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Coal and Electric Power.

A STRONG plea for an improved utilisation of coal as a source of motive power is made in the second part of the volume "Coal and Power,"[1] the Report of an Enquiry presided over by the Rt. Hon. D. Lloyd George, the first part of which has been referred to already in these columns (August 23, p. 265). The Committee of Liberal Members of Parliament and other persons responsible for the Report has examined the present system of generation and distribution of electrical power in Great Britain, and has come to the conclusion that "immense saving and improvement can be effected in this respect."

The waste that occurs in the methods now in vogue in connexion with the utilisation of coal for industrial and other purposes is a subject which has been under close study on the part of engineers in Great Britain, as well as in other parts of the world, for several decades past; the measures by which this waste can to some extent be reduced have been repeatedly indicated by them. The subjects of coal conservation, home-grown food, and the better utilisation of our labour were, for example, chosen for the theme of the able and brilliant presidential address which Mr. S. Z. de Ferranti delivered on November 10, 1910, to the Institution of Electrical Engineers (see Jour. I.E.E., 1911, vol. 46). In this address, Mr. de Ferranti directed attention to many of the matters which are dealt with, under the title "Power," in the Report before us, and pointed clearly to the direction in which a reduction in the cost of production of electrical energy should be sought, indicating, at the same time, that the increased use of electricity was a matter that depended almost entirely on the cheapness at which it could be sold. In view of the slow progress which has been made in Great Britain in extending the use of electricity for industrial and domestic purposes, and for the reason that important benefits would follow on its extended use, it is all to the good that the Committee should, in its Report, have again directed attention to the advantages to be gained from the electrification of our industries and our homes.

The Committee points out that the reorganisation of the coal-mining industry which it is advocating, though a matter of the utmost importance, is only part of a programme which aims at the rejuvenation of British industry, and it frankly admits that it is seeking the solution to the problem of how to increase wages without at the same time increasing the cost of manufactured commodities. The Committee shows that there is nothing incompatible in aiming at attaining

[1] Pp. xiv + 139 + 16 plates. (London: Hodder and Stoughton, Ltd., 1924.) 1s. net.

both these ends simultaneously. "A survey of the chief industrial countries of the world reveals," says the Report, "the extremely significant fact that those people are best paid and most prosperous that make most use of the resources of science"; the reason for this state of things being found in the fact that the average level of earnings must depend on production, and production increases as the use of power per head of the population increases.

Attention is directed in the Report to the circumstance that Great Britain became, in the first half of the nineteenth century, pre-eminent in the world as the greatest of all manufacturing countries because it was the first country in the world to realise the potential powers of steam. British engineers led all other countries; and, in the matter of railways, our system was the pioneer one. In the early days of steam engineering it was Great Britain that other countries copied: but now, in the matter of electrical development, the rôles are reversed. The Committee alludes to the activities of other countries which are our competitors in the world's markets, and mentions the fact that most of them are pressing ahead with schemes of electrification. "When one surveys the modern industrial world from this angle, it almost seems," says the Report, "as though we alone are content to mark time." An authoritative estimate indicates that the increase in the production of electricity in Great Britain during the period 1913 to 1922 was 130 per cent., an increase which is less than that achieved in any of the countries of our chief competitors. Again, whilst the development in Great Britain has hitherto been almost entirely in the direction of adding units to existing small and scattered local supply stations operating independently each of the others, foreign countries have in recent times been concentrating on larger power supplies on modern methods linked up and co-ordinated by main transmission lines.

A brief examination is made in the Report of the electrical development in certain foreign countries. This examination discloses the fact that the United States of America leads the way, its output having quadrupled since 1912; Chicago alone produces five times as much electricity as the whole of the North-East Coast plant, the largest scheme of electrification in England. The output in France had, up to April 1924, increased more than three and a half times as compared with 1913; the network of transmission lines is now so widespread that the ordinary hydro-electric stations are linked up with the glacier stations, and both with the thermic stations, and all with the consumers in the industrial region. It is expected that, by 1927, sixty-nine per cent. of the population will have electricity available. Germany, though harassed by many adverse factors, has made a greater advance in the direction of electrical development along coal-saving lines than has Great Britain; its output has more than doubled since 1913. Lignite, a mineral of very poor qualities, is now supplying nearly one-half of the electrical power of Germany.

In Holland, production more than doubled between 1913 and 1918. A scheme is now in hand which aims at covering the country with a network of high-tension transmission lines with the view of supplying Dutch industries with cheap power; on its completion, the output of the country will be increased 76-fold. In the case of Italy, special State encouragement is being given to the development of hydro-electric generation; in the year November 1922-November 1923 no fewer than 134 concessions for water-power schemes were granted by the Government. A great scheme intended for the development of the resources of Calabria was begun in 1923. In Czecho-Slovakia an Electricity Act was passed in 1919 providing for financial aid from the State for electrical development. Great activity on the development of hydro-electric schemes has prevailed in Canada in recent years. Although the population of the Dominion is only about one-sixth that of the United Kingdom, Canada will by the end of 1924 be getting from hydro-electric plant alone more power than the engine capacity for the whole of the iron, steel, engineering, shipbuilding, and textile trades in Great Britain. As regards the supply of cheap electric power through hydro-electric plants, Great Britain cannot compare favourably with some other countries. It is, however, becoming more evident every year that water-power is not an indispensable adjunct to many electro-chemical and electro-thermal enterprises, and that other sources of power sometimes possess decided advantages.

The reason for Britain's comparative failure in the field of electrical development is traceable, the Report rightly points out, to the state of our legislation, the effect of which has been gravely to handicap the genius of our engineers; "the power companies established under the Power Acts have never been given an adequate chance to develop. They have suffered from the fact that already there had been established in all industrial centres and in all our great cities, local and municipal power supply undertakings which were organised on a purely local basis." This circumstance precluded free competition between the power companies and the existing authorities. The measures taken to remedy this unfortunate situation are mentioned. As a first step, a Coal Conservation Committee was established in 1917; it made a Report of the utmost importance (Cmd. 9084). The matter was afterwards considered by another Committee, under the chairmanship of

Sir A. Williamson, which made certain specific recommendations.

