres would be 100 metres and 250 metres respectively.

The value of Δg is 5·18 cm. and of a $6{\cdot}37 \times 10^8$ cm. The maximum value of the equatorward acceleration on the two icebergs, which occurs in latitude 45°, would be 0·000081 and 0·000203 cm. per sec. per sec. respectively. At latitude 60°, the latitude of Cape Farewell in Greenland, these figures would be reduced to 0·000070 and 0·000176 cm. respectively; but even the smallest of the four accelerations acting for an entire day would, if unresisted, set the iceberg in motion, give it a velocity of more than 6 cm. per sec. at the end of the day, and move it 2·6 km. At the end of twenty days the velocity would be 1·2 metres per sec. and the displacement 1050 km., or more than nine degrees of latitude. With greater acceleration the effects would be greater in proportion.

It is fairly certain, however, that the resistance of the water would prevent the iceberg from actually attaining any of the larger velocities. Probably the terminal velocities from these small forces are of the order of magnitude of a very few centimetres per second. The dominant forces are the winds and currents, but these small forces arising from the earth's field would act more effectively on the higher icebergs and bring them more rapidly into low latitudes. One gets the impression in reading accounts of ice observed in low latitudes that large icebergs are the rule there rather than the exception. There are some obvious reasons for this. The large icebergs are less apt to be overlooked and better able to survive the warm weather than are the small ones. The selective effect of the earth's field is merely an additional reason for the frequent occurrence of large icebergs in low latitudes; to say how important a reason it is would seem to require more data than we now have.

WALTER D. LAMBERT.
U.S. Coast and Geodetic Survey, Washington, D.C., January 20.

Revival of Sporophores of Schizophyllum commune, Fr.

As has been pointed out by Prof. A. H. R. Buller ("Researches on Fungi," 1909, p. 113), sporophores of *Schizophyllum commune* which have curled up as the result of definite xerotropic action can be revived by suitable treatment in a moist chamber. The following illustrations afford interesting photographic confirmation of Prof. Buller's experiments:—

Fig. 1 shows a group of dry sporophores on their original matrix, bark of *Populus sp.*, four months after collection, and Fig. 2 a similar group of the same gathering after revival.

It has been remarked, but not further emphasised by Prof. Buller (*loc. cit.*), that the pileus of *S. commune* is of an absorbent nature. Indeed, the pileus shows a remarkable avidity for water, and the hairs composing the woolly covering of the pileus enable it

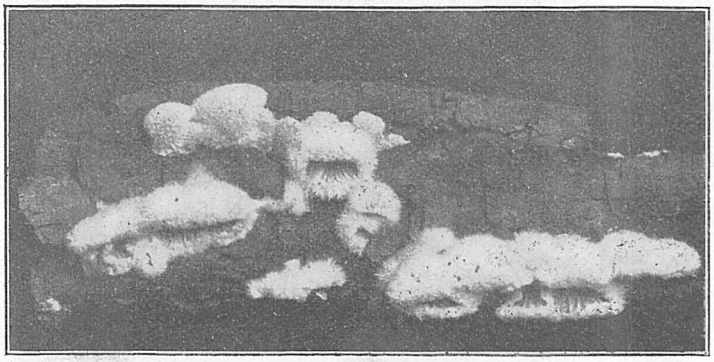

FIG. 1.—Xerotropic form of *Schizophyllum commune*. Natural size.

to absorb moisture with a greater rapidity than is usual in fungi, so far as I am aware.

The moist condition of the edge of the pileus remote from the matrix, immediately after wetting the latter, and rendered evident by the transition from snow-white to a silvery-grey colour, led to several experiments. It was found that the application of a drop of water to one edge of a dry pileus resulted in an immediate, and apparently uniform, diffusion of moisture throughout the woolly covering of the whole pileus—about 1·5 cm. diameter. The rate of absorption is much greater than that seen in the absorption

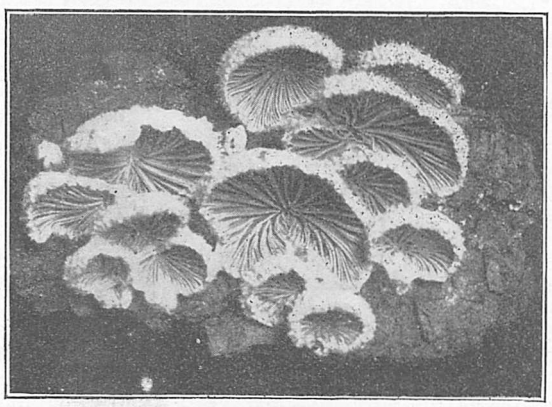

FIG. 2.—*Schizophyllum commune* after revival. Natural size.

of ink by blotting-paper, and this fact was more convincingly demonstrated by the use of a dilute aqueous solution of methylene-blue.

It seems reasonable to suppose that the possession of this property will enable the fungus, in its xerotropic condition, to take the fullest advantage of any raindrop that may fall upon it by instantly absorbing it. This supposition was tested by allowing drops similar in size to tropical raindrops to fall from a height on to the pileus, and it was observed that each drop was immediately absorbed, without splash, until saturation point was reached. Were its absorbent power less, much water would be lost to the fungus on account of its sharply convex outline.

Conservation of water, in the case of a group, is assured by the imbricate habit of *S. commune*. The pileus of a plant growing at the top of a group of sporophores collects all the raindrops that reach it until it becomes saturated, after which the surplus drips on to the pileus of a plant below, and so on, until a whole group has obtained its full requirements without the loss of a single drop.

The moisture-content of the fully expanded fungus and of the xerotropic form respectively are given below. They are the results of one determination only in each case. The specimens were dried in a water-oven at 99°-100° C. for five hours with all the precautions usually taken in the estimation of moisture.

Normal sporophore .	water = 84·3 per cent.
Xerotropic form .	water = 16·0 per cent.

I am indebted to Messrs. Murphy and Son, Ltd., for the use of the accompanying photographs, and to Mr. W. N. Cheesman, of Selby, for the specimens, which were collected at the Worcester foray of the British Mycological Society in September last.

F. A. MASON.
Bureau of Bio-Technology, Leeds.

Statistical Studies of Evolution.

I SHOULD like to suggest that the curves shown by Dr. Willis and Mr. Udny Yule in their article in NATURE of February 9, p. 177, are capable of a different interpretation from that which the authors place upon them.

It is possible that the curves are not, so to speak, a function of the organisms themselves, but rather of their environment.

Consider a habitable area of large size such as a continent. The environment will vary in character in different parts of the continent, the variation being due to the presence or absence of environmental limitations such as warmtn, moisture, particular food, etc.

In the continent considered, the greater the number of environmental limitations in any area the greater will be the number of possible combinations of these limitations. Thus there will be in the continent a great many different kinds of environment with a large number of limitations (such as mountain peaks, deserts, salt marshes, etc.), far fewer kinds of environment with a moderate number of limitations, and still fewer with a small number of limitations.

Since the continent we are considering is large, we can consider it to be divided evenly between areas with many limitations down to areas with few limitations. But we have already seen that there are many kinds of environment possible in areas with many limitations, and therefore each of these areas with one particular environment will be of small size.

Conversely, the areas with fewer possible kinds of environment and few limitations will be large in size.

In fact, could we plot the number of kinds of environment possible in any one size of area against size of area, we should obtain the same type of hollow curve as that obtained by Dr. Willis.

Assuming, as is legitimate, that, on the whole, organisms are adapted to their environments, it follows that areas with many limitations will require many adaptations in the constitution of the organism, and therefore few organisms will live in these areas, and these will be highly adapted types or species.

Hence the small areas with many limitations will each possess a few characteristic species; and since

there are very many such small areas, we see that there will be very many species which occupy small areas.

We can obtain, in fact, Dr. Willis's (number of species) against (size of area) curve simply by assuming (1) that in any very large area the distribution of different kinds of environment is random, and (2) that organisms are adapted to their environment.

I therefore come to conclusions exactly opposite to those of Dr. Willis, for I think we have in his curves direct evidence that:—

(1) Evolution has proceeded almost entirely by natural selection adapting a species to the limitations of its environment.

(2) Animals are so closely adapted to their conditions of existence that it is impossible to conceive of evolution proceeding by the large mutations suggested by Dr. Willis.

Space prevents me considering here Dr. Willis's (number of genera) against (number of species) curves, but these also are susceptible of a similar interpretation in terms of natural selection.

C. F. A. PANTIN.

Christ's College, Cambridge, February 16.

WE find it very difficult to follow the hypotheses made by Mr. Pantin in his interesting letter, and cannot agree that they accord with reality. We cannot see how, for example, the hypothesis that natural selection is the dominant factor affords any explanation of the fact that the numbers and proportions of local species increase towards the south; nor how it can explain the fact that in New Zealand (*cf. Ann. of Bot.*, vol. 32, 1918, p. 339) a great many families show their maximum number of endemics in every genus at the far north, all these families being Indo-Malayan; while a second group of families, characteristic of the northern hemisphere, show their maximum number at the south of New Zealand, and a third group at the centre. The northern families and genera diminish as one goes southward in New Zealand, and pass over, without paying any attention to, the regions where the maxima of the central and southern groups occur. These groups in the same way show no unusual change when they reach the region where the northern maximum occurs. Are the environmental conditions so peculiar at these points that those of the north should cause a multiplication of species only in Indo-Malayan families, and those of the south only in families of the northern hemisphere?

J. C. WILLIS.
G. UDNY YULE.

Columnar Structure in Sandstone Walls of a Glass Furnace.

IN the issue of NATURE for December 29, 1921, p. 567, I described the occurrence of columnar structure in optical glass and in fireclay.

Through the courtesy of Mr. Currie, of the Scottish Central Glass Works, Alloa, I had recently an opportunity of examining columnar structure that had developed in the lowest sandstone course of the side walls of a small tank glass furnace. The walls comprised two upper courses of fireclay blocks, in which no columnar structure developed, and the bottom course of rough-grained sandstone blocks obtained from the Penshaw Quarries, Durham. Their cross-section was about 1 sq. ft. Firebrick jack-arching formed the floor of the tank, under which was situated the regenerator.

The sandstone course was laid in August 1913, and taken down in November 1921, during which operation the structure was observed.

When emptying the tank the floor failed, and the glass discharged itself through a space between the floor and the regenerator roof. Thus while the walls were rapidly chilled the floor was maintained at a comparatively high temperature.

The accompanying photograph (Fig. 1) is of one typical fragment taken from the inner surface; other portions showed curvature of the columns, which at

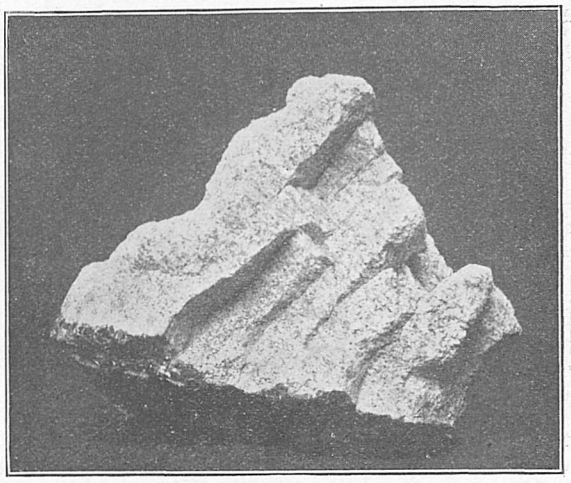

FIG. 1.

the upper end were nearly normal to the corroded Λ-shaped surface of the joint, and at the lower to the bottom surface of the block.

The similarity between these sandstone specimens and those of optical glass previously illustrated is worthy of remark.

JAMES WEIR FRENCH.

Anniesland, Glasgow, February 13.

The Action of Sunlight: A Case for Inquiry.

READERS of NATURE are no doubt aware that the Medical Research Council has just appointed a Committee on the action of light upon the human body in health and disease, thus meeting the need which I have been allowed to urge in these columns under the above heading (NATURE, December 8, 1921, and January 5).

I see no end to the inquiries in which we are now at last to participate in England, the country the smoke-darkened cities of which need them most. Before me now is a series of papers which I owe to Dr. A. F. Hess, of New York, who has demonstrated that sunlight can cure or prevent rickets in human infants and animals irrespective of the absence or presence of the supposed anti-rachitic vitamin. Again, along this coast, from Cannes to San Remo, I find French and Italian clinicians at work curing what I have called the diseases of darkness by sunlight; also a voluminous literature, as yet entirely unknown in England, which raises questions of high racial, genetic, and eugenic importance, such as the influence of sunlight, or the lack of it, upon the normal development of the reproductive system and its functions during adolescence. But clinicians elsewhere had assured me—and I fear I may have repeated their statements in these columns—that the sun-cure cannot be practised on the Riviera!

Never henceforth, I predict, will the columns of NATURE cease to bear records of the new study of the biology of light now to be begun.

C. W. SALEEBY.

Hôtel Royal Westminster, Menton,
February 19.

The Mechanism of Heredity.[1]

By Prof. T. H. MORGAN, Columbia University, New York City, U.S.A.

II.

Linkage and Crossing-over.

MENDEL'S second law has been found to be restricted in its application. Two pairs of characters do not always assort independently. This fact was first observed by Bateson and Punnett in 1905, and called gametic coupling—not that gametes (ripe germ-cells) are coupled, but that when certain genes enter together from one parent they tend to hold together, as though coupled, in later generations. A specific case will serve to illustrate this kind of inheritance.

If a sweet pea with genes for purple flowers and long pollen grains is crossed to a pea of another strain with red flowers and round pollen, the expectation for the two pairs of genes would be in F_2 9 : 3 : 3 : 1. Instead of this ratio there was found approximately 177 : 15 : 15 : 49. Purple long and red round have come out in the second generation in unexpected ratios, or, in other words, the results are explicable only on the hypothesis that the genes that went in together have shown a tendency to stay together instead of freely assorting.