The Government of the day then took action and passed the Electricity (Supply) Act, 1919 (9 and 10 Geo. V. c. 100), in which was incorporated many of the recommendations alluded to, and under its provisions have been brought into existence the Electricity Commissioners; in this body has been vested the general control over the generation and distribution of electricity in the United Kingdom. The Government did not secure in the Act of 1919 all the powers in relation to electricity supply it was seeking; the Bill was strongly opposed in the House of Lords. Later, the Government sought and obtained further powers under the Electricity (Supply) Act, 1922 (12 and 13 Geo. V. c. 46), which, though it improved matters to some extent, did not effect, and was not designed to effect, the original intention, namely, that of replacing many small stations by a few great power stations, with resultant economies in coal and in money.

Dealing with the place of electricity in modern life, the essential requirement, it is pointed out, is cheap power; so far, this result has not been secured in Great Britain on any notable scale. As an illustration, the case of Lancashire is quoted; this county is, from the technical point of view, the most favourable area in England for the generation and distribution of electricity cheaply, yet, at the date the Coal Conservation Committee of 1917 made its Report, the cost per unit was in Lancashire nearly three times that paid in the North-East Coast district of England. Examples of a similar disparity in the cost of energy are to be found in other parts of the country, and are due to the same cause; whereas in Lancashire a number of corporations are supplying energy in circumscribed areas, in the North-East Coast district a super-power station is transmitting energy in an area of suitable dimensions through well-placed main transmission lines. The need for the elimination of waste, the importance of securing an increase in the use of electrical power and the financial and other advantages likely to accrue to the community from the removal of the smoke evil, the saving of by-products and a revival of rural industries, are all duly emphasised in the Report.

The Committee makes allusion to the very conservative policy which has been pursued by British railway companies in the matter of the electrification of their systems, and expresses the hope that in view of the fact that the financial and technical advantages of electric over other forms of traction are being clearly demonstrated in foreign countries, our railway directors will reconsider their policy in this matter, and further, that in the event of a national scheme of electric supply being undertaken, the railways will give it the advantage of their co-operation. "Railway electrification would do much," says the Report, "to assure the economic and technical success of electrical production on a national scale"; in this view many eminent engineers concur. The Committee also points out that there are many recent processes, *i.e.* (1) the fixation of atmospheric nitrogen, (2) electric smelting, (3) the recovery of dyes, which are only possible economically in a country well equipped not only with electrical plant, but with *modern* electrical plant.

The unemployment problem also receives attention in the Report. The Committee attributes the failure in Great Britain to utilise the great unemployed labour force which has been available for construction purposes since the War partly to the limitation of the powers of the Electricity Commissioners. "We believe that it would have paid the State," says the Report, "to have expended large sums in the development of our resources by the provision of State credits, or the loan of public money at low rates of interest, for by so doing the internal economy of the country would have been improved and non-productive expenditure reduced."

In view of the present situation, the Committee is impressed with the necessity that exists for steps to be taken immediately to remedy the backwardness of Great Britain in electrical development. It recognises that the Electricity Commissioners have since their creation rendered most valuable services, but feels that this body is seriously handicapped owing to the insufficiency of its powers, and to some extent by the vested interests of the local undertakings, which, in the nature of things, are not and cannot be "as efficient as a national system developed in accordance with the most recent practice and supplying electricity in bulk from super-power stations." For these reasons, the Committee recommends that the powers of the Electricity Commissioners should be enlarged; this body could thus be placed in a position effectively to remove the obstacles which now block the way to electrical development in Great Britain.

It is mainly in two directions that the development of our great power-producing organisations is now being hindered: (1) by the existence of a number of small and inefficient local supply bodies; and (2) by reason of the magnitude of the undertaking and the uncertainty of financial success under existing conditions. To overcome the first of these difficulties, the Committee would like to see the Electricity Commissioners endowed with compulsory powers of acquisition, co-ordination, and regulation. To overcome the second of these difficulties, the Commissioners should, it is suggested, be granted full powers to employ every practicable means for encouraging and helping

electrical undertakers, public and private, who are prepared to establish generating stations of suitable capacity and type. Finally, the Report lays particular stress on the need for the Commissioners being authorised to empower electricity undertakers "to acquire compulsorily and at reasonable prices all land, rights of way, rights relating to water, and all ancillary rights, which may be necessary for the adequate execution of a national scheme."

The additional powers which it is recommended should be conferred on the Electricity Commissioners are undoubtedly large; however, few persons, if any, who are familiar with the electricity requirements of Great Britain are likely to cavil at the proposals made by the Committee. The situation which has to be dealt with is a very complicated one, and the reforms indicated, which undoubtedly are all urgently required, can only be brought about expeditiously by vesting in the Commissioners exceptional powers.

An idea as to how complicated the present situation is may be gathered from a perusal of the recitals of the "Order made by the Electricity Commissioners under Sec. 7 of the Electricity (Supply) Act, 1919, constituting the London and Home Counties Electricity District and establishing and incorporating the London and Home Counties Joint Electricity Authority" (H.M.S.O.). This Order was made on July 17 last after an investigation of many days' duration, and has been submitted to the Minister of Transport for confirmation; the interests and rights of the London County Council, the City Corporation, and 14 Power companies are involved, and it has been necessary to promote two Bills in the present session of Parliament in connexion with the Order. Situations which are equally, if not more, complicated exist in those parts of the country which have yet to be dealt with by the Commissioners.

It may well be asked, Why is it that the United States of America lead in the matter of electrical development? The answer to this question is to be found in the presidential address which Mr. W. H. Patchell delivered on March 21, 1924, to the Institution of Mechanical Engineers: this exceptional development, he tells us, is the direct outcome of the skill and zeal of those who handle the sales department of the American electricity supply undertakings. It will be evident, then, that if results similar to those obtaining in the United States of America are to be achieved in Great Britain, not only must additional powers be given to the Electricity Commissioners, but those responsible for the conduct of our electrical undertakings must also take a broad view of the commercial side of the business and adopt active measures for pushing the sale of their commodities.

Nature and Man in Tropical Africa.

Big Game and Pygmies: Experiences of a Naturalist in Central African Forests in Quest of the Okapi. By Cuthbert Christy. Pp. xxxi+325+56 plates. (London: Macmillan and Co., Ltd., 1924.) 21*s.* net.

DR. CHRISTY'S "Big Game and Pygmies," based as it is upon almost twenty-five years' continuous experience of tropical Africa, is a most interesting and valuable book. The "external aspects of organic nature" are not merely being modified by human interference in Africa; they are there being rapidly and almost completely transformed. The value of the observations so faithfully recorded in this volume will therefore steadily increase. When at last the varied face of Africa shall have been reduced to a dead level of cultivated monotony; when all its nobler animals and plants shall have been replaced by peaceful beasts of the farm and dull vegetation of economic importance, this will be one of the books that will enable our heirs to appreciate what sacrifices we made in the names of civilisation and commerce.