This coupling is often spoken of to-day as linkage, because it applies not only to two genes, but to any number of them. A few further cases may be given; in one the characters, as in the pea, are not sex-linked, and in the other they are. There is a strain of *Drosophila melanogaster* that is black. It gives with the wild fly in the second generation a 3 : 1 Mendelian ratio. There is another strain that has vestigial wings. It, too, gives with the wild fly a 3 : 1 Mendelian ratio. It is easily possible to make a strain that is pure both for black (*bb*) and for vestigial (*vv*). If a black vestigial male (*bv*) is mated to a wild female (B V) (grey long wings) all of the offspring are grey long (Fig. 11). If one of the F_1 sons is mated to a black vestigial female of pure stock, only two kinds of offspring are obtained; half of them are black vestigial, and half are grey long. In other words, the two recessive characters that went in together (black vestigial) have come out together. These characters are completely linked in the male. It may be said, in exactly the same sense, that the other two characters, the dominant ones, namely, grey long (which went in together from the other side), are also linked. Now if the genes for black and for vestigial are carried in the same chromosome, then their partners or allelomorphs (grey long) lie in the other chromosome of the same pair, and if these chromosomes remain intact the result is what is expected to take place.

Linkage is also excellently illustrated in the case of sex-linked characters. As has been shown, white-eye *versus* red-eye colour of Drosophila gives a Mendelian ratio. Another sex-linked character, yellow colour, also gives the same result. If a strain is made up that has white eyes and yellow colour, and if a female of this strain is mated to a wild-type fly (red eyes, grey colour), all the sons will be white-yellow, and all the daughters red-grey (Fig. 12). If these are inbred, the great majority of the offspring (98·5 per cent) are yellow-white and grey-red (half and half). In other words, these characters are linked, but only in 98·5 per cent. of the cases. The remaining 1·5 per cent. is composed of two kinds of individuals, red-yellow and white-grey. It may be said, therefore, in this case, that the white eye of the yellow type has crossed over to the grey type, and in exchange the red eye of the grey type has crossed over to the yellow type.

The four kinds of offspring obtained in this cross can be accounted for, if once in a hundred times an interchange has taken place between the two X-

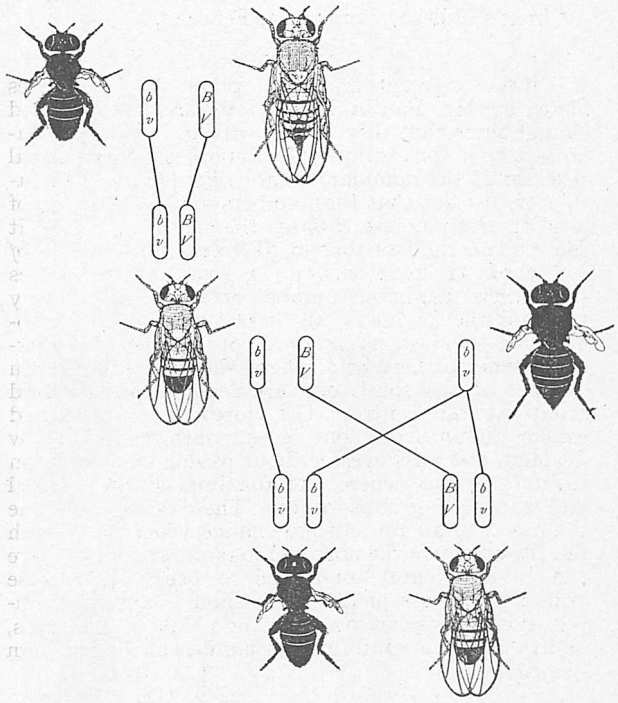

FIG. 11.

chromosomes of the F_1 female, in such a way that the part containing the gene for white eye is interchanged for a corresponding part of the other chromosome with the gene for red eye.

Another example of crossing-over may be given, one involving the same characters, black and vestigial, which were used to illustrate complete linkage. It is possible to use the same combinations of characters to illustrate both absolute linkage and crossing-over, because in the male of Drosophila there is no crossing-over, but in the female crossing-over occurs. Therefore, in the first case above, in which this combination was utilised, an F_1 male was back-crossed, while in the present case an F_1 female will be employed. If, as shown in Fig. 13, a black vestigial fly be crossed to a wild-type fly (long wings, grey), the F_1 female will be wild-type. If she is back-crossed to a black

[1] Continued from p. 244.

vestigial male of pure stock, the F_2 offspring will be of four kinds, in the proportions given below :—

Non cross-overs		Cross-overs	
Black vestigial	Grey long	Black long	Grey vestigial
41·5 per cent.	41·5 per cent.	8·5 per cent.	8·5 per cent.
83 per cent.		17 per cent.	

In this experiment 17 per cent. of crossing-over occurs in the F_1 female. As before, the relation of these facts to the chromosomes is illustrated by the rods in the centre of the diagram. The two pairs of elements (genes) involved are indicated by the letters inside the rods.

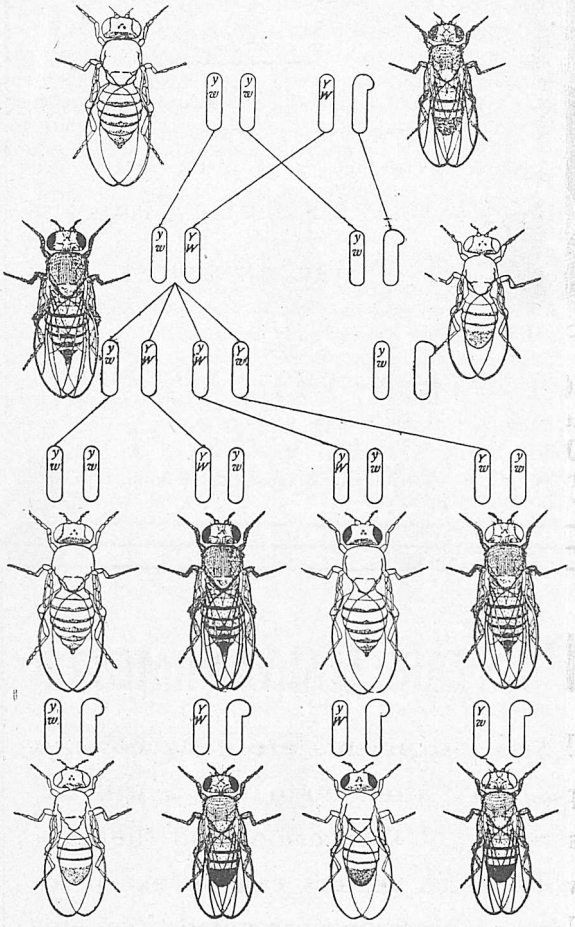

FIG. 12.

Many examples of linkage and crossing-over are known at the present time. Linkage is said to be strong when, as in the yellow-white case, crossing-over takes place in a small proportion of cases. Linkage is said to be weak when crossing-over takes place frequently. Crossing-over may be less than 1 per cent., or even not take place at all (complete linkage), as in the case of the black vestigial male given above. It may take place in nearly 50 per cent. of the individuals of a back-cross, which means that about half of the flies show linkage, and half show crossing-over. This would be, of course, numerically the same result as when the two pairs of characters involved freely assort. A case of this kind could not, in fact, by itself alone be distinguished from a case where the pairs are carried by different chromosomes. It may appear, therefore, incorrect to speak here of linkage, and this would be true were there no other evidence showing that the two characters involved are in the same chromosome. But whenever a number of other characters are known in the same group the linkage of the two characters giving 50 per cent. of crossing-over can still be shown, for if each of the characters is found to be linked to a third one they must be linked to each other.

In Drosophila there are more than one hundred sex-linked characters. If their linkage relations are studied *in series* an important result comes to light. This may be illustrated by the following example. It has been stated that crossing-over takes place in 1·5 per cent. of cases between yellow colour and white eyes. There is another eye character, called echinus,

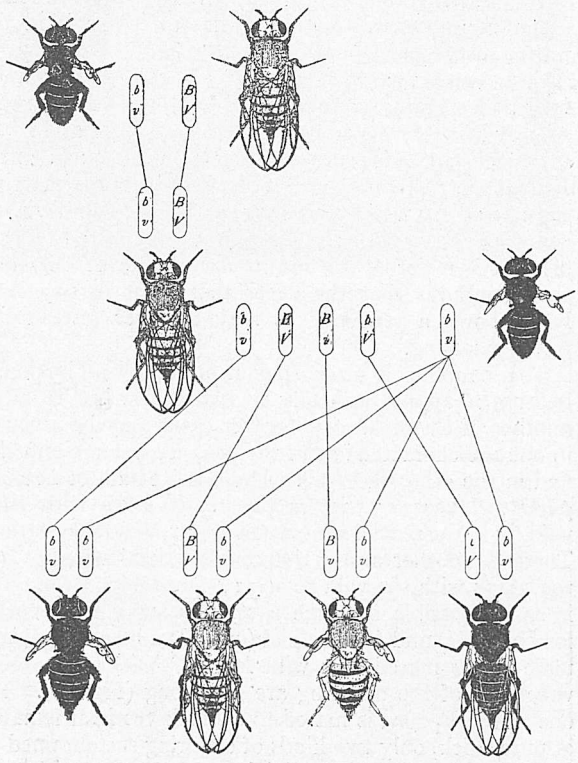

FIG. 13.

that gives 5·5 per cent. of crossing-over with yellow (Fig. 14). If, now, the position of echinus is represented as 5·5 units of distance from yellow, then its "distance" from white must be either $5·5+1·5=7·0$, if it lies to the "north" of yellow, or else $5·5-1·5=4·0$ if it lies to the "south." In fact, when the experiment is made, the percentage of crossing-over between white and echinus is found to be 4·0.

There is another sex-linked character, ruby, that gives 7·5 per cent. crossing-over with yellow. If it lies to the north of yellow it must give with echinus $7·5+5·5=13$; or if to the south of yellow, $7·5-5·5=2·0$. It is found to give 2 per cent. of crossing-over. Hence, lying south of yellow, it should give with white 6·0, and this is what is found.

Such a method of analysis can be followed step by step until the whole of the sex-chromosome is plotted. This procedure has a twofold significance. First, if a new mutant character is found, its "linkage-group" is first made out; then its "distance" from any one

member of that group is determined. It is then necessary to find its position with respect to another known member of the group (preferably one near by) which determines whether it is north or south of the first member. Once this has been done, the method of inheritance of the new character with all other members of its group can be worked out on paper from the crossing-over data, plotted as distance. In other words, the heredity of this new mutant, with all the other known characters of Drosophila, can be predicted, since, with its normal allelomorph, it will give a 3 : 1 ratio; with any character in another group it will give a 9 : 3 : 3 : 1 ratio; and with other members of its own group it will give a definite result which can be calculated from the "distance" of the plotting.

The second point of significance concerning the plotting of the genes in terms of distances is as follows: the discovered relation of genes, as expressed in distances, is one that holds for points in a line. This means that if the genes in question are represented in space, their relation to each other is that of points in a line. If the line is a chromosome, then the chromosomes are to be thought of as made up of a single line of genes. The reasons for referring the genes to the chromosomes have already been given. The possibility of explaining crossing-over on a chromosome basis will be discussed later.

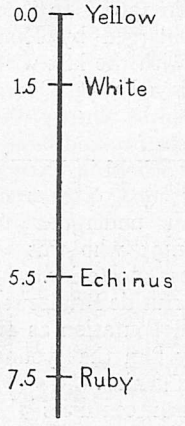

FIG. 14.

There is one situation where, on superficial examination of the data, an apparent disturbance of the linear order may appear, namely, when crossing-over takes place at two levels in the same linked series at the same time (double crossing-over). But by marking intermediate points between the extreme ones all double cross-overs can be detected and the distances corrected for them. When this is done, it at once becomes apparent that the linear order is the correct arrangement of the genes. In fact, far from throwing doubt on the linear order, these cases, where double crossing-over occurs, furnish a strong corroboration of the correctness of the hypothesis.

The use of the word "distance" as an expression for the percentage difference in crossing-over values does, unfortunately, lend itself to misunderstanding, unless one knows just what meaning is attached to the word when used as defined above. An example will make this clear. If crossing-over is more likely to occur in one region of the linear order than in other regions, the plotted "distances" will be relatively too short in comparison with the distances of the remainder of the series. Distance, therefore, must be understood in a relative, not in an absolute, sense. We have been aware of the necessity of this restriction from the beginning of our studies of the linear order of the genes, and have warned others of the danger in numerous publications, but apparently without complete success. It has also been shown that the percentage of crossing-over changes under external (Plough) and internal (Bridges) conditions. As the female gets older, crossing-over becomes less in some cases, hence the "distances" appear to become less. It has also been shown by Sturtevant that genetic factors may exist that affect the crossing-over in certain regions of the linear series, in one case shortening that region to zero, since all crossing-over is suppressed. But the significance of this result, from our present point of view, is that when the shortening factor is removed (by a definite genetic procedure) the original distance of the genes in this region reappears, *and the genes are shown not to have changed their original order.* This reassures us that the linear order stands on a firm basis. A recent attack on the theory of the linear

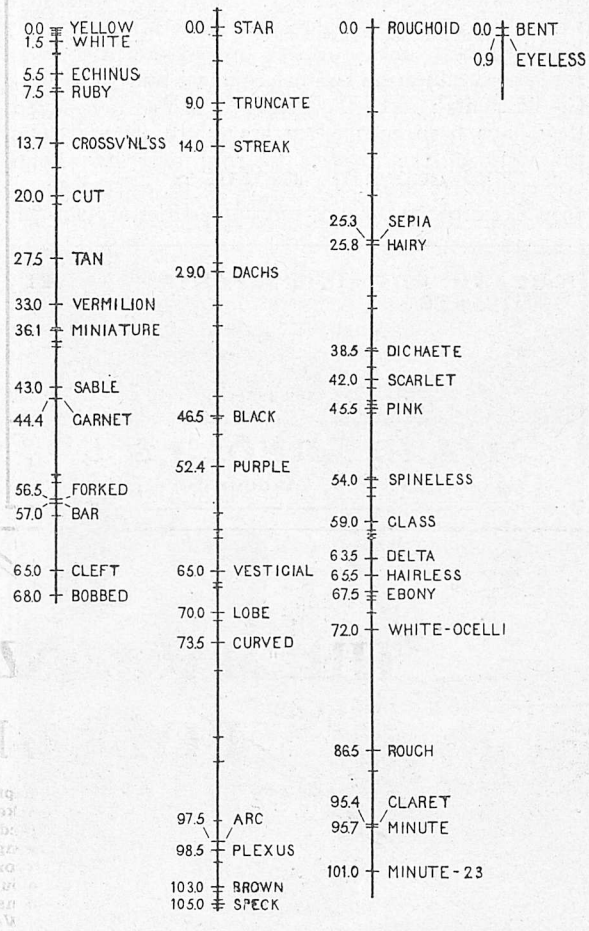

FIG. 15.

order is based on evidence that shows that "through selection" the distances between certain genes changed. The result really has no bearing on the point, because the order of the genes was not shown to have been affected. Moreover, Sturtevant's case, more thoroughly worked out, shows that where even greater changes of distance had taken place the order of the genes had not changed.