An admirable account of the great equatorial rain-forest is given by Dr. Christy. Stating that it must once have stretched as an unbroken belt completely across the continent, he describes its destruction at the hands of men. A good deal of the forest was destroyed before the advent of the whites; and to-day too, the barbarous methods of agriculture employed by the natives are responsible for a great deal. Strip after strip is cleared, by felling and by fire, along the forest margins. Ignorant of the art of maintaining its fertility, the natives soon exhaust the virgin richness of the forest soil and proceed to make further depredations upon the forest. The abandoned clearings are quickly overgrown by grass and bush; but upon their sun-baked and exhausted soil rain-forest never reappears. The forest once destroyed thus goes for ever; and with it must disappear many of its inhabitants. Not improbably much of that progressive desiccation of Africa, about which so much has been written from the days of Livingstone onwards, is to be regarded as a direct consequence of the destruction of the equatorial forest. That is a matter worthy of consideration, and it is possible that the conservation of the remnants of this great forest will loom as largely in African politics in a few years' time as reparations, for example, have done in those of Europe recently.

While native activity slowly but surely results in the replacement of one African type of life by another, white enterprise appears to be leading to the extirpation of the African biota. Enormous tracts of country are being cleared of the indigenous vegetation and replanted by exotic plants of economic importance.

For example, Dr. Christy foretells the time when South American Ceara rubber will replace the "profitless" bush and marginal forest and supply the world with india-rubber serviceable for all ordinary purposes at a penny a pound. From the selfish point of view of the dweller in remote temperate countries, that, no doubt, is good news; but from the point of view of a naturalist it is a deplorable prospect. A proportion of the native vegetable and animal inhabitants of Africa will doubtless succeed in adjusting themselves to the new conditions, but for a very large number, and among them the most interesting of the purely African forms of life, it spells extinction. Like the rain-forest, they are doomed if the commercial exploitation of the continent continues to proceed upon the present lines. So far as the larger mammalia are concerned, the process is hastened considerably, of course, by the rifles of ivory hunters and sportsmen. Dr. Christy says:

"As an indication of the amount of ivory that has come, and comes, out of the Congo annually, I may mention that I have seen lying in a trader's store at Boga about fifty fine tusks. . . . The trader informed me that the collection was the result of a month's buying from the natives. He also said that he received an average of one ton of ivory per month, about seventy-five or eighty fair-sized tusks, from his Kifuku branch store on the Ituri River south of Irunu. His was only one of many scores, perhaps hundreds, of similar trading and collecting stores, at which ivory was the chief cause of their existence."

In view of what we have permitted in our own African possessions, we have no right to point an accusing finger at that Belgian enterprise to which Dr. Christy pays a high tribute. But no scientific man can contemplate the slaughter on such a scale of slow-breeding animals like elephants without realising that it must result in complete extermination. The thought too that, in spite of this butchery, and notwithstanding the great wealth derived from ivory, the material at present existing in our museums is wholly insufficient to enable the zoologist to determine how many species or sub-species of the African elephant should be recognised, or to obtain a detailed knowledge of its soft anatomy and skeleton, does not allay that feeling of resentment which must arise in every scientific breast.

It must not be thought that Dr. Christy shares the despondence of the reviewer. On the contrary, he light-heartedly treats of things seen and deeds done; despondence comes only with reflection and at a distance. In this book, Dr. Christy, while primarily concerned with the Ituri forest and its inhabitants, gives us the fruit of experience gained while engaged in general scientific and medical research or upon hunting expeditions in many parts of tropical Africa. To him is due the credit of making one of the finest zoological collections ever brought together from any part of Africa. This collection was made for the Belgian Government, and is now housed in the museum at Tervueren. It is especially rich in mammals. Of these, the smaller species were worked out in the British Museum by Mr. Oldfield Thomas, and as a result our national collection has been greatly enriched by the joint labours of the collector in the field and the systematist at home.

The chapters upon the okapi, the African elephant, and the African buffalo are of especial interest. Dr. Christy's views upon the status of the various forms of buffalo, illustrated as they are by numerous photographs and some most excellent maps, will merit and receive the serious consideration of all mammalogists busied with the African fauna. Many interesting observations upon other mammals, such as the forest hog, chimpanzi, bongo, duikers, aardvarks, ant-eaters, small mammals, and upon other vertebrates and insects, are also recorded. Chapters dealing with the skinning and preservation of specimens and with matters relating to forest-hunting and armament will be found useful by those who contemplate collecting trips in Africa.

Lastly, but by no means least, Dr. Christy's accounts of the Ituri pygmies and other native races will make a strong appeal to all interested in anthropology and ethnography. M. A. C. H.

The Study of Textile Fibres.

The Textile Fibers: their Physical, Microscopical, and Chemical Properties. By Dr. J. Merritt Matthews. Fourth edition, rewritten and enlarged. Pp. xviii + 1053. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1924.) 50*s.* net.

TEN years having elapsed since the appearance of the third edition of this well-known text-book on the properties of textile fibres, the author has, for the purposes of the present edition, been under the necessity of re-writing, re-arranging, and greatly enlarging the volume, which now runs to upwards of a thousand pages, with more than four hundred illustrations.

In order to estimate the degree of success which has attended the very considerable labours of the author, due regard must be paid to his assertion, in the preface to the present edition, that "the great majority of his readers are neither chemists nor scientists"; for it is to this majority that the appeal of the book is directed. These readers, presumably those engaged on the practical side of the textile industry, are given an admirable summary of information upon the properties and uses

of all the important textile hairs and fibres, which is marked by a praiseworthy attempt to incorporate the results of recent advances in textile research made both in Great Britain and on the Continent.

The magnitude of such an attempt will be fully appreciated by any one actively engaged in textile research, and, in the result, defects of arrangement and lack of balance in the treatment of the various portions of such an enormous subject as the textile fibres are only to be expected. For example, wool and silk are both treated in an adequate and well-balanced fashion which might well have served as a model for the treatment of the other important hairs and fibres. On the other hand, in spite of the importance of the linen industry and of the amount of recent work carried out, both in Great Britain and on the Continent, upon problems connected with the structure, retting, and mercerisation of flax fibres, linen is dismissed with a short chapter of twenty-two pages, while the relatively unimportant minor seed hairs have sixteen pages devoted to them.

Of the seven chapters assigned to the cotton hair, some are unnecessarily elaborate, while from others important omissions are numerous. Those on mercerised cotton and the chemical treatment of fabrics for water- and flame-proofing are almost complete enough to form part of a technical handbook on these processes. Moreover, in the former, descriptions are included of the processes of schreinering and emerising which have no connexion with the problem of mercerisation.

Turning to the omissions, no account of the microscopic structure of the cotton hair can be regarded as complete which does not adequately take into consideration the work of Balls and Denham. Yet the former receives scant attention, while the latter is almost ignored. Again, in the chapter on the chemical properties of cotton there is no mention of the results of recent important researches on the nitrogen content of the cotton hair, the determination of copper number and the absorption of methylene blue by cotton. From the summaries of the physical and physico-chemical properties of cotton, notable omissions are the results of recent work upon the lustre and regularity of yarns and the swelling of single cotton hairs in solutions of sodium hydroxide, all of which are problems of vital concern to the cotton industry and of fundamental importance in textile research.

The reasons for such omissions will be sympathetically appreciated by the research worker on textile problems. During the last five years, the whole appearance of the field of textile research has been altered, chiefly owing to the activities of the research associations of Great Britain, and one is driven to the conclusion that an adequate summary of the origin, properties, and employment in industry of cotton, linen, silk, wool, and artificial silk is now quite beyond the powers of a single author. Such a summary must not only be a record of progress in several wide fields, all of which are being actively explored in every direction, but must also, at the same time, remove from a position where it affects the views of those who are "neither chemists nor scientists," a large amount of pseudo-science which has established itself in the technical literature. For example, the problem of mildew in cotton goods is one of very great economic importance in the cotton industry. Yet, in Chapter xvii. (pp. 554-555) of the volume under review, the first portion of a section on the action of mildew in cotton, is not only quite inaccurate and unscientific, but is also substantially the same as has been transferred from one technical handbook to another since the appearance in 1879 of "The Sizing of Cotton Goods" by Wm. Thomson. The section is completed by the addition of recent work by Thaysen and Bunker (unacknowledged) on the application of the viscose swelling test to damaged cotton, and of Denham on the destruction of cotton hairs by micro-organisms. To the uninstructed all this work is of equivalent value.

The information on commercial varieties of cotton in Chapter xii. might have been more carefully checked. No account is given of contemporary progress and tendencies in the cultivation of cotton within the British Empire and in Egypt; nor is it now quite correct to state that "India is destroyed as a possible source of supply [of long staple cottons] for the English mills." Such cottons are now being successfully raised in the Punjab and are rapidly bought up when available. Egyptian cotton is also dealt with in an inadequate manner. Hindi cotton is actually given as one of the principal varieties grown in Egypt, whereas it has long been known as a pestilential weed-cotton causing endless trouble in the cotton field, owing to the ease with which it crosses with cultivated varieties.

The chapters dealing with the properties and analysis of jute, ramie, hemp, and the minor vegetable fibres are particularly well done, and, with their illustrations, represent a great advance on previous works. Those upon the analysis of textile fibres, fabrics, and yarns, and the testing of textile fabrics are similarly worthy of praise; although a more systematic arrangement of the tests would have been possible and some discussion of their comparative values useful.

In a work of such importance, errors and misprints should be lacking. During perusal a number have been noticed, *e.g.* the length of individual cotton hairs on p. 339 is given as ranging from 1½ to 1¾ inches; Nubari cotton is spelt Unbari (p. 389); Smyrna cotton is included as African (pp. 391 and 414); the diameter of

Sea Island cotton is given as 9·65μ (p. 414), whereas it should be at least 50 per cent. greater; the cross-sections of cotton hairs given in Fig. 201 are mostly unlike any ever seen by the reviewer, while the sections shown in Fig. 186, p. 414, are those of hairs which have only been partially mercerised. A misprint on p. 787 gives the diameter of ramie fibre as ranging from 9·04 mm. to 0·06 mm. Such minor defects might be eliminated from subsequent editions.

F. SUMMERS.

Some Applications of Psychology.

(1) *Applied Psychology*. By Prof. Bernard C. Ewer. Pp. xii+480. 10*s*. 6*d*. net.

(2) *How to Experiment in Education*. By Prof. William A. McCall. (Experimental Education Series.) Pp. xv+281. 12*s*. net.

(3) *Intelligence Measurement: a Psychological and Statistical Study based upon the Block-design Tests*. By Prof. S. C. Kohs. Pp. xii+312. 14*s*. net.

(4) *The Psychology of Algebra*. By Edward L. Thorndike, Margaret V. Cobb, Jacob S. Orleans, Percival M. Symonds, Elva Wald, and Ella Woodyard. Pp. xi+483. 12*s*. net.

(New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.)

EVERY man considers himself an expert on psychological matters and is ready and willing to give his opinions. "Psychological" is a word used and misused countless times to connote the human or popular side of any activity, until its scientific implication is often buried under a sea of colloquial generalisations. No other scientific worker suffers, to the same degree as does the psychologist, from the unsought-for popularity of his subject. The chemist does not see "Chemical Drama" staring at him from the posters of the daily papers, nor does the geologist find a complex geological hypothesis used as a subject of drawing-room conversation. Such general interest has been aroused in psychology that quacks and charlatans turn it to their financial advantage. Prof. Ewer is evidently smarting under these popular misrepresentations of the subject. Again and again in his "Applied Psychology" he harps on the need for caution in accepting psychological beliefs. "As in the case of many another development in the history of culture," he writes, "this one has been characterised by great enthusiasm, overweening confidence, and a somewhat uncritical evaluation of results. Gradually, however, we see the ebullient assurance giving way to a more cautious spirit of inquiry, the glittering but unsubstantial froth of superficial investigation disappearing, and a solid precipitate of valuable information settling."