The plotting of the linear order of the genes in the four chromosomes of *Drosophila melanogaster* is shown in Fig. 15. The four great groups of linked genes are represented by straight lines with the approximate positions of the genes indicated by short cross-lines. The numbers opposite these cross-lines give the distances from a base chosen as far "north" as possible. The location of some of the genes rests on an immense

amount of data; other genes are less accurately placed. Still others, not so well determined, have been omitted from this diagram.

The localisation of the genes has been calculated from numerical data independently of any assumption as to how crossing-over takes place in the animal. Perhaps it might be safer to let the matter rest on the genetic evidence alone in the present uncertain frame of mind of most cytologists concerning the conjugation of the chromosomes at maturation; but there are at least certain facts admitted by a number of cytologists concerning the maturation of eggs and sperm that seem to fall into line with the simple mechanism that the genetic evidence for crossing-over calls for. This evidence may next be considered.

(*To be continued.*)

Science in Poland.

DURING the past seven years Poland has suffered all the miseries of war. Amid the desolation in which the country was plunged, the votaries of science did their best, until 1919, to uphold the interests of study and education against inimical and contending Governments; since the Polish State was resuscitated they have been engaged in laying the foundation of the work of the future. In 1914 only two Polish universities (Cracow, Lwów) were in existence; in 1922 five large State-endowed universities are actively at work; the University of Warsaw was started in 1915, those of Poznan and Wilno in 1919. Centres of technical teaching and research are springing up; in Warsaw and Lwów important colleges of mechanical and electrical engineering, of applied chemistry, of architecture, etc., are well attended, and in 1919 a High School of Mines was established in Cracow. These institutions are sufficiently equipped with appliances required for practical teaching.

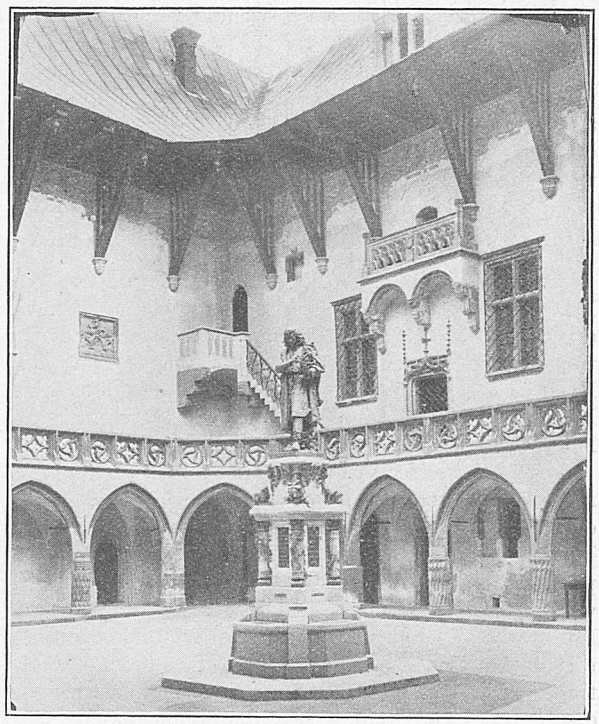

FIG. 1.—Interior Court of the Library of the Jagellonian University, Cracow, with the statue of Copernicus.

Agricultural science also receives a good deal of attention; in addition to faculties or other schools of university rank existing in Cracow, Warsaw, Lwów, and Poznan, a National Institute of Agricultural Research was founded in Pulawy in 1917. This institute is under the direction of Profs. Godlewski and Marchlewski, and shows a remarkable completeness of arrangement. For the study of the mineral resources of Poland, a National Geological Institute was created in 1920 in Warsaw, under Prof. Morozewicz; a branch institution in Cracow, under Dr. Nowak, has for its object the investigation of oil-bearing regions. An Epidemiological Institute, a Central Meteorological Office, and a Natural History Museum have been constituted; but within the brief compass of an article it is impossible to do more than refer simply to the fact of their inauguration.

At the head of Polish educational institutions stands the Jagellonian University of Cracow, founded by Casimir the Great, King of Poland, in 1364. In 1400 the university was restored and enlarged by King Ladislas Jagello, who thus complied with the last wish of his universally honoured and beloved wife, Queen Jadwiga. At the end of the fifteenth century the university was at the height of its influence and fame; there was probably no contemporary school in Europe where mathematics and astronomy were prosecuted with more zeal and success. An undergraduate matriculated in the university in 1491 who was to transmit his name to the remotest posterity. At that time Wojciech Brudzewski (Albertus de Brudzewo) had attained a wide and established reputation as an astronomer, and it was probably by him that young Copernicus was taught to employ his genius.

In the seventeenth and eighteenth centuries the university suffered much from the insecurity of the times, and for many years was on the decline. A new epoch began about 1870; an impulse was given to study, and research, although hampered by financial embarrassments, had greater importance assigned to it than at any previous period. Among the mathematicians of that period are Mertens, Baraniecki, and Zrawski; Rudzki did creditable work in geophysics, especially seismology; Zygmunt Wróblewski and Karol Olszewski, by their activity in the domain of low temperature research, achieved success that shed lustre on the Cracow laboratories; Witkowski, by the pains he took to ensure accuracy, paved the way for much subsequent thermodynamical investigation; Smoluchowski (whose untimely death, in 1917, was a matter of universal regret) accomplished brilliant work, largely influencing progress towards a kinetic theory of matter. Within the precincts of the Jagellonian University, Janczewski, E. Godlewski, Sen., Rostafinski, Raciborski, Rothert, Kulczynski, Prazmowski, Wierzejski, Jentys, Adametz, Majer, Kopernicki, and Talke-Hryncewicz — names well known to students of

botanical, zoological, or anthropological science—were engaged in teaching and research. The medical faculty will always be associated with the names of Dietl, Teichmann, Cybulski, Browicz, Jordan, Pieniazek, Korczynski, Jaworski, Mikulicz, Rydygier, Wicherkiewicz, and others.

The Jagellonian University always consisted, and now consists, of four faculties. The faculty of theology has nine professors; the faculty of jurisprudence has sixteen professors and four lecturers; while the faculty of medicine includes twenty-six professorial chairs and thirteen lectureships. The philosophical faculty embraces literature and philology, history and philosophy, mathematical, physical, and natural science; in connection with this faculty there is a college of agriculture, a department of pharmacy, and a teachers' training school. No less than sixty-eight professors and twenty-two lecturers are engaged in the work of this faculty. The total number of matriculated students during the session 1921–22 is 4631.

Space will permit only of a reference to the library of the university (Biblioteka Jagiellonska), renowned for the precious MSS. it contains.

L. N.

Current Topics and Events.

THE national manifestation of rejoicing on the occasion of the marriage of H.R.H. Princess Mary to Viscount Lascelles on Tuesday, February 28, is a sign of the secure place which the Royal Family occupies in the hearts of the British people and also, we hope and believe, a token of national unity. In common with all classes of the community, workers in scientific fields marked the occasion with affectionate interest and shared with much satisfaction in the chorus of good wishes by which the nation expressed itself in perfect harmony with a happy event.

THE following fifteen candidates have been selected by the Council of the Royal Society to be recommended for election into the Society:—Prof. T. H. Bryce, Mr. C. G. Darwin, Dr. C. G. Douglas, Dr. S. R. Douglas, Prof. A. J. Ewart, Dr. A. Hutchinson, Dr. F. W. Lanchester, Mr. J. Mercer, Prof. S. R. Milner, Prof. M. S. Pembrey, Prof. F. Lee Pyman, Prof. G. A. Schott, Dr. N. V. Sidgwick, Mr. D. M. S. Watson, Sir Alfred Yarrow, Bart.

THE Report of the Aeronautical Research Committee on the causes which led to the loss of the airship R. 38 was issued by the Air Ministry on February 23. The Committee has come to a number of clear findings and has summarised them at the end of its report; it has concluded, from an examination of the evidence available, that the airship broke in two as a result of defects in design, but that the loss of life was to be attributed largely to a subsequent fire. It appears that the only calculations made by the designers were of the type used in general engineering and had little special reference to airships. In addition, no account was taken of the aerodynamic forces which an airship might reasonably experience in normal usage. Information as to the importance of the air forces is said to have existed from experiments on models of airships in the wind tunnels, but the warning was not acted upon even to the extent of referring the problem to the Aeronautical Research Committee. Shortly expressed, the result of the enquiry shows the marked deficiency of rule-of-thumb as compared with scientific methods as an instrument of progress. The accounts of the accident in America to the semi-rigid airship, *Roma*, further point the moral. The obvious fundamental fact in engineering design is that the details of a structure should depend on the forces it has to withstand. In an airship the bending arises in part from the distributed weights and in part on aerodynamic loading, the former being independent of the speed of flight and the latter to its square. Hence an airship moving at 30 knots may have the stresses due to weight and buoyancy twice those due to aerodynamic causes, whilst at a speed of 60 knots the proportions are exactly reversed. The accident to R. 38 appears to have occurred when the air loading was at least five times that provided for by the designers on the basis of weight alone. There is great difficulty in introducing improvements into aircraft with the present official organisation, and it is to be hoped that the report will receive due consideration from the point of view that it is desirable to provide for scientific progress rather than for a process of trial and error on a large scale and at great expense in life and money.

THE third and final Report of the Committee on National Expenditure (Cmd. 1589, price 4s.), issued on February 24, deals, among other services, with the British Museum, National Gallery, National Portrait Gallery, Wallace Collection, London Museum, Imperial War Museum, Geological Museum, and National Galleries (Scotland). The Estimates for 1921–22 and the Provisional Estimates for 1922–23 are respectively £506,771 and £405,864. Over 80 per cent. of the Estimate is in respect of the cost of personnel. The Committee thinks that further economies might be produced by a close investigation into the size of the warding staff, especially in the case of the British Museum and the Natural History Museum. It recommends that there should be four paying days a week for all National Museums and Art Galleries without distinction. The Committee is of opinion that the net sum of £405,864, which is asked for in the Provisional Estimates for 1922–23, should be reduced to £392,264, a saving of £13,600. With regard to the grants for scientific investigation, amounting in all to £200,423, it is recommended that the grant to the Medical Research Council—£130,000—should be as proposed by the Treasury. As regards the smaller grants, the Committee says: "We are averse from an arbitrary and uniform reduction on a percentage basis on the ground that the saving to the Exchequer would be small compared with the detriment which would be caused to the activities of the learned and scientific world and the discouragement which would be given to private subscriptions and donations if the Exchequer grants were reduced. We therefore recom-

mend that the Provisional Estimate, as framed by the Treasury, should be accepted, with the qualification that it may be possible, under the terms of the Irish Settlement, to omit £2200 proposed for the four Academies and Societies in Ireland. The Department of Scientific and Industrial Research was instructed, in May last, to effect at least a 20 per cent. reduction on expenditure. The Department succeeded in effecting this, and presented a Provisional Net Estimate of £330,287. Since arriving at that figure the Department and the Treasury have agreed on an additional cut of £17,700, and, as the result of a further review, the Department have intimated that a still further reduction can be made, which will bring their Net Estimate down to £298,071. We are unable to recommend any further reduction beyond the saving of £32,216 already effected."

THE Minister of Health announced last week that the Rockefeller Foundation had offered a sum of two million dollars (approximately £454,000 at the present rate of exchange) for the provision of an institute of State Medicine in London—site, building and equipment—on the understanding that the British Government accepted the responsibility for staffing and maintenance. At present public health teaching is given at some seven or eight institutions in London, which instruct about 120 students per annum for the examinations for the Diploma of Public Health; for toxicology and medical jurisprudence practically no advanced course is available. The need for an Institute of State Medicine has long been recognised, and some years before the war the Board of Hygiene of the University of London formulated a scheme for the provision of such an institute, but funds for its establishment were never forthcoming, and in 1921 the Committee for post-graduate medical education in London made a similar recommendation. The offer of the Rockefeller Trustees has been gratefully accepted by the Minister of Health, and the Government proposes, we believe, to allocate a sum of £25,000 annually for the maintenance of the Institute, the work of which will be devoted both to education and to research in all branches of State Medicine.

ON Wednesday, March 1, there was opened at the British Museum a special exhibition of Greek and Latin papyri presented at various dates by the Egypt Exploration Society. This body (formerly the Egypt Exploration Fund) is celebrating the twenty-fifth anniversary of the foundation of its Graeco-Roman Branch, the excavations of which at Behnesa (Oxyrhynchus) and elsewhere have made so many additions to our stock of Greek literature and to our knowledge of the political, economic, and social history of Graeco-Roman Egypt; and it is in honour of the anniversary that the Museum is arranging its exhibition. A guide-book to the exhibition, with introduction, detailed descriptions of the papyri shown, a preface by Sir Frederic Kenyon, and one photographic facsimile, is being published by the Society, and will be on sale at the Museum, price 1s. The exhibition, which will be found in the MSS. Saloon, Case A, includes many interesting papyri of various kinds, selected to illustrate the wide range of papyrological discovery. There are examples of famous additions to Greek literature, like the Paeans of Pindar, the poems of Cercidas, and the Oxyrhynchus historian; theology is represented by the Sayings of Jesus; and the economic and social life of Egypt finds illustration in many non-literary documents, several of them rich in human interest.

THE Referee, under section 1 (5) of the Safeguarding of Industries Act, has given judgment against the complaint of the British Cellulose and Chemical Manufacturing Company, Limited, that calcium carbide had been improperly excluded by the Board of Trade from the lists published by them of articles chargeable with duty under Part I. of the Act. The effect of the award is that calcium carbide is not to be subject to import duty.

THE ambitious project for opening up a navigable channel of sufficient width and depth to enable ocean-going vessels to reach the group of inland ports fringing the shores of the Great Lakes of North America, and there to ship and discharge their cargoes direct without any intermediate handling, is steadily being urged in influential quarters, and, despite strong and determined opposition, appears to be gaining ground. The report of the International Commission, which has been holding an inquiry into the feasibility, necessity, and cost of the scheme, has just been presented to the respective Governments at Washington and Ottawa. The position may be briefly summarised as follows:—At the present time vessels loaded with grain at the great depôts of Port Arthur, Fort William, Duluth, and Superior, on Lake Superior, and of Chicago and Milwaukee, on Lake Michigan, are unable, on account of the rapids on the St. Lawrence, to proceed further than Buffalo, at the lower end of Lake Erie, where the grain has to be transferred either into barges to proceed along the Erie Canal to New York for reshipment or into small ships capable of traversing the Welland Canal as far as Montreal, where again reshipment is required for the ocean journey. This repeated handling of the cargoes means increased cost of carriage, delay, and dearer bread for the countries to which the grain is consigned. The necessity for transhipment can be avoided only by the formation of a waterway of sufficient capacity for ocean-going vessels, and, as contemplated in the proposed scheme, this means the enlargement and deepening of the Welland Canal from a depth of 25 ft., to which it is at present being increased, to a depth of 30 ft., and the construction of four lateral canals and impounding dams at the rapids on the St. Lawrence River, together with the deepening of the river-bed itself. There is an additional advantage attaching to the scheme in that by the construction of the dams a very considerable amount of hydro-electric power could be developed, and it is claimed that on this ground alone the project should prove a sound and profitable enterprise.

WE learn from *Science* that Capt. Roald Amundsen has made arrangements for co-operative work in

terrestrial magnetism and atmospheric electricity with the Department of Terrestrial Magnetism of the Carnegie Institution of Washington throughout his forthcoming expedition to the Arctic regions. During the North-East Passage, 1918–21, the Amundsen Expedition made a series of highly valuable magnetic observations at rather more than fifty different points, and Capt. Amundsen's chief scientific assistant, Dr. H. U. Sverdrup, has been associated with the Department of Terrestrial Magnetism since last October in order to complete the reduction and publication of the magnetic observations thus far obtained by the expedition. He will rejoin the *Maud*, Capt. Amundsen's vessel, early in March at Seattle. It is expected that Capt. Amundsen will resume his Arctic expedition, the chief object of which is to obtain scientific data relating to geography, oceanography, meteorology, gravity, terrestrial magnetism, and atmospheric electricity, about June 1.

H.R.H. The Duke of York will open the Research Laboratories of the British Cotton Industries Research Association, Shirley Institute, Didsbury, Manchester, on Tuesday, March 28. The opening ceremony will take place at 3.30 P.M.

THE Société Genevoise d'Instruments de Physique informs us that it has not at the London address, 95 Queen Victoria Street, E.C.4, a specimen of the printing chronograph referred to in Our Astronomical Column on February 16, p. 217.

THE trustees of the Percy Sladen Memorial Fund have given a substantial grant towards the expenses of the expedition to S.W. China by Prof. J. W. and Mr. C. J. Gregory, who are leaving for Rangoon at the end of March. The expedition will therefore be conducted as one of the Sladen Trust Expeditions.

PROFESSOR NILS BOHR, of the University of Copenhagen, will give a course of five lectures on the "Quantum Theory of Radiation and the Structure of the Atom" in the Cavendish Laboratory, Cambridge, on March 6, 7, 10, 13, and 14, at 4.45 P.M. The last two lectures, of a more advanced character, will deal with "Selected Problems in the Theory of Atomic Constitution."

THE members of the Geologists' Association of London are about to entertain at dinner their retiring President, Mr. William Whitaker, F.R.S. Mr. Whitaker, who is in his 86th year, joined the Geological Survey in 1857 and the Geologists' Association in 1875. He has frequently served as a member of the Council and has conducted innumerable excursions. He was President from 1900 to 1902, and has recently completed a second term of office. The dinner will be held on Saturday, March 25, at Stewart's Restaurant, 50 Old Bond Street, W., at 7 o'clock. A large attendance is expected.

AT a joint meeting of the Faraday Society and the Oil and Colour Chemists' Association, to be held on Thursday, March 9, at 8 P.M., in the rooms of the Chemical Society, Burlington House, W.1, a group of papers will be presented dealing with the properties of powders considered from various aspects. Prof. T. Martin Lowry and Mr. L. C. McHatton will deal with the grading of powders by elutriation, Prof. P. G. H. Boswell will contribute a paper on elutriation from the point of view of the geologist, and Dr. J. W. French will speak on grinding and polishing powders. Dr. R. S. Morrell, Mr. C. A. Klein, and Mr. W. J. Palmer will discuss the subject from the point of view of the oil and colour chemist, and Mr. R. W. Whymper will deal with certain applications to cocoa and chocolate. The subject will then be thrown open for general discussion.

Our Astronomical Column.

RELATION OF SPECTRAL TYPE TO MAGNITUDE.—The Henry Draper Catalogue of the Spectra of Stars, which is now completed but not yet fully published, contains as many as 225,000 stars. The classification is based on the Harvard system, wherein more than 99 per cent. of all the stars fall into the six main groups designated by the arbitrary letters B, A, F, G, K, and M. It is now known, from the work of Lockyer and Russell, that the actual sequences of changes in a star's spectrum are from M to B as the star increases in temperature (giants), and from B to M as the star cools (dwarfs). Thus for each letter mentioned above there are two distinct kinds of stars, and the nearer the letter is to M the greater this distinction becomes. It is necessary, therefore, to bear this fact in mind when reading the Harvard College Observatory Circular (No. 226) on the relation of spectral type to magnitude by Dr. Harlow Shapley and Miss Annie J. Cannon. Of the numerous tables given in the paper the following abstract of one of them exhibits some of the main results of the investigation.

The second column may be considered as representing the distribution of naked-eye stars among the various spectral classes. It will here be seen that the hot A stars exceed in number those of any other type, the cooler K class running it a close second. This state of things is reversed in the three following columns, which show a drop in magnitude for each column. In all columns, however, the A and K type stars are prominent features. In discussing the frequency of spectral divisions for successive fainter magnitude intervals, the B type stars rapidly fall off as fainter stars are considered. The A stars fall off to about the 8th magnitude, but then rapidly rise again. The F and M types maintain their frequency nearly throughout to magnitude 8·5, but fall slightly afterwards. The frequency of the G type increases very rapidly throughout the whole series up to magnitude 9·5, while the K class increases up to the 8th magnitude and then falls off. A plate accompanying the paper shows graphically many of the features of the tables.

Spectral division	Visual magnitudes brighter than 6·25	7·25	8·25	9·25
B	719	1,286	2,061	3,026
A	2,018	5,904	15,884	39,342
F	680	2,160	6,536	15,224
G	656	2,456	8,776	27,160
K	1,984	6,144	20,760	51,008
M	538	1,453	4,491	10,657

Research Items.

MAYA HIEROGLYPHS.—Though much attention has been bestowed on the decipherment of the Maya hieroglyphs since a key was supplied by Diego de Landa, the first Spanish bishop, the result, except as regards some numerals, has been disappointing. It is obvious that the way to begin such a study is by an examination of the modern language of the country, as the study of Coptic has helped in ancient Egyptian. Hitherto the grammars of the Maya tongue have supplied an inadequate basis for its study, because their authors, Spanish priests, were ignorant of philology and phonetics and tried to build up a grammar of a primitive language by following the Latin or Spanish models. This naturally led to two classes of defects: unnatural forms were invented to express corresponding ideas in Latin or Spanish, and numbers of native expressions were overlooked because they could not be brought within the European system. Mr. A. M. Tozzer, the first travelling fellow in American ethnology of the Archæological Institute of America, spent a considerable time in Central America, from 1901 to 1905, and he issued in 1907 a report of his ethnological work. This he has now followed up by a comprehensive grammar of the Maya language on modern lines and a bibliography of the literature. He omits any discussion of the phonetic character of the Maya hieroglyphs, and he deals with the language as unrecorded up to the time of the Spanish conquest. But he justly remarks that any elucidation of the hieroglyphs will be impossible until an advance is made in our acquaintance with their phonetic elements. This in recent years has not advanced in comparison with the gains made in deciphering the numerical parts of the hieroglyphic writing. A successful correlation of the modern Maya language with the hieroglyphs holds out a prospect of success. In this respect Mr Tozzer's book, forming vol. 9 of the Papers of the Peabody Museum of Archæology and Ethnology, Harvard University, deserves hearty commendation.

MARINE MOLLUSCAN FAUNA OF AMERICA.—A useful summary of the marine shell-bearing molluscs of the north-west coast of America has been published by Mr. W. H. Dall (U.S. Nat. Mus. Bull. 112, pp. 217, 22 plates). In the preparation of this summary the results of more than fifty years' study of the molluscan fauna of the north-west coast have been brought together, Mr. Dall's investigations having begun in 1865. The molluscan fauna of this coast falls into three main divisions—the Arctic, containing many circumboreal species, and extending from the Arctic Sea to the southern limit of drift-ice in winter in the Bering Sea; the temperate, extending from this line southwards to Point Conception, California; and the tropical, from the latter place to Point Aguja on the coast of Peru. The total number of species (excluding nudibranchs and cephalopods) for the region is 2122. The Tertiary and Pleistocene fossils of the shores of Bering Sea afford evidence of a communication with Atlantic waters during the prevalence of more genial conditions. Several species now living in Bering Sea are found fossil in the late Pliocene of Nantucket and the Pliocene of Iceland, and, conversely, the common periwinkle of New England (*Littorina palliata*) is one of the species found in the elevated beaches of Nome, Alaska, and is now extinct on the Pacific coast. The intercommunication between the two oceans would seem to have been tolerably free at the time, though now there are quite pronounced differences between the Greenlandic and the Bering Strait Arctic assemblages of molluscs.

A PARASITIC AMŒBA WITH PATHOGENIC CAPACITIES.—Prof. C. A. Kofoid and Dr. Olive Swezy have recently described (Univ. California Zool. Publ., vol. 20, No. 7), under the name *Councilmania Lafleuri*, a parasitic amœba of the human intestine which "appears to have pathogenic capacities." They state that this organism is apparently cosmopolitan in distribution, but has hitherto been confused with *Entamoeba coli* because of its eight-nucleated cyst. The cyst has a thick wall, and in addition to the eight nuclei, each with a large dispersed karyosome, there are in the protoplasm acicular chromatoid bodies, fasciculate or massed in the later phases. The cysts are spheroidal, ellipsoidal, or asymmetrical, and their non-spherical form and the dispersed karyosome are among the characters given to distinguish this new amœba from *E. coli*. In fresh stools the cysts exhibit a process of repeated budding, resulting in the escape of amœbulæ. Protoplasm issues through a minute pore formed in the cyst-wall, a nucleus slips out into the protoplasmic bud, and this bud detaches itself as an amœbula. A new bud is formed and creeps away, and so on until as many amœbulæ have been produced as there were nuclei. The authors are emphatic that this is a normal process. They state that in the division of the nucleus in the cyst eight chromosomes are demonstrable at the metaphase, whereas *E. coli* has only six. In ordinary practice there will be great difficulty in distinguishing the active stages of Councilmania from those of *Entamoeba histolytica* and the cysts from those of *E. coli*. The reason for creating the new genus Councilmania is not obvious, and is not stated by the authors.

BUD MUTATIONS.—That bud sports, or bud mutations, frequently give rise to important new varieties has long been known. Darwin studied many such cases, and Cramer in 1907 compiled an account of all the cases then known. Mr. A. D. Shamel, in a recent publication of the Experiment Station of the Hawaian Sugar Planters' Association, describes and clearly illustrates many modern instances. He believes that in many plants the selection of bud mutations is quite as important as seed selection in the origination of new varieties. Such occurrences are notoriously frequent among citrus fruits, where many often occur on the same tree, but they are also relatively common and have given rise to new varieties in potatoes, sugar-cane, apples, peaches, and pears, as well as in grapes, plums, strawberries, and a great variety of cultivated garden-plants, such as dahlias, chrysanthemums, roses, and carnations. Less is known concerning the frequency with which they will come true from seed, and this, of course, lessens their evolutionary significance.

PRESERVATION OF THE KAURI PINE.—Most of the Kauri pine, *Agathis australis*, the finest conifer south of the equator, has been destroyed in New Zealand by the lumberman. It is satisfactory to learn from the State Forest Report for 1920–21 that a remnant of the primeval forest of this species near Dargaville, 908 acres in area, was acquired by the State last year, and will be preserved intact as the National Kauri Park. An illustration in the report shows the stem of one veteran which is 36 ft. in girth. Other forests, of which the Kauri is an important constituent, need not, however, disappear. Investigations commenced a year ago by Mr. W. R. McGregor show that this species is readily regenerated under the shade of a natural-shelter wood. Complete re-establishment of a felled area requires a period of

twenty-five to fifty years, and is effected by the selection method. With proper precautions against fire, the Kauri forests that remain in New Zealand can be so managed as to yield a rich store of timber for centuries to come. The other important conifers in New Zealand, *Dacrydium cupressinum*, *D. Colensoi*, *Podocarpus dacrydioides*, and *P. totara*, also regenerate vigorously, and the process of their regrowth is in evidence in all situations where fire and grazing are excluded.

THE MOSS ROSE.—The origin of the moss rose is the subject of a paper by Major Hurst and Miss M. S. G. Breeze in the current issue of the Journal of the Royal Horticultural Society. It differs from the cabbage rose (*R. centifolia*) only in the much greater development and branching character of the glands on petioles and sepals and the branching of the latter. The cabbage rose has been in cultivation for more than two thousand years, and the earliest record of the moss rose is from Carcassonne, in southern France, where it probably originated as a bud-mutation from the cabbage rose at least as early as 1696. The mossy character has since arisen independently from two other varieties of the cabbage rose. In 1775 the Unique Rose appeared in a garden in the Eastern Counties as a tinged-white variety, and in turn gave rise to the "Unique Moss" through a bud-mutation in France about 1843. The Rose de Meaux is a miniature variety of the cabbage rose which may date from about 1637. A moss mutation appeared from this in the West of England in 1801. Both the moss and cabbage rose are sterile, and there is little doubt that all these derivatives arose from the old cabbage rose as bud-mutations. The records show that at least seven bud-reversions from the moss rose to the cabbage rose occurred in the period between 1805 and 1873. In the half-century following 1788 seventeen varieties of the moss rose appeared, one of which was single and fertile and extensively used in crossing. Twelve of these bud-mutations are parallel to corresponding earlier variations in the old cabbage rose. Bud-mutation is therefore a frequent phenomenon in *Rosa centifolia* under cultivation, and there is, as the authors suggest, a direct connection between this condition and the sterility. The evidence indicates that the mossy character is probably a simple Mendelian dominant.