(1) Prof. Ewer has set himself the difficult task of writing a book which shall pass between the Scylla of technicalities intelligible only to the expert and the Charybdis of popular over-simplification, and he has succeeded singularly well. The book is divided into four parts covering the main field of applied psychology: "Aims, Principles, and Methods," "Education and Everyday Life," "Mind and Health," and "Industry and Commerce." In the first more general portion, the author gives an introduction to the chief mental factors and the methods of their interpretation and control. The rest of the book is devoted to a description of their practical applications. This is fascinating reading and is of immediate use as well as of interest, for every one will find some advice applicable to himself. Prof. Ewer has not originated any great new schemes for training or curing the mind, but he gives a clear and impartial account of the main theories on these matters. He is fully alive to the dangers of the various applications of psychology and shows how to avoid their abuses as well as how to promote their beneficial effects.

Especially interesting are the chapters on "Intellectual Efficiency" and "Everyday Psycho-therapy." Here, as in all his work, Prof. Ewer keeps as close as possible to common experience. As he says: "Psychology often succeeds only in giving precise form to what wise persons have long known, or reasons for what they have always done; but it is none the less desirable to have such exactitude and rationality scientifically established." If every one was to read this book before airing his views on applied psychology, there would be much less inconsequent babbling.

(2) "How to Experiment in Education" is a book that will save young educational psychologists from many a weary hour and tedious mistake. Prof. McCall has succeeded in summarising his experience in such a manner as to hand it on to those starting in his field. It is almost as if one is buying experience with the 12*s*. that is the cost of the book. The author remembers his own difficulties when his professors trusted to his "genius to supply the missing half of research methodology." "There are excellent books," he writes, "dealing with the statistical manipulation of experimental data, but there is little help to be found on the methods of securing adequate and proper data to which to apply statistical procedure. Training is given and books exist only for the last step of a several step process. As a result, the final step often becomes little more than statistical doctoring for the ills in the data." Prof. McCall starts, therefore, at the very beginning and gives advice as to the selection and formulation of the experimental problem and the procedure of making a bibliography. His fundamental criteria for constructing a test are particularly helpful.

Psychological research has the peculiarity, compared to other scientific research, that its subjects are human and bear human relationships to the investigator and each other. Prof. McCall gives good advice as to the errors that arise from the faulty selection of the subjects, from the bias of the experimenter, and from other important causes. About half the book is devoted to comparing the three fundamental experimental methods: the one group method, the equivalent group method, and the rotation method. The author discusses their various uses and gives a chapter to the computations for each method. A useful chapter is also given to "Casual Investigations," in which standardised methods of observation are suggested when experimentation is for some reason impracticable. The book concludes by discussing twenty-eight typical experimental problems, showing the best method to apply to each. The author has attempted to make his book particularly clear and concise by expressing all relationships by formulæ, but here perhaps he rather defeats his own ends, as the abbreviations used necessitate a three-page key.

(3) The position of intelligence tests is now thoroughly established, and it is acknowledged that they form a means of obtaining a quick and trustworthy measurement of an individual's general ability. Until recently, most intelligence tests have had a linguistic bias, but it is now realised that some people can do themselves justice more adequately when dealing with things rather than with words. Several practical or "performance" tests have been standardised with varying degrees of success, and some were used in the giant investigation of testing the whole American Army. There is, however, a great need for additional trustworthy tests of this type. Dr. Kohs has limited his book "Intelligence Measurement" to a description of a series of block-design tests devised by him, which he has proved to give results corresponding closely to other criteria of intelligence. The tests consist of a series of coloured blocks which must be put together to make patterns of such varying degrees of difficulty that some can be passed by a five-year-old child and others are difficult for an adult. The technique of standardising the tests is extremely well described, and the ninety tables of figures in the explanation should serve as a warning to those who believe that to devise an intelligence test it is only necessary to think of some questions and give them to a few children.

(4) Any teacher of algebra, whether he started this term or has had forty years of experience, will be stimulated by reading Prof. Thorndike's "Psychology of Algebra." Experimental proof is worth a lot of theorising, and this book is the outcome of large scale investigations on many aspects of the subject. Many of the topics are quite original, but the more familiar problems, such as the best order of presenting matter, and the optimum distribution of practice, are not neglected. An interesting study is made of the use of algebraical knowledge to science students. *Questionnaires* were sent to lecturers of the various physical and social sciences, and text-books were analysed to see the relative practical value of the different algebraic topics. But although such applications of the subject are studied, its intrinsic value is also realised—the appeal of "the love of thought for thought's sake by those who can play the game of thought well."

WINIFRED SPIELMAN.

The Cactus Family.

The Cactaceæ: Descriptions and Illustrations of Plants of the Cactus Family. By N. L. Britton and J. N. Rose. Vol. 4. (Publication No. 248.) Pp. vii + 318 + 37 plates. (Washington: Carnegie Institution, 1923.) 6.50 dollars.

THE issue of the fourth volume of "The Cactaceæ" brings this sumptuous monograph of the family to a conclusion. Previous volumes have been discussed in NATURE, vol. 107, p. 580, and vol. 111, p. 426.

Vol. iv. is carried out in the same excellent manner as the preceding volumes, and completes the account of the smaller and more popular species of this family. It deals with the remaining three subtribes, namely, the Coryphanthanæ, consisting of 14 genera, of which the principal is the familiar genus Mammillaria (herein renamed Neomammillaria); the Epiphyllanæ, consisting of 9 genera, which of all Cacti are probably the greatest favourites with horticulturists; and the Rhipsalidanæ, consisting of 8 genera. There is also an appendix and an index to the whole work. The volume is beautifully illustrated with 37 fine plates, most of them coloured, and 263 figures in the text. Full references are also given throughout the work to figures that have appeared in other books.

Altogether (including two new genera and 24 new species described in the appendix) this volume treats of 33 genera and 358 species, the largest genera being Neomammillaria, 150 species; Rhipsalis, 57 species; Coryphantha, 37 species; Epiphyllum, 16 species; and Thelocactus, 12 species; 14 genera are monotypic, and the others have only 2-8 species each. In the entire work, 124 genera and 1241 species are described and illustrated by 137 plates and 1119 figures; of these, a considerable number are described and figured as new.

About two-thirds of the species dealt with in the present volume belong to plants known in gardens under the generic names of Echinocactus and Mammillaria; the latter name, however, has now been

altered by the authors to Neomammillaria, because the name Mammillaria properly belongs to a genus of Algæ! It is unfortunate that previous monographers of Cacti had not long ago recognised this and changed the name in accordance with the rule of priority, for the name Mammillaria has become so firmly established in books and gardens for these Cactaceæ that it will be difficult to supplant it by the new name.