THE EXAMINATION OF TEXTILES BY X-RAYS.—An interesting addition to the many and varied uses of X-rays in the examination of materials has been developed by Messrs. Truesdale and Hayes in the research laboratory of the Dunlop Rubber Co., Birmingham. In the Journal of the Textile Institute, vol. 12, No. 11, November 1921, they describe how, by the aid of radiography, they have studied the movement of the threads in the canvas of a motor-tyre during the several processes of manufacture of the tyre. For this purpose the canvas was specially woven so that every twentieth thread, both warp and weft, had been previously impregnated with a heavy salt. Thus the X-ray photograph reveals a series of squares, the pattern being in the form of a check. The most suitable salt for the purpose was found to be lead chromate formed by precipitation on the yarn by first soaking it in lead acetate and then in potassium bichromate. The X-ray plates or films were placed in actual contact with the material, so that the dimensions of the radiograph were those of the canvas. In the case of a tyre the film was placed inside the tyre, in contact with the first ply, and held in position by spring clips. The X-ray tube was on the outside, and care was taken that the X-rays were normal to the film. As the series of reproduced radiographs shows, the dimensions of the sides and angles of the squares are affected in some of the processes. By measuring predetermined squares on the radiograph taken after each process the change due to the previous process can be arrived at. The method proves to be an effective means of ascertaining whether the stretch of the canvas threads, resulting from the various processes in the manufacture of the tyre, is within the limits of stretch tolerated by the yarn—a point of extreme importance to the tyre manufacturer.

PROPAGATION OF EARTHQUAKE WAVES.—Dr. S. W. Visser, of the Royal Magnetic and Meteorological Observatory of Batavia, has recently issued an important paper on "The Distribution of Earthquakes in the Netherlands East Indian Archipelago during 1910–19, with a Discussion of Time-tables." For several years the tables in use of the times of transit of the primary and secondary waves as recorded on seismometers have been recognised as requiring corrections, and both Geiger and Gutenberg in Germany and G. W. Walker in this country have made definite suggestions towards this end. By a detailed discussion of the earthquakes having their origin near Batavia, Visser has been able, by means of a careful examination of the records obtained at distant stations, to draw up new sets of tables so far corroborating the suggestions already made, but carrying out the corrections much more completely and through the whole range of distances from the epicentre. The corrections of the primary times of transit are most conspicuous in the range from 50° to 100° arcual distance, being an increase of as much as 10 seconds at the distance of 60° or 70°. In the case of the secondary times of transit the corrections are more in evidence, being a decrease for small arcs (less than 50°), an increase for larger arcs (up to 70°), and a marked decrease for arcs greater than 80°. Visser also discusses what seems to be the manner of propagation of the waves which enter the nucleus of the earth, and gives general support to the views expressed by Knott in his recent paper on the propagation of earthquake waves. In the light of the corrections now supplied it will be necessary to recalculate the forms of the seismic rays, especially for the secondary waves. Visser fully bears out the conclusion already come to that the primary wave ceases to be recorded at distances greater than about 110°, but finds evidence of their reappearance beyond 140° with a retarded time of transit.

HARMONIC DEVELOPMENT OF TIDAL THEORY.—Dr. A. T. Doodson, of the Tidal Institute, University of Liverpool, has just published in the Proceedings of the Royal Society (A, vol. 100, p. 305, 1921) a paper on "The Harmonic Development of the Tide-generating Potential." Since 1883 the development given by Sir G. H. Darwin has been universally used and has proved of remarkable value, but the assumption usually tacitly made, that no terms not included in his schedule need be considered in tidal prediction, has been shown by work at Liverpool on tidal observations to be unjustified. It was therefore decided to make a new development in which, in view of the possibility of terms being magnified by resonance, great accuracy has been striven after. All terms the coefficients of which exceed one ten-thousandth of the leading term are included; this degree of accuracy is unnecessary for practical tidal work, but the needs of research were also kept in mind. Unlike Darwin's development, which was algebraic and founded on the old lunar theory, referring everything to the orbit rather than to the ecliptic, the present work is essentially numerical and strictly harmonic; Brown's new lunar theory is taken as the basis of the development. Many terms which are too large to be ignored for modern purposes, but do not occur in Darwin's schedule, have been found.

The Jubilee of the Institution of Electrical Engineers.

IT is now fifty years since the Society of Telegraph Engineers held its first meeting. The title of the Society was changed to that of the Institution of Electrical Engineers in 1883, and it has grown from a membership of about 100 in 1872 to one of more than 10,000 in 1922. Last year the Institution was granted a Royal Charter, and it celebrated its jubilee last week by holding meetings at which some of the pioneers of electricity gave recollections of the early days of the industry.

Prof. Fleming gave fascinating lectures on Michael Faraday. He showed how well this great investigator laid the foundations on which the impressive superstructure of modern electrical practice has been built. In particular he laid stress on the marvellous thoroughness with which Faraday stated the physical laws of electrolysis and electromagnetism. Many of Faraday's statements which survive intact in our modern text-books are models of lucidity. For its rapid development the industry is largely indebted to the unselfish labours of this great physicist.

Electrical engineering more than any other branch of engineering is based on pure science. The ease with which measurements of the highest accuracy can be made has been the greatest boon to engineers. It is not surprising, therefore, that electrical machines have gradually been evolved the efficiency of which approximates to a hundred per cent. No one appreciates more highly than the electrical engineer the value of scientific research, and no one takes a keener interest in every discovery in pure science.

Many of the reminiscences given by speakers at the commemoration meetings carried us back to the earliest days of the industry. It has to be remembered that the incandescent lamp was invented and the first telephone exchange was built only 44 years ago. Many of the speakers, therefore, had watched the growth of the industry from the start. Several tales were told of the founding of the Institution. It was pointed out that the ideas underlying any new movement are usually present in a vague way in the minds of many people and, therefore, it is difficult to assign the credit for the original idea with any degree of certainty. We think that greater stress might have been laid on the work done by Lord Lindsay—afterwards the Earl of Crawford and Balcarres—in founding the Society. He had a laboratory in a slum called Eaton Place (now swept away), lying between Green Street, Grosvenor Square, and Oxford Street. Some of the apparatus used is still in use at Faraday House, a college and testing institution which he helped to establish in 1889. It was in this laboratory that the first inception of founding a Telegraph Society was made in 1869. Cromwell and Arthur Varley, who worked in it, were anxious that the Society should be started at once, and they particularly wished that Sir William Thomson, who was then the leading electrical expert, should be the first President. It was not, however, until 1872 that the Institution got under way, the first President being Dr. Carl Siemens (Sir William Siemens). In 1874 Sir William Thomson became President for the first time, Lord Lindsay being one of his Vice-Presidents.

Listening to the speakers brought vividly back to the memory the halo of wonder that surrounded many of the early discoveries. The telephone, invented by Alexander Graham Bell, is regarded to-day as a mere domestic appliance. In 1876 the fact that you could hear a whisper at a distance of ten miles was rightly regarded as an almost supernatural achievement. Mr. Kingsbury recalled that Bell and his associates stated in 1877 in their first business circular that they were "prepared to furnish telephones for the transmission of articulate speech through instruments not more than 20 miles apart." To-day conversation has taken place over 5000 miles, and if the necessity ever arose an Indo-European telephone could be made without the need of further research.

Mr. Judd, who has been intimately connected with submarine telegraphy for more than 50 years, pointed out that notwithstanding the fact that hundreds of thousands of miles of submarine cable are now in existence, yet so well had the foundations of the industry been laid by British engineers and men of science that the cables of to-day are of the same general type as in 1866. Sir William Thomson solved the problem of operating submarine cables, first with the mirror galvanometer and then with the siphon recorder. Both instruments remain practically unaltered. The first great change in cable operation was the introduction of duplex working by which messages could be sent simultaneously from both ends of the cable. Judd was convinced that submarine telegraphy would continue to play the *rôle* assigned to it by the early pioneers of drawing together all the nations of the world.

Col. Crompton began electrical work 44 years ago by installing Gramme dynamos and Serrin lamps. He said that he had to learn the technicalities of his art from the telegraph engineers. Accustomed to working with primary batteries they told him that the resistance of the armature should never be less than the resistance of the external circuit. In the year 1883, as the result of an escape of gas, the Ring Theatre in Vienna was burned down with a lamentable loss of life. The Austrian Emperor issued an order that gas lighting would not be allowed in any of the Imperial Theatres. The Vienna Gas Company, therefore, decided to take up the supply of electric light, and they invited Col. Crompton to assist in the design and erection of their Central Supply Station. This installation was the prototype of many central stations built in this country in the early 'nineties.

Mr. Partridge narrated how the Earl of Crawford and Sir Coutts Lindsay installed a portable electric light plant in a yard behind the Grosvenor Gallery in 1883. From this small beginning emerged the Grosvenor Gallery Station, which was the first to adopt the parallel system of using transformers, thus revolutionising all the methods then in use. This station was burned down in 1890. In this year, after overcoming many difficulties, Ferranti successfully transmitted electric power at 10,000 volts from Deptford to Trafalgar Square.

Sir Charles Parsons gave an interesting account of the first turbo-alternator. This machine ran at 18,000 revolutions per minute, the armature of the dynamo being less than three inches in diameter. It was essential to have the diameter small, as otherwise the centrifugal forces called into play would have been prohibitively high. These small machines were used on board ship; they were far from economical, but they worked satisfactorily for several years. The modern large turbine-driven generator constructed on the lines of Parsons' inventions is the most economical generator of electricity from steam at present in existence. All the proposed "superpower" steam stations will be equipped with these sets.

Sir Oliver Lodge directed attention to the invaluable pioneering work in electrical theory done by Oliver Heaviside, who has shown how to calculate the eddy-current losses in cores, and the effects pro-

duced by high-frequency currents in cylindrical wires. His most important discovery, however, was that of the distortionless circuit, a discovery which led to most important practical developments in long-distance telephony both in land and in submarine cables.

References were made to the discovery of X-rays, of radio-telegraphy, and of the atomic nature of electricity.

The Institution of Electrical Engineers has been fortunate in having so many eminent men of science as Presidents in its early days. Lord Kelvin was President three times, and John Hopkinson was President twice. Amongst others we may mention Sir William Crookes, Sir Joseph Swan, and D. E. Hughes. The wonderful physical insight of Sir William Crookes is only now being fully recognised. Many years ago he had visions of electrons and even considered the possibility of isotopes.

The Institution was founded in order to promote the general advancement of electrical and telegraphic science. In its Journal many important scientific and mathematical papers have been published. In conjunction with the Physical Society of London it has published, at considerable expense, *Science Abstracts* for the past 24 years. Its activities are ever widening and we congratulate it on its well-merited success.

The American Association at Toronto.

THE second Toronto meeting of the American Association for the Advancement of Science and of the associated scientific societies, which was held during the last week of 1921, at the invitation of the University of Toronto and of the Royal Canadian Institute, was the seventy-fourth meeting of the association. It was successful in every way, and must go on record as the most satisfactory meeting thus far held, apart from the greater four-yearly meetings. Fourteen sections of the association were represented and twenty-six associated societies. About nine hundred addresses and papers were presented, and the official registration showed an attendance of 1832 persons. The sessions were held in the buildings of the University, which are excellently adapted for such purposes, while the majority of those in attendance were very conveniently housed in the University dormitories. These arrangements proved to be unusually convenient and satisfactory.

On the afternoon of Monday, December 26, the day before the official opening, the secretaries of the sections met with the general secretary and the permanent secretary to discuss some general problems of the association. On Tuesday afternoon Dr. F. R. Moulton, professor of astronomy in the University of Chicago, showed some very fine motion pictures on scientific subjects, illustrating the use of motion pictures in education.

The meeting was formally opened on the evening of Tuesday, December 27, under the able presidency of Dr. E. H. Moore, professor of mathematics in the University of Chicago. The president was introduced by the retiring president, Dr. L. O. Howard, chief of the Bureau of Entomology of the United States Department of Agriculture, who was permanent secretary of the association for many years. Sir Robert Falconer, president of the University, delivered an admirable address of welcome, emphasising the close and friendly relations that have so long obtained between Canada and the United States. This was followed by the address of the retiring president. In the first part of his address, among other interesting things, Dr. Howard directed attention to the fact that the average age of the presidents of the British and of the American Associations since 1895 is about the same, sixty-one years and eleven months for the British and sixty-one years and five months for the American. The second part of Dr. Howard's address dealt with the topic "The War against the Insects." It was pointed out that unceasing warfare must be waged by mankind against the almost countless and omnipresent forms of insect-life, which threaten the very existence of the human race. A report of the latter part of the address appeared in NATURE of January 19, p. 79. The opening sessions were followed by a reception in the room behind Convocation Hall, where members and their friends had an opportunity to meet one another and to examine the fine series of exhibits of scientific apparatus and products brought together by the local sub-committee on exhibits, of which Prof. E. F. Burton was chairman.

The Wednesday evening session in Convocation Hall was of a twofold character. Dr. W. Bateson, director of the John Innes Horticultural Institution, Merton Park, Surrey, who was present at Toronto by joint invitation of the American Association and the American Society of Zoologists, delivered a stimulating address on "Evolutionary Faith and Modern Doubts." He clearly emphasised the point that students of evolution harbour no doubts as to the fact of evolution, but the exact mode of evolution remains still an unsolved problem. He dwelt on the important progress recently made in America in relation to inheritance and the problems of genetics, especially with reference to chromosomes.

At the close of this address the session was transformed into a convocation of the University of Toronto, Sir Robert Falconer presiding, and the degree of Doctor of Science *honoris causa* was conferred on Dr. Bateson, Dr. Howard, and Dr. Moore. A reception followed the convocation.

Sir Adam Beck, chairman of the Hydro-Electric Power Commission of Ontario, addressed a general session on Thursday afternoon under the auspices of Section M (Engineering). His subject was "Hydro-Electric Developments in Ontario," and he showed a series of moving pictures illustrating the various hydro-electric projects in Ontario.

The Thursday evening conversazione in Hart House was one of the greatest social functions ever held in Toronto, and was unique in the history of the association. For three hours the two thousand guests of the University and the Royal Canadian Institute enjoyed the entertainment facilities of the magnificent students' social centre in Queen's Park.

The weather throughout the meeting was fine, though cold enough to be stimulating, and with an almost unclouded sky. The necessity for using artificial ice for winter sports in Toronto furnished an agreeable surprise to those who had anticipated arctic cold.

The Toronto meeting was especially international in character. It emphasised the point that the American Association is an international organisation. Although the majority of its members are now residents of the United States, it was clearly seen at Toronto how much the future of the association depends upon Canadians. The meeting was an occasion for a pronounced increase in the Canadian membership, and it is hoped that the time will soon come when Canadian men of science will all regard the association as theirs. A wonderfully fine

spirit of international good-fellowship and understanding prevailed throughout the meeting.

Sixteen well-attended dinners were held during the meeting by the various groups of scientific workers. The programmes of the sections and of the societies associated with them were generally extensive, and all were interesting and important. Many vice-presidential and presidential addresses were given and many symposia held. Special mention should be made here of the fine programme of Section M (Engineering) and of the symposium on an international auxiliary language, which was arranged for Toronto under the auspices of Section K (Social and Economic Sciences). The engineering programme was unusually excellent in many ways. Arrangements for this were due to the very efficient work of Mr. J. B. Tyrrell, of Toronto, vice-president of Section M. The Society for the Promotion of Engineering Education met with Section M.

The social and economic sciences (Section K) had no separate programme, but through the enthusiastic and efficient work of Dr. F. G. Cottrell, of the U.S. National Research Council, a symposium on an international auxiliary language was arranged. This was held at a joint session on Friday afternoon of Sections K and Q (Education). The symposium was preceded by the address of the retiring vice-president of Section K, Dr. F. L. Hoffman, of the Prudential Life Insurance Co. of America, on "The Organisation of Knowledge."

A programme of great general and cultural interest was presented by the Committee on the History of Science in a session held on Thursday morning. Among others, Dr. J. P. McMurrich—afterwards elected president of the association for 1922—gave a paper on the artistic anatomical work of Leonardo da Vinci.

The extraordinary success of the meeting was due mainly to the tireless and varied activities of the members of the local committee under the chairmanship of Prof. J. C. Fields, who foresaw all needed arrangements and added many pleasant and convenient details. Especially was praise given to the very artistic official badge, which will serve as a worthy commemoration of one of the most satisfactory meetings of the association. The very onerous and pressing work of caring for the publication of the general programme was undertaken by Dr. J. P. McMurrich, who handled this very difficult and confusing complex of details with very great skill. The University of Toronto Press gave very efficient service in this connection.

Publicity was unusually well handled. The recently organised Science Service co-operated with the association in arousing public interest in the meeting through the daily press. Dr. E. E. Slosson, editor of Science Service, and Mr. Watson Davis were present throughout the meeting on behalf of Science Service. Besides the valuable publicity work of Science Service, which is under the control of the American Association, the U.S. National Academy, and the U.S. National Research Council, and which operates for the sole purpose of disseminating scientific knowledge through the newspapers, just as valuable and efficient publicity work was accomplished by the local Sub-Committee on Publicity, of which Prof. A. G. Huntsman was chairman.

At the council meeting of the association the sum of 4000 dollars was allocated in grants for research, according to the recommendations of the committee on grants. Prof. B. K. Emerson, of Amherst, Mass., and Prof. E. A. Smith, of the University of Alabama, were elected to emeritus life-membership on account of the Jane M. Smith Endowment Fund. On a vote by the council the president appointed the following committee to consider the subject of reciprocity between the United States and Canada so far as this concerns scientific work:—E. L. Nichols (chairman), F. D. Adams, T. C. Chamberlin, J. C. Fields, and J. C. Merriam. It was decided that the next annual meeting of the association should be held at Boston, Mass., on December 26–30, 1922, and the 1923–24 meeting at Cincinnati, Ohio, in December 1923.

Dr. J. P. McMurrich, professor of anatomy in the University of Toronto, was elected president of the association. The following vice-presidents of the several sections were elected:—A (Mathematics), G. A. Miller, University of Illinois; B (Physics), Frederick A. Saunders, Harvard University; C (Chemistry), W. Lash Miller, University of Toronto; D (Astronomy), Otto Klotz, Dominion Observatory, Ottawa, Ontario; E (Geology and Geography), Charles P. Berkey, Columbia University; F (Zoological Sciences), Maynard M. Metcalf, Oberlin College; G (Botany), Francis E. Lloyd, McGill University; I (Psychology), Raymond Dodge, Wesleyan University; K (Social and Economic Sciences), Henry S. Graves, Washington, D.C.; L (Historical and Philological Sciences), William A. Locy, Northwestern University; M (Engineering), George F. Swain, Harvard University; N (Medical Sciences), Francis W. Peabody, Harvard Medical School; and O (Agriculture), R. W. Thatcher, University of Minnesota.

BURTON E. LIVINGSTON.

The Use of Light as an Aid to Aerial Navigation.

AT the meeting of the Illuminating Engineering Society on January 31, Lt.-Col. L. F. Blandy, who is associated with the Air Ministry, delivered a paper on "The Use of Light as an Aid to Aerial Navigation." Gen. Sir Frederick Sykes, Controller-General of Civil Aviation, presided. In the introductory portion of the paper the author described the lighting of the passengers' accommodation and crew's quarters, etc., on a modern airship, the light being derived from electric lamps fed from a generator driven by the engine. Small candle-power lamps are used for illuminating the dials of instruments, etc., on some machines. The external lighting of aircraft has been closely studied by the International Air Convention, which has defined precisely the equipment of a forward white light of 8-km. range, a red light of at least 5-km. range on the left hand, and a green light of similar range on the right. Special arrangements must be made to prevent the green light being seen from the left side or the red light from the right. A white rear light is also provided.

In navigating the air, principles similar to those in use at sea are thus being adopted for external lights, but owing to the motions of aircraft and their high speed the arrangement of navigation lamps demands special care. The relative speed of approaching machines may attain 200 m.p.h., *i.e.* 3·3 miles per minute. From the time of sighting headlights to the moment of collision the time available may be only 90 seconds, and it looks as though the range of navigation lights may have to be increased. Lights used by aircraft to facilitate landing may be either chemical or electric. Gas-filled electric lamps of 1000–2000 c.p. have been developed for this purpose, and appear to have some advantages over flares, notably as regards ease of control and extinction at will. Aerodrome lighting includes lights used to define the positions of buildings and other obstruc-

tions, illumination of the actual ground, and fixed illuminated signs to show the position of wind, etc. At Croydon the lighting of high wireless masts, which form dangerous obstructions, has been effected by placing 1000-c.p. gas-filled lamps, screened red, on the top of the masts. These form a good recognition mark.

Ground illumination requires special care to avoid dazzling the eyes of pilots at some angles. A special arrangement recommended at the International Air Convention is the use of lights arranged in the form of two " L's " to indicate positions for " taking off " and landing. Such lights were originally mounted in reflectors covered by flat glass discs in such a way that they were readily visible from above, but invisible at close range. Better methods of diffusion, enabling lights to be seen at all angles, have since been devised. Searchlights appear helpful, but have to be used with care to avoid confusing shadows when the machine is near the ground. An appendix to the paper contains particulars of the recommendations of the International Air Convention in regard to signals of distress, etc. Much has yet to be done in this new field, but the paper affords a useful review of existing procedure.

The Preservation of Stone.

A LECTURE to the Royal Society of Arts on the above subject by Mr. Noel Heaton is published in the Journal of the society for December 30 last. The lecturer gave an account of the various attempts which have been made to solve the important problem of preventing the decay and disintegration of stonework in buildings. The great majority of modern stone buildings, and a still greater proportion of medieval buildings, are constructed of limestone or sandstone, and the problem centres around these varieties rather than about the more resistant granite, used only to a limited degree. The causes of disintegration may be natural, depending on fluctuations of temperature, on rain, on erosion by wind, and, in ferruginous sandstones, on oxidation. Minute differences in structure often cause great differences in durability. The growth of vegetation on stone usually hastens decay. The most potent cause of decay is, however, the " unnatural " action of sulphuric acid, derived from coal-smoke, coupled with the accumulation of soot and grime. Sir Frank Baines, who introduced the lecturer, stated that, roughly, 80,000 tons of sulphuric acid are thrown annually into the London atmosphere. Strain set up by the rusting of iron is also a contributory cause of decay. The lecturer then turned to the means of preventing decay.

An indirect method of preventing decay is to further, by every possible means, the campaign against atmospheric pollution. The stone may be treated with preservatives, which were divided into three groups: (*a*) those acting merely as surface coatings; (*b*) those impregnating the stone without chemical action; and (*c*) those operating by chemical reaction with the stone. In the first class are paint and limewash, the latter being useful where the stone is subjected to a moist atmosphere, but protected from rain. In the second class are mineral wax applied by heat or in solution in benzene, drying oils, creosote, or gelatinous precipitates formed on the stone. The first process is very old, and is effective for certain purposes. Treatment with alum solution, followed by soft soap, which results in the precipitation of an aluminium salt of the fatty acids, is recommended.

In the third class treatment with baryta is effective in repairing a stone disintegrated by sulphuric acid. A common method is the deposition of silica or silicates. Treatment with waterglass leads to unsightly efflorescence. This may be reduced by treating with a solution of arsenic acid after the waterglass, but the most satisfactory results are obtained with silicofluorides, introduced in France by Kessler in 1883. A solution of magnesium silicofluoride reacts with limestone:

$$MgSiF_6 + 2CaCO_3 = SiO_2 + MgF_2 + 2CaF_2 + 2CO_2.$$

The solution, known as " Fluate," is manufactured in France, and the lecturer stated that, although the results were conflicting, it appeared to be beneficial. In America the double salts of magnesium and zinc were preferred. The use of the solution has recently been investigated by Prof. Desch, in conjunction with the Department of Scientific and Industrial Research, and, although the detailed results have not yet been published, the conclusions appear to be that too strong a solution should not be used (not stronger than 10 per cent.), and that the mode of application should be adjusted to particular conditions. The method is most useful on new work. The use of nostrums of unknown composition is strongly condemned, as they may cause great injury. Sir Frank Baines also contributed some valuable information in the discussion on the lecture.

Mathematics in Japan.

A GOOD many years ago there was an exhibition at Earl's Court in which the Japanese Government and nation took a conspicuous part. For several reasons the Japanese art section was particularly interesting. It contained priceless and authentic specimens of their national painting and handicraft before they were influenced by foreign methods and ideals. Besides this, there were paintings by some of their modern artists who adopted Western methods and conventions. The contrast was very striking, and in some respects not very satisfactory.

Similar reflections are suggested by the present state of Japanese mathematics, as shown, for example, in various mathematical papers recently received from the University of Tokyo. Circumstances are different because mathematical science is now cosmopolitan, and no single nation can afford to neglect its various developments. At the same time, like nationality in drinks, there is a kind of nationality in science, art, or any other human activity, which is justifiable, and even instructive, if it is not carried to excess. We may notice it, for example, in the papers and treatises of the leading mathematicians, such as Klein and Dedekind on one hand and Poincaré, Hermite, and Darboux on the other. The elegance of the best French text-books is scarcely equalled, if at all, by those of any other nation; at the same time, the corresponding German works are distinguished by thoroughness, method, and fulness of references. The treatise on elliptic modular functions by Klein and Fricke and Poincaré's memoirs on Fuchsian functions illustrate the point.

It is difficult to be sure how far Japanese mathematics is entirely original. They had various approximations to π, some of which, at any rate, seem to have been of their own invention. They had an extraordinary gift for solving numerical equations of high degrees by approximation, and one Japanese writer appears to have anticipated many of Steiner's

theorems on poristic systems of circles. Besides this, they discussed elegant problems more or less suggested by familar objects, such as fans, toys, etc.

It would be a pity if all truly Japanese characteristics were to become obliterated. Apart from æsthetic considerations, if they avoid falling into the rut of Western methods there is a chance of their producing something really novel and suited to their genius. They might, for instance, solve some of the outstanding problems of group theory or make some notable advance in Diophantine analysis—a subject which seems to have lost its fascination for most European mathematicians.

The attitude of an individual towards foreign mathematics is sometimes peculiar, and even amazing. Not very long ago an English lady spending a holiday at Utrecht was introduced to an eminent Dutch mathematician. Having a mathematical friend in England, she asked the professor his opinion of English mathematicians. The answer was to the effect that their work was so strangely insular that he could not spare the time to make himself familiar with it. This was after Cayley, Sylvester, and Salmon had published much of their best work on invariant theory.

G. B. M.

University and Educational Intelligence.

CAMBRIDGE.—In connection with the meeting of the Royal Agricultural Society at Cambridge in the coming summer, honorary degrees are proposed for H.R.H. Prince Albert, the President of the Society, Mr. C. R. W. Adeane, Sir Gilbert Greenall, Sir A. Daniel Hall, Mr. E. S. Beaver, Mr. A. E. Humphries, Mr. Ernest Mathews, and Mr. G. P. Hawkins.

An open Fellowship, for which all graduates of the University are eligible who took their first degree not earlier than June 1919, is announced by King's College. Any one who wishes to offer himself as a candidate should communicate with the Provost as early as possible.

LEEDS.—Prof. Sir Berkeley Moynihan has given to the University an endowment for the annual award at the Leeds Medical School of a gold medal to the best student of the year in Medicine and Surgery. In accordance with Sir Berkeley Moynihan's wish the gold medal will bear the name of William Hey in commemoration of the work of that great Leeds surgeon. The Council of the University in accepting the endowment have recorded their thanks to Sir Berkeley Moynihan for his generous gift. William Hey (1736–1819) was one of the pioneers of modern surgery. A brilliant operator and teacher, he established the tradition of surgical skill which has ever since been one of the chief distinctions of Leeds. He was a friend of Joseph Priestley when the latter was Minister of Mill Hill.