Another generic change of name, now rightly made, which ought to have been done long ago by previous monographers, is to retain the name Epiphyllum, which was first published in 1812, for those plants known in books and gardens under the name of Phyllocactus, which was not published until 1831. The plants known in books and gardens under the name of Epiphyllum belong to the genera Zygocactus and Schlumbergera.

Of the genera, 12 are published in this volume for the first time, and there are 3 others that have been published elsewhere since the issue of the first volume. Although some of the genera in this work will probably not be upheld by future workers, the authors have consistently followed their plan of utilising all vegetative and structural characters that differ in degree or nature for the formation of genera, with the result that the species having the same characters in common are associated together in a more complete manner than hitherto.

The authors deserve the hearty thanks of all lovers of Cacti for the admirable and efficient manner in which they have completed their task. In doing this they have fortunately been better equipped for it than any previous monographers of the group. For not only have the authors themselves visited some of the regions where these plants grow, and studied them under natural conditions, but they have also received great aid from many others interested in the group who reside in or have visited the various countries in which Cacti grow wild, and have contributed quantities of living material, photographs, and information appertaining to them, all of which has been utilised in constructing this fine monograph; the result being that, not only is it the first monograph of Cactaceæ that has been published in the English language, but is also one that is far in advance of the German works upon the subject that have hitherto held the field.

It cannot be expected that a work of this kind is without errors, but to the knowledge of the writer the authors have done their best to avoid them. The one thing wanting appears to be a series of plates clearly illustrating the distinctions between the various genera. Perhaps the authors may see their way to supply them as a supplement.

N. E. BROWN.

Our Bookshelf.

The Work of the Royal Engineers in the European War, 1914–1919. Work under the Director of Works (France). Part 1: Historical; Part 2: Technical; Part 3: Maps and Plates. (Published by the Secretary, Institution of Royal Engineers, Chatham.) Pp. viii+279+6 maps+81 plates. (Chatham: W. and J. Mackay and Co., Ltd., 1924.) 21*s*.

THIS volume from its very nature lacks some of the thrilling interest which characterised some of the earlier volumes of the series to which it belongs, owing to the fact that it deals with a struggle against difficulties carried out for the most part at a distance from the enemy. When enemy action upset the plans of the Director of Works it was, save in the case of the bombing of hospitals, power stations, or important bases, generally due to a change in the plans of the whole army, in which the Director of Works had become necessarily involved. The struggle outlined in this volume is one to meet the demands of constant expansion and development with inadequate resources of labour, personnel, and equipment. Granted the conditions, it is marvellous how much was achieved and, on the whole, how successfully new demands were met.

The volume under review contains six chapters outlining the changes in each year of the War, the developments characteristic of successive phases, followed by twenty-five chapters of a technical nature discussing the separate branches of work for which the Director of Works became responsible. It is well illustrated by maps of the lines of communication areas, and by numerous diagrams of camps, larger buildings, huts, machines, and plant of various types. Much useful information is given about such items as camp sanitation, disinfection, and protection against hostile aircraft. On the whole, the book is of the nature of a technical guide to the engineer officer who is concerned with the design of camps.

The human element is rather lacking in the book, though we may mention the consternation caused among the inhabitants of Rouen when it was discovered that the goats in the Halle des Blés, protected from inclement weather by shutting all doors and windows, needed ventilation, and when on the windows being opened the pent-in effluvium of the goats rushed out and spread about the neighbourhood. Another human touch is supplied by the provision that on the lines of communication all hospitals *must* be lit by electric light, ammunition, supply, and ordnance depots *should* be lit, and camps, remount depots, and veterinary hospitals *might* be lit, if a supply could be obtained locally at a reasonable cost.

Die Entfaltungsbewegungen der Pflanzen und deren teleologische Deutung. Ergänzungsband zur "Organographie der Pflanzen." Von Prof. Dr. K. Goebel. Zweite, neu bearbeitete Auflage. Pp. x+565. (Jena: Gustav Fischer, 1924.) 20 marks.

THE work of Prof. Goebel, of the University of Munich, is known to all students interested in the morphology and physiology of plants. His "Organographie der Pflanzen" was translated into English

by Prof. (afterwards Sir) I. B. Balfour and published by the Clarendon Press, vol. i. in 1900, vol. ii. in 1905. Since these dates a new German edition has been appearing (1913–23), and to it there was added in 1920 a supplementary yet independent volume dealing with the movements of attached plant-organs. The first edition of this last volume was quickly exhausted, and a second, considerably enlarged, has now been issued.

Much of Prof. Goebel's work can be described as a synthesis of morphology and physiology, and the present work is no exception. Here, however, the author has set himself a definite problem, namely, to investigate the kinds and methods of movements shown by plant-organs, and especially to decide whether or not they are adaptational. The word "Entfaltungsbewegungen" would seem scarcely to cover all the contents of the book, for the stimulated movements of floral parts and of sensitive plants, and also "sleep-movements," are considered, in addition to movements connected with the unfolding, growth, and development of buds, leaves, and flowers. The various movements are fully described in the text, which is illustrated by 278 figures, more than half of which are reproductions from photographs.

The number and variety of species on which observations are recorded, and on many of which experiments were made, enable Prof. Goebel to put forward his views with some confidence, albeit he is not dogmatic. Throughout the work he is decidedly sceptical concerning the various teleological theories which have been proposed, largely under the influence of Darwinism, as explanations of the movements of plant-organs. Unavoidable reaction, not purposeful response, is suggested again and again. That the movements often are relatively advantageous is not to be denied, and it may be granted that Natural Selection would tend to eliminate any species which had developed decidedly disadvantageous movements, but the advantages or disadvantages are secondary, not the purpose of the movements the origin of which has been fortuitous. Goebel further emphasises the manifold ways in which the movements of plant-organs occur, and it seems possible that the usual classification is misleading and has itself suggested false teleological conclusions. At least, the extensive studies which have been published by Prof. Goebel indicate that generalisations based on limited, even if intensive, observations and experiments may often prove false. W. B. T.

Medical and Veterinary Entomology: a Textbook for Use in Schools and Colleges as well as a Handbook for the Use of Physicians, Veterinarians and Public Health Officials. By Prof. William B. Herms. Second edition, completely revised. Pp. xv+462. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1923.) 28*s.* net.