LONDON.—The following course of free public lectures is announced: At King's College, Strand, at 5.15 on Wednesdays, March 8, 15, and 22, "The Quantum Theory of Radiation and the Constitution of the Atom," Prof. Nils Bohr (in English)

THE bearing of improved means and methods of education receives striking confirmation in the figures adduced by Mr. Percival Sharp in his address in January at the annual meeting of the Association of the Directors and Secretaries for Education held in the County Hall, London. Dr. Sharp submitted official statistics for England and Wales showing the curve of crime from 1870, when the population of England and Wales was 22,000,000, down to 1919, when it had reached nearly 37,000,000. In 1870 107,621 men and 39,604 women above sixteen years of age—a total of more than 147,000 persons—were committed to prison. In 1919 the numbers fell to 22,289 men and 8718 women—a striking difference, having regard to the great increase in population. There are no figures available earlier than 1893 concerning indictable offences tried at the Quarter Sessions. The number of men convicted shrank in 1919 to 5200, as compared with 8200 in 1893, whilst the number of women convicted declined from 1245 in 1903 to 826 in 1919. The number of men tried summarily for indictable offences fell from 20,000 in 1893 to 16,000 in 1919, and of women from 5000 to 3900. The figures for non-indictable offences fell from 133,000 to 73,700 for men in the same years, and from 43,000 to 18,000 for women. The Home Office has decided to close eight prisons and to shut down the female wings of six other prisons at the end of March next. So far as a great industrial and commercial area like Manchester is concerned, two large industrial and reformatory schools have recently been closed, and the returns available show that between 1907 and 1921 the number of children under maintenance shrank from 659 in 1909 to 209 in 1921. These figures are conclusive as to the value and influence of education in the training of the children of the nation, and condemnatory of any proposed legislative measures of economy with regard to the restriction of such training. Rather they enforce the necessity for continued development and improvement.

A LIST of students from the King's Dominions overseas and from foreign countries studying in the universities and university colleges of the United Kingdom has been compiled by the Universities Bureau of the British Empire. The following figures gleaned from the list are of general interest, which would, however, be greatly enhanced if to them could be added statistics of the very numerous students from abroad who are studying at the Inns of Court, in other professional and technical institutions not included in universities and university colleges, and privately:—Of the total number, 4470, Asia contributed over a third (1576), Africa 1187, America 781, Europe 645, and the Pacific, 281. Of the Asiatics 1240 are from India, Burma, and Ceylon; this includes 446 at London, 173 at Edinburgh, 171 at Cambridge, 170 at Oxford, and 65 at Glasgow. The Indian Students' Department of the Office of the High Commissioner in 1921 estimated that there were 1500 Indian students at the universities and technical colleges and 600 at the Inns of Court. From China came 143, of whom 49 are at London, 25 at Edinburgh, and 17 at Cambridge. Of 73 from Japan 55 are at London. South Africans and Rhodesians number 832, including 327 at London, 178 at Edinburgh, 95 at Dublin, 82 at Oxford, and 42 at Cambridge. Of 294 from Egypt, 88 are at London and 52 at Birmingham. The U.S.A. contributed 400, of whom 210 are at Oxford, a large proportion being Rhodes scholars. Of 200 from Canada, 87 are at Oxford. South America contributed 75 and the West Indies 101, of whom 33 are at London and 23 at Edinburgh. Of the Europeans, 91 are from Russia, 61 from Switzerland, 62 from France, 52 from Greece, 70 from Scandinavian countries, 49 from Rumania, and 48 from the kingdom of the Serbs, Croats, and Slovenes. Of 178 Australians, 50 are at Oxford, 41 at London, 36 at Edinburgh, and 35 at Cambridge; while of 102 New Zealanders, 27 are at London, 25 at Edinburgh, 24 at Cambridge, and 20 at Oxford.

Calendar of Industrial Pioneers.

March 2, 1892. Sir John Coode died.—A pupil of J. M. Rendel, Coode became resident engineer, and then engineer-in-chief, of the Portland breakwater, completed in 1872, and afterwards rose to be the most distinguished harbour engineer of his time. Among his greatest works were those at Cape Town, Fremantle, and Colombo. From 1889 to 1891 he served as president of the Institution of Civil Engineers.

March 3, 1895. Alfred Giles died. March 4, 1847. Francis Giles died.—Both the Giles, father and son, were successful civil engineers. Francis Giles was employed under Rennie, and later carried out various important harbour and canal works; while his son was largely concerned with railway projects in Denmark, France, Canada, Galicia, and other countries. In 1893 Alfred Giles was president of the Institution of Civil Engineers.

March 4, 1902. Bryan Donkin died.—The grandson of Bryan Donkin (1768–1855), known for his pioneering work in paper-making machinery, Donkin succeeded to the business founded by his grandfather. He was, however, best known for his study of thermodynamics and the scientific testing of steam engines, his investigation of steam jacketing and condensation, and his work on gas and oil engines.

March 6, 1900. Gottlieb Daimler died.—A native of Würtemberg, Daimler became a practical engineer, worked in England under Whitworth, and about 1870 became associated with the gas-engine pioneer Nicolas Otto. In the 'eighties he constructed small internal-combustion engines, one of which he fitted to a bicycle, and in 1890 he founded the Daimler Motorengesellschaft at Cannstadt, where he died.

March 7, 1809. François Blanchard died.—One of the most celebrated of the early aeronauts and a reputed inventor of the parachute, Blanchard made some sixty ascents. On January 7, 1785, with Dr. John Jeffries, he was the first to cross the Channel in a balloon. His wife, Sophie Armant, was also an intrepid aeronaut, and perished in a balloon accident in 1819.

March 8, 1803. Francis Egerton, Duke of Bridgewater, died.—The Duke of Bridgewater has been called the founder of British inland navigation. Succeeding to the family estates at an early age, he settled in Lancashire, and to develop his collieries engaged Brindley to construct the canal from Worsley to Manchester and that from Manchester to the Mersey, the first English canals.

March 8, 1887. James Buchanan Eads died.—Born in Indiana in 1820, Eads's whole life was bound up with the Mississippi. He made a fortune by raising steamboats sunk in the river, achieved a great reputation during the Civil War by the rapid construction of gunboats for its defence, in 1867–74 constructed the great steel arch bridge which spans it at St. Louis, and later originated the jetties at its mouth for improving the channel. He was the first American to be awarded the Albert medal of the Royal Society of Arts.

March 8, 1889. John Ericsson died.—A fertile inventor, a noted engineer, and one of the foremost constructors of warships, Ericsson was a native of Sweden. From 1826 to 1839 he was in England, where he produced the first steam fire-engine, constructed the locomotive "Novelty," and built the screw-driven vessel *Robert F. Stockton*. The remainder of his life was spent in America, where during the Civil War he inaugurated the era of the armoured turret battleship. The great fight between Ericsson's *Monitor* and the *Merrimac* took place on March 9, 1862. E. C. S.

Societies and Academies.

LONDON.

Royal Society, February 23.—Sir Charles Sherrington, president, in the chair.—C. D. **Ellis**: β-Ray spectra and their meaning. A method of finding the wave-lengths of γ-rays of too high a frequency to be measured by the crystal method depends on the fact that γ-rays are converted into β-rays according to the quantum relation. If the energies of the groups of electrons ejected by γ-rays be added to the work done in removing the electron from inside the atom to the surface, $h\nu$ is obtained. The work is found from observations of the energies of corresponding groups excited in different substances, and the method is applied to find the wave-lengths of the γ-rays emitted by radium B, radium C, and thorium D. The energies of the β-ray groups of thorium D have been measured for this purpose. The γ-rays are emitted from the nucleus and the numerical values of the wave-lengths suggest that the quantum dynamics applies to the nucleus and that part of the structure can be expressed in terms of stationary states. Suggestions for the energy of these stationary states in radium B and thorium D nuclei are given.—A. E. **Conrady**: A study of the balance. The first weighings by the Gaussian method of exchange made with an inexpensive analytical balance gave a probable error of only 0·004 mg. A constructional fault in the suspensions was remedied and the probable error fell to 0·0013 mg. A further systematic error, depending on the sequence of pointer readings in successive exchanges was attributed to imperfect elasticity and irregular curvature of knife-edges. A method of double exchange of loads which, by close adjustment of a light rider, caused all readings to fall on two alternating positions of rest, brought the probable error to 0·0008 mg., and it seemed now largely due to irregular air-currents. Arrangements allowing manipulation of loads without opening of balance case reduced the probable error to an average value of 0·0004 mg. If the centre of gravity of the moving parts falls in the supporting line of the central knife-edge ("autostatic" state), the reading of the pointer becomes independent of levelling of the balance case, and highly accurate results can be obtained on very infirm supports.—J. S. **Owens**: Suspended impurity in the air. The essential part of a new instrument for measuring impurities is a fine jet of air which strikes a glass surface with high velocity, depositing its dust thereon. The velocity of jet affects the operation of the instrument. The adhesion of dust to the glass has suggested applications which indicated (*a*) that visibility is usually a function of amount of suspended impurity; (*b*) that suspended dust travels over great distances; records being described of dust from the Continent; (*c*) that the microscopical examination of such records indicates differences depending upon wind direction.—R. V. **Southwell**: On the free transverse vibrations of a uniform circular disc clamped at its centre; and on the effects of rotation. An analysis of the influence of rotation upon the normal modes and frequencies of free transverse vibration in a uniform circular disc, complete freedom from constraint being assumed, is extended to cover the effects of constraints which prevent, along a small circle concentric with the free edge, the occurrence either of finite transverse displacement w, or of finite slope $\delta w/\delta r$. The constraints are assumed to have no effect upon the centrifugal stress-system. Clamping a non-rotating disc along a small circle produces only slight changes of frequency in modes characterised by two or more

nodal diameters, but is important in its effect on the "symmetrical" modes and on modes having one nodal diameter. In the other extreme case, when the flexural rigidity may be neglected, the central constraint has no effect upon the natural frequencies. In the general case, in which both flexural and centrifugal stresses are considered, the gravest frequencies in modes which have nodal diameters may be calculated by the formula previously given; a special investigation is made of the gravest frequency in a symmetrical mode.—A. E. **Oxley**: Magnetism and atomic structure. II.—The constitution of the hydrogen-palladium system and other similar systems. The susceptibility of palladium black charged with hydrogen is less than that of pure palladium black. From this it is concluded that the occluded hydrogen is neither in the atomic nor molecular state. The results agree with the existence of a chemical compound, probably Pd-H. In the hydrogen molecule; each atom thrusts its electron into the other atom, the bond being represented by a pair of electrons held in common. The palladium atom has 46 electrons, the hydrogen atom 1 electron, the latter being thrust into the outer shell of the palladium atom. If these 47 electrons take up a configuration like that of the silver atom (atomic number 47), which is diamagnetic, the fall of susceptibility may be accounted for. Paramagnetic manganese fused in hydrogen becomes ferro-magnetic. The occluded hydrogen atoms probably thrust their electrons into the outer shells of the manganese atoms, producing in them electron configurations analogous to that of the iron atom.—T. **Carleman** and G. H. **Hardy**: Fourier's series and analytic functions. If $f(\lambda)$ is integrable in the interval $(0, 2\pi)$, and the associated function $\phi(u) = \frac{1}{2}\{f(a+u)+f(a-u)\}$, where $0<a<2\pi$, is harmonic and bounded in a certain neighbourhood of $u=0$, then the necessary and sufficient condition for the convergence of the Fourier series of $f(\lambda)$, at $\lambda=a$, is that $\phi(u)$ should tend to a limit when u tends to zero through positive values.—A. **McAulay**: Multenions and differential invariants. Pts. II. and III. The quadratic form is introduced: all multenion formulae may be put into invariant form. Tests, both by finite and by infinitesimal transformation, are given, for ascertaining whether invariance of each one of six types subsists for any given function. Multenion methods are compared with those of the Theory of Tensors and details are furnished for translating from one mode of presentation to the other. Pt. III. is a general survey of the applications of a Riemann manifold to relativity. In relation to matter and gravitation no new principle is introduced but the electro-magnetic field is treated in a novel manner. The scalar and vector potentials are wholly ignored. The application to matter in bulk is kept in mind, and it is considered imperatively necessary to adapt relativity methods to a sufficiently general set of relations as at least to leave Maxwell's explanation of crystalline reflection, refraction, and transmission of light intact.

Linnean Society, February 16.—Dr. A. Smith Woodward, president, in the chair.—R. R. **Gates**: The inheritance of flower size in plants. Reciprocal crosses were made between *Œnothera rubricalyx* and *Œ. biennis*, with petals 40 mm. and 20 mm. in length respectively. The size of flowers in F_1 was intermediate and relatively uniform. In F_2 there was a marked difference in size of flowers (*a*) on different plants, (*b*) in different flowers of the same plant, and (*c*) sometimes in the different petals of a flower. Measurements on F_2 and F_4 plants show that the hypothesis of several Mendelian factors for length of petal is an insufficient explanation. Variation curves show a tendency to segregation in flower-size between different plants, but also a tendency for the occurrence of smaller flowers, some petals being only 7 mm. in length. Segregation is therefore not confined to germ-cell formation, and is not Mendelian. Probably cytoplasmic differences are involved in this type of inheritance and variation.—W. **Dallimore**: The effect produced by wind at Llandudno. Wind causes remarkable dwarfing of trees and shrubs on the exposed rocks of the Great Orme's Head.—J. L. **North**: The possible successful growth of *Glycine Soja*, Sieb. & Zucc., as a profitable crop in Great Britain. The flattening of the branches, the result of close sowing—the Chinese method—is retained even when plants are grown wide apart. Also if a plant starts at a wrong angle it twists itself upon its base to bring it into line with the other plants. By using the earliest ripening seeds of the previous year of a so-called German acclimatised plant earlier maturity has been obtained. Plants in 1914 ripened on November 28, while last year they reached a corresponding degree of ripeness early in September.

Royal Microscopical Society, February 15.—Prof. F. C. Cheshire, president, in the chair.—A. L. **Booth**: The microstructure of coal from an industrial standpoint. Microstructure can be applied to augment chemical analysis in fuel selection. Thin sections of bituminous coals can be classified as humic, spore, and cannel. These are arbitrary standards, thus the use of the microscope in industrial coal problems is purely empirical. For selection purposes an unknown coal is compared with coals of known properties. Little is known of the influence of the various coal constituents on the properties of coal. Chemical analysis does not necessarily give information as to the coal type. Much published work on coal lacks the essential common factor, the microanalyses, whereby the whole can be correlated.

CAMBRIDGE.

Philosophical Society, February 6.—Prof. A. C. Seward, president, in the chair.—H. Hamshaw **Thomas**: On some new and rare Jurassic plants from Yorkshire (V): Fertile specimens of *Dictyophyllum rugosum* L. and H. *Dictyophyllum rugosum* has been known since 1828 and its sporangia have now been found near Scarborough. They are similar to those of the modern ferns Cheiropleuria and Platycerium and confirm the suggested relationship to the Dipteridineae.—F. A. **Potts**: On the food of Teredo, the shipworm. The Teredinidae are invariably found burrowing in wood. The minute fragments excavated by the rotating shells pass through the alimentary canal and are in part digested by it. The stomach has an enormous coecum which retains quantities of wood, but digestion takes place in the so-called "liver," some of the cells of which are gorged with particles of wood. In living tissue their amoeboid pseudopodia are active and many of the cells are detached and float freely in the lumen. There are no commensal organisms assisting in wood digestion and it seems unlikely that plankton forms play any significant part in the nutrition of these molluscs.—E. H. **Neville**: The definition of an envelope.

MANCHESTER.

Literary and Philosophical Society, November 29, 1921.—Mr. T. A. Coward, president, in the chair.—F. T. **Peirce**: Electromagnetic valency and the radiation hypothesis. A magnetic doublet, consisting of two electrons in small orbits (ring or vortical electrons), furnishes a probable physical basis for a

radiation hypothesis of chemical reactivity, and suggests the following results for non-electrolytes :— The bond can be broken only by radiation of definite frequency ν, the most intense impact resulting only in ionisation. External illumination as a criterion should be large for unimolecular decomposition or transformation, considerable for reversible reactions, especially the effect due to the radiation exciting the endothermic process, and inappreciable for irreversible combination. Corresponding frequencies are selectively absorbed or emitted. The energy change is double, corresponding to the attainment of the critical unstable equilibrium and of the normal stable state. For the complete change in intrinsic energy U, $-U = nH(\nu - \nu')$ per mol. The system can accumulate absorbed radiant energy up to a limit of one quantum per electron. It emits in quanta, but absorbs and scatters continuously. The frequencies and energy changes are altered by solvents, but not by intermediate compounds.

December 13, 1921.—Mr. T. A. Coward, president, in the chair.—Laura E. **Start**: Sea Dayak fabrics and their decoration. The patterns of part of the group of Iban cloths collected during the Cambridge Expedition to the East Indian Archipelago in 1899 are traditional. They are symbolical, and in some cases designate the rank or tribe of the wearer. Anthropomorphs, zoomorphs, and phyllomorphs form the chief motives, and of these the animal patterns predominate. For the origin of the life-history of patterns, in which man, the frog, the crocodile, the shrew, and the tiger are used symbolically, we must go back to the Proto-Malay stock, from which the Iban probably sprang, or consider the patterns a development due to the Ibans themselves.

January 6.—Joint Meeting with the Manchester Sections of the Society of Chemical Industry, the Institute of Chemistry, and the Society of Dyers and Colourists.—Dr. Edward Ardern in the chair.—A. **Harden**: Biochemical method. The methods and the difficulties of obtaining trustworthy results in biochemical research are due to the many factors which involve the living organisms. The occurrence of vitamins in foodstuffs, the differences between the various kinds of vitamins, the serious effects of ill-chosen diet for children, and the destruction of vitamins by heat and contact with air were discussed.

Society of Glass Technology, February 15.—The president, Dr. M. W. Travers, in the chair.—F. W. **Hodkin** and W. E. S. **Turner**: The relative advantages and disadvantages of limestone, burnt lime, and slaked lime as constituents of common glass batches containing soda ash and saltcake. Pt. II. The rates of melting depend upon the form of alkali and lime used as well as the relative amounts of lime and soda used. In the case of glass such as that used for bottles made on automatic machines, and containing about 8 per cent. of lime, the soda ash burnt lime batch appeared to be the most readily melted. With lime-containing glasses, the melting is assisted by the addition of small amounts of other oxides, particularly of magnesia. In the case of glasses containing about 12 per cent. of lime, the slaked lime containing batches generally melted most readily. A discussion followed the paper, and the remainder of the meeting was taken up with a debate on the subject of "The Melting of Glass." A number of questions on the subject had been submitted by members, and formed the basis of the discussion; this being continued from the Leeds meeting in November 1921, at the general request of members.

Diary of Societies.

MONDAY, MARCH 6.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.—General Meeting.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—E. Ambrose and others: Discussion on E.H.T. Cable-testing.

ARISTOTELIAN SOCIETY (at University of London Club, 21 Gower Street, W.C.1), at 8.—S. N. Dasgupta: The Logic of the Vedanta.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—Special and Business Meetings.

ROYAL SOCIETY OF ARTS, at 8.—Prof. A. F. C. Pollard: The Mechanical Design of Scientific Instruments (3).

SOCIETY OF CHEMICAL INDUSTRY (at Chemical Society), at 8.

SURVEYORS' INSTITUTION, at 8.—B. P. Davies: The Analysis of Building Costs.

ROYAL GEOGRAPHICAL SOCIETY (at Æolian Hall), at 8.30.—C. E. N. Bromehead: The Influence of its Geography on the Development of London.

SOCIETY OF CHEMICAL INDUSTRY (London Section) (at Chemical Society), at 8.—W. Cullen: Gold Metallurgy of the Witwatersrand, Transvaal.

TUESDAY, MARCH 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Arthur Keith: Anthropological Problems of the British Empire. Series I.—Racial Problems in Asia and Australasia (3).

ROYAL SOCIETY OF ARTS (Dominions and Colonies Section), at 4.30.—Major Sir Humphrey Leggett: Tanganyika Territory (formerly German East Africa).

ANGLO-SWEDISH SOCIETY (at Swedish Hall, Harcourt Street, W.1), at 5.30.—Dr. F. A. Bather: The Sea-lilies of Gotland and Dudley.

ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—N. S. Lucas: Report on the Deaths which occurred in the Society's Gardens during 1921.—F. Balfour Browne: The Life-history of the Water-Beetle *Pelobius tardus* Herbst.—Dr. R. Broom: The Temporal Arches of the Reptilia.—F. W. Urich, Dr. H. Scott, and Dr. J. Waterston: Note on the Bat-Parasite *Cyclopodia greeffi*, and on a new Species of Hymenopterous (Chalcid) Parasite bred from it.—S. K. Montgomery: Direct Development in a Dromiid Crab.

INSTITUTION OF CIVIL ENGINEERS, at 6.—A. C. Walsh and W. F. Stanton: The Improvement of the Port of Valparaiso.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Technical Meeting), at 7. H. W. Lee: A Chart for finding the Depth of Focus of a Lens.—H. Farmer: Direct Photography: a fully efficient alternative and addition to our present system.

RÖNTGEN SOCIETY (at Institution of Electrical Engineers), at 8.15.—L. H. Clark and B. D. Watters: Comparisons between the Therapeutic, Photographic and Ionisation Effects of Ultra-Violet and of Beta Radiation.—E. E. Burnside: Apparatus for deep X-ray Therapy.

WEDNESDAY, MARCH 8.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—Dr. G. D. Bengough: Notes on the Corrosion and Protection of Condenser Tubes.—At 2.30.—F. Adcock: The Internal Mechanism of Cold-Work and Recrystallization in Cupro-Nickel.—Research Staff of the General Electric Company: The Effect of Impurities on Recrystallization and Grain Growth.—Dr. H. Moore and S. Beckinsale: Further Studies in Season-Cracking and its Prevention. Condenser Tubes.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—Baron F. Nopsca: The Geological Importance of the Atavistic Reptilian Fauna of the Upper Cretaceous of Transylvania.

ROYAL SOCIETY OF ARTS, at 8.—W. A. Appleton: The Proper Functions of Trade Unions.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—A. A. Remington: The Design and Function of Laminated Automobile Suspension Springs.

THURSDAY, MARCH 9.

INSTITUTE OF METALS (at Institution of Mechanical Engineers), at 10 A.M.—Prof. C. A. Edwards and A. J. Murphy: The Rate of Combination of Copper and Phosphorus at Various Temperatures.—Dr. W. Rosenhain: Some Cases of Failure in "Aluminium" Alloys.—Prof. F. C. Thompson and E. Whitehead: Some Mechanical Properties of the Nickel-Silvers.—Dr. D. Hanson and Marie L. V. Gayler: A Further Study of the Alloys of Aluminium and Zinc.—A. Westwood: The Assay of Gold Bullion.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. H. M. Lefroy: The Menace of the Insect Pest: The Balance of Life in Relation to Insect Pest Control (2).

ROYAL SOCIETY, at 4.30.—Prof. T. R. Merton and S. Barratt: The Spectrum of Hydrogen (Bakerian Lecture).

LONDON MATHEMATICAL SOCIETY (at Royal Astronomical Society), at 5.—W. H. Young: The Theory of Functions of Two Complex Variables.—Col. R. L. Hippisley: The Nodes of the Three Bar Sextic.—R. F. Whitehead: The Number of Solutions in Positive Integers of the Equation $yz+zx+xy=n$.—T. Stuart: The Determination of the Criterion to prevent "Hunting" in Hartnell's Governor.—N. Wiener: The Average Value of a Functional.—Lt.-Col. A. Cunningham: On Least Primitive Roots.

ROYAL COLLEGE OF PHYSICIANS, at 5.—Dr. M. Greenwood: The Influence of Industrial Employment on General Health (Milroy Lectures) (1).

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Coombs, Mrs. Bottrill, and others: Discussion on the Family Group System in Infant Schools.

OPTICAL SOCIETY (at Imperial College of Science and Technology), at 7.30.—T. Smith and J. S. Anderson: A Criticism of the Nodal Slide as an Aid in Testing Photographic Lenses.—A. J. Bull: A Non-polarising Spectrophotometer.—J. Guild: The Photometry of Optical Instruments.—T. Smith: A Projective Treatment of the Submarine Periscope.—A. J. Dalladay: Some Measurements of the Stresses Produced at the Surfaces of Glass by Grinding with Loose Abrasives.

INSTITUTE OF METALS (London Section), (at Sir John Cass Technical Institute), at 8.—Dr. D. Hanson: Microstructure and Physical Properties of Alloys.

FRIDAY, MARCH 10.

ROYAL ASTRONOMICAL SOCIETY, at 5.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science and Technology), at 5.—R. L. Smith-Rose: The Electromagnetic Screening of a Triode Oscillator.—Dr. H. P. Waran: A New Form of High Vacuum Automatic Mercury Pump.—W. N. Bond: Viscosity Determinations by means of Orifices and Short Tubes.

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society).

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. T. R. Merton: Problems in the Variability of Spectra.

SATURDAY, MARCH 11.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Sir Ernest Rutherford: Radioactivity (2).

PUBLIC LECTURES.

(A number in brackets indicates the number of a lecture in a series.)

MONDAY, MARCH 6.

CITY OF LONDON (BOYS') SCHOOL, Victoria Embankment, at 5.30.—Miss Rosa Bassett: The Dalton Plan of Self-education (5).

UNIVERSITY COLLEGE, at 5.30.—A. R. Powys: The Preservation of Ancient Buildings.

TUESDAY, MARCH 7.

IMPERIAL COLLEGE—ROYAL SCHOOL OF MINES, at 5.30.—Col. N. T. Belaiew: The Crystallisation of Metals (3).

KING'S COLLEGE, at 5.30.—F. H. Rolt: Accurate Measurements in Mechanical Engineering: The Use and Testing of Gauges (4).

LONDON SCHOOL OF ECONOMICS, at 6.—Sir Josiah C. Stamp: The Administrative Factor in Government (4).

WEDNESDAY, MARCH 8.

EAST LONDON COLLEGE, at 4.—Prof. F. E. Fritch: Certain Aspects of Freshwater Algal Biology (4).

LONDON (R.F.H.) SCHOOL OF MEDICINE FOR WOMEN (Hunter Street, W.C.1), at 5.—Dr. H. H. Dale: Some Recent Developments in Pharmacology (3).

KING'S COLLEGE, at 5.15.—Prof. N. Bohr: The Quantum Theory of Radiation and the Constitution of the Atom (1).

HORNIMAN MUSEUM (Forest Hill), at 6.—W. W. Skeat: The Living Past in Britain (7).

UNIVERSITY COLLEGE, at 8.—The Current Work of the Biometric and Eugenics Laboratory (4). E. C. Rhodes: The Relation of Caries in the Teeth of School Children to Health and Home Conditions.

THURSDAY, MARCH 9.

INFANTS' HOSPITAL (Vincent Square, S.W.1), at 4.—Dr. W. M. Feldman: The Physiology of the Infant.

SCHOOL OF ORIENTAL STUDIES, at 5.—Dr. L. D. Barnett: The Hindu Culture of India (2).

UNIVERSITY COLLEGE, at 5.15.—Sir Robert Blair: The Education Programme of the Labour Party.—Prof. J. E. G. de Montmorency: Welsh and Irish Tribal Customs (5).

KING'S COLLEGE, at 5.30.—Dr. O. Faber: Reinforced Concrete (8).

FRIDAY, MARCH 10.

METEOROLOGICAL OFFICE (South Kensington, S.W.7), at 3.—Sir Napier Shaw: The Structure of the Atmosphere and the Meteorology of the Globe (8).

TAVISTOCK CLINIC FOR FUNCTIONAL NERVE CASES (at Mary Ward Settlement, Tavistock Place, W.C.1), at 5.30.—Dr. H. C. Miller: The New Psychology and its Bearing on Education (7).

SATURDAY, MARCH 11.

LONDON DAY TRAINING COLLEGE, at 11.—Prof. J. Adams: The School Class (8).

HORNIMAN MUSEUM (Forest Hill), at 3.30.—Miss M. A. Murray: Cleopatra's Needle and Sun-worship.

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