IN the second edition of this work the chief new features are the historical introduction, dealing with the development of medical entomology, and the additions to various chapters of material derived from the author's experience as a sanitary officer in the U.S. Army during the War. The external features used in classification and the life-history of the insects of medical and veterinary importance are considered, but internal anatomy is dealt with only in a few cases. Methods of control are carefully discussed, and references given in the most important cases to the original sources of the respective methods. The most detailed chapters are those devoted to lice, mosquitoes, house-flies, larvæ which produce myiasis, and ticks, and these are the chapters which will be most useful to the majority of readers. The accounts of other insects, *e.g.* fleas, are less satisfactory from the medical point of view; thus, although the characters of *Xenopsylla cheopis* are given there is no reference to *X. astia* or to *X. brasiliensis*—which the reader should be shown how to differentiate from *X. cheopis*, and the author is in error in regard to the structure labelled as hypopharynx in the figures of the fleas shown on p. 322. In the brief account of the life-history of *Dipylidium caninum* the work of Joyeux (1916) might have been referred to. The observations of Dr. and Mrs. Connal (1922) on the life-cycle of *Filaria* (*Loa*) *loa*, and the work of Christophers (1922) on the segments of mosquito larvæ, were perhaps published just too late to receive notice. In the description of Fig. 20 the term pupa (of the house-fly) should be replaced by puparium. Good drawings would have been more helpful to the reader than certain of the photographic illustrations provided, *e.g.* Figs. 91, 140, 141, 143, 152, 161, 168, 180, 210.

The book has no doubt been written with particular reference to the needs of medical and veterinary students and public health officials in the United States, but the greater part of the work has a general application to the conditions in warm climates elsewhere, and will be found useful by those who desire a concise account of the biology and methods of control of the insects which attack man and animals.

A Third Year Experimental Chemistry. By W. H. Crabb. Pp. viii+247. (London: Mills and Boon, Ltd., n.d.) 3*s.* 6*d.* net.

ON leaving the university and entering a secondary school to teach science, the young graduate quickly finds that he has much to learn, and as he progresses he realises more and more the folly of spoon-feeding his pupils on "academic" science. If he is keen and progressive, he will construct his own notes and piece together the scaffolding of a potential text-book; and in compiling such data he will gather valuable experience. Whether his work will be published or not depends upon many factors: ambition, the self-regarding instinct, inertia, modesty—and publishers.

The small work under review appears, rightly or wrongly, to have originated in some such manner as the above, and it will be very useful not only to the author, but also to other teachers, if they do not prefer their own notes. The author is evidently a clear and conscientious teacher, and the only adverse criticism to be offered is that he covers too much ground; with the exception of pupils who are specialising between 17 and 19 years of age, it is very doubtful if any ordinary school class could adequately assimilate more than half the contents of this book in a working school year, say, of 30 weeks; and probably only a small minority of pupils could tackle the work successfully after a two-years' course in elementary chemistry. To take one

lesson as an example. The sixth lesson, on diffusion and liquefaction of gases, comprises revision of experiments on these subjects, Graham's law, and practical applications; then some historical notes leading to a very sketchy notice, without diagrams, of liquefaction of gases by self-cooling; and lastly, as "topics for discussion," commercial liquefaction of gases, separation of oxygen and nitrogen from liquid air, uses of liquid air, methods of nitrogen-fixation, uses of liquid sulphur dioxide, chlorine and ammonia, carbon-dioxide "snow."

It is regrettable that attempts are still made in our schools to turn out ready-made chemists and physicists. Enlightened university teachers, and employers, do not want students of this kind; they want youths with acute and alert minds, having a sound knowledge of elementary principles and a keen desire for more.

Arabische Alchemisten. 1: Chālid ibn Jazīd ibn Mu'āwija. Von Julius Ruska. (Heidelberger Akten der von-Portheim-Stiftung, Heft 6.) Pp. 56. (Heidelberg: Carl Winter's Universitätsbuchhandlung, 1924.) 3 marks.

THIS scholarly dissertation upon Khalid ibn Yazid will receive a hearty welcome from all those who are interested in the history of chemistry. It must serve as a foundation for all future work upon Khalid, who is one of the most attractive of early Muslim chemists. Much that is legendary has been associated with him from a very remote period, and this apocryphal matter has naturally increased with the passage of time. Prof. Ruska carefully examines the principal sources for the life of Khalid and is able to show that they contain numerous inconsistencies and anachronisms. It is clear that none of them is entirely trustworthy, and the same may be said of the various books and poems in Arabic ascribed to Khalid, which are probably all spurious, even though they may contain authentic passages.

Prof. Ruska considers the Khalid-Morienus story at some length, and rejects it. He explains that in its earliest form the story makes Stephanus, contemporary with Herakleios (died 641), the teacher of Khalid (died 704), but suggests that when Muslim historical knowledge came to recognise that Stephanus had died before Khalid was born, a "pupil of Stephanus," Marianus or Morienus, was invented to act as a link between the two.

All the Latin works which pass under the name of Khalid or Morienus are declared by Ruska to be falsifications, particularly the "Liber Secretorum Artis compositus per Chalid filium Jaichi," and "Liber Trium Verborum Kalid Regis acutissimi." While this is probable enough, there is good reason to suppose that certain sections are of extremely ancient origin, as they may be found in Arabic in the "Kitāb al-Muktasab" (*c.* 1300), which goes back to "Ares" and Khalid for its authorities and is quite independent of the line of development passing through Rhazes and the Spanish Arabs.

One small error may be noted. On p. 49, Prof. Ruska attributes the "Rutbatu'l-Ḥakīm" to Maslama al-Majriti; it was in fact written about 100 years after Maslama's death. E. J. H.

The Fauna of British India, including Ceylon and Burma. Edited by Sir Arthur Shipley. *Birds.* Vol. 2. By E. C. Stuart Baker. Second edition. (Published under the authority of the Secretary of State for India in Council.) Pp. xxiii + 561 + 8 plates. (London: Taylor and Francis, 1924.) 30*s.*

THE second of the volumes on Indian birds undertaken by Mr. E. C. Stuart Baker, for the "Fauna of British India" series, is a worthy successor to the first. It contains a further instalment of the Passeres from the Cinclidæ (Dippers) to the Regulidæ (Goldcrests, etc.), and deals with 473 forms in a remarkably thorough manner. So far as is known, the vernacular names, nidification, and habits of each form, in addition to a complete systematic description, are given, and it is hoped that further observations under the first three headings will be recorded by Indian ornithologists. A noteworthy feature, as in the first volume, is the numerous coloured plates executed by the author himself, which are a credit to his artistic ability. A few eggs and nests might with advantage have been figured; a series of the former as a coloured plate would have made a fitting frontispiece, or a figure of the egg of each of the forms of which plates have been given might have been included in them. The absence of a full synonymy is again noticeable, but we learn with satisfaction that a sixth volume has been sanctioned which will contain a full synonymy of the forms dealt with in the previous volumes, and such addenda and corrigenda as are necessary.

The "Fauna of British India" series is, we believe, meant primarily to serve as complete handbooks on various groups for Indian collectors, and if this object is to be fulfilled in dealing with the birds, Mr. Baker would do well to take the opportunity of introducing a brief but complete introduction to Indian ornithology, containing notes on collecting, geographical distribution, and a map, with some account of the topography of the region insomuch as it concerns the Indian birds, in the sixth volume of his series. Mr. Baker's extensive knowledge of Indian field ornithology would make such an introduction most valuable. He is to be congratulated on producing a series which again makes it possible for those who have not his special knowledge to identify Indian birds correctly without wading through a mass of confusing synonymy.

C. DOVER.

Engineering Non-Ferrous Metals and Alloys. By Leslie Aitchison and William R. Barclay. (Oxford Technical Publications.) Pp. xx + 300. (London: Henry Frowde and Hodder and Stoughton, 1923.) 21*s.* net.

A TRUSTWORTHY account of the non-ferrous metals and alloys used for engineering purposes has been needed for some time, and Dr. Aitchison and Mr. Barclay have made an excellent effort to meet this need. Without entering into processes of manufacture, they discuss generally the properties of cast and wrought metals, and then describe in detail the several metals and alloys with their physical and mechanical properties, together with their principal uses. The statements of the authors are based on a wide practical experience, and may be regarded as authoritative. The section on the alloys of nickel will be found

particularly valuable. The metallographic side of the subject is less fully dealt with, and the photo-micrographs included do not constitute a representative series. The equilibrium diagrams might well have been omitted, as they bear no indication of the phases present, and the copper-aluminium diagram on p. 125 is impossible. The engineering reader would not derive any information from such diagrams, and the metallurgist would have to look elsewhere for an explanation of them. Mechanical testing is well and clearly described, but it is rather surprising that the now familiar Erichsen test is not included, it being greatly superior to the crude cupping test.

The book was completed too early to admit of the incorporation of the detailed report of the Alloys Research Committee on light aluminium alloys, but we may expect that this section will be expanded in a future edition. The same may be said of the die-casting alloys, as to which more information is now available than the authors have provided. It is certain that the book will be welcomed by engineers, and will be found useful by metallurgists.

The Literature of the Charadriiformes from 1894–1924: with a Classification of the Order, and Lists of the Genera, Species, and Sub-species. By Dr. George C. Low. Pp. xi+220. (London: H. F. and G. Witherby, 1924.) 12*s.* 6*d.* net.

MUCH labour has obviously been expended in the preparation of this work of reference, and ornithologists must be correspondingly grateful to Dr. Low for his having placed so useful a tool in their hands. Its purpose is to supply a complete guide to the literature dealing with the Charadriiformes in the thirty years which have elapsed since the publication of volume xxiv. of "The British Museum Catalogue of Birds." The labours of other workers in this field will be greatly facilitated by the availability of these collected and classified references. A preliminary chapter discusses the classification and nomenclature of the group, and a second gives references to works of a general kind bearing on the subject. The rest of the book is devoted to references grouped under the names of the ninety-seven genera, in ten families, which Dr. Low admits to the order, and under each genus they are arranged chronologically. Some idea of the bulk of modern ornithological literature may be gathered from the fact that the references to this one order, admittedly an important and interesting group, fill about two hundred pages. Frequent use in actual work is the only true means of testing a book of this kind, but such checks as one can readily impose show that Dr. Low has performed his laborious task with the thoroughness and accuracy for which it called.

The Irish Setter: its History and Training. By Colonel J. K. Millner. Pp. 80+8 plates. (London: H. F. and G. Witherby, 1924.) 5*s.* net.

FROM the introduction we learn that this is the first book devoted solely to the Irish setter. It cannot, however, be regarded as more than a random collection of miscellaneous notes about the breed, and some of its most distinguished representatives, with an admirable chapter on training and a clear description of the points of the breed as approved by the Irish Red Setter Club. The origin of the Irish setter is apparently shrouded in oblivion. Beyond the suggestion that it has been derived from the red spaniel of the eighteenth century, used largely in hawking, and that its development dates from the beginning of the practice of shooting at flying birds in the last half of the same century, there is nothing really definite that is known, and no records are available which help to establish its history. A century ago there were apparently two distinct strains—red, and red and white, the latter predominating; but with the introduction of dog shows and the somewhat arbitrary requirements of fanciers, the red-and-white strain has largely disappeared. For show purposes only the merest traces of white on the head, chest, throat, and toes are allowable. Mr. S. W. Carlton contributes the introduction, and the book is illustrated by eight half-tone blocks of celebrated Irish setters, taken from the dogs themselves or from oil paintings.

Automatic Telephones. By F. A. Ellson. (Pitman's Technical Primers: Double volume.) Pp. xii+215. (London: Sir Isaac Pitman and Sons, Ltd., 1924.) 5*s.* net.

AT first sight, automatic telephony appears to be a hopelessly complicated subject. Yet next year it will be necessary for all telephone subscribers to begin to get a working knowledge of it, as the British Post Office decided a year ago that automatic equipment is to be adopted in all important areas. We wonder whether in the future it will be well known that the "double dog" is knocked away until the wipers clear the banks and that during this process the stationary dog supports the weight of the shaft. In any case these terms will have to be included in technical dictionaries. The list of British standard terms made by the Engineering Standards Association and included in this volume is excellent. The advantages of the automatic system are the large savings that can be effected in the annual charges, the continuous day and night service, and the increased efficiency and accuracy. The disadvantages are the greater capital cost and maintenance charges, and the increased liability to faults at the subscribers' end. To the intelligent reader who wishes to understand the basic principles of the ordinary systems in use, we can recommend this book.

Anatolica. By Harry Charles Luke. Pp. xii+210+40 plates. (London: Macmillan and Co., Ltd., 1924.) 16*s.* net.

IN this volume Mr. Luke again shows the knowledge and insight, together with the charm of style, that have made notable his previous volumes on the Near East. Among the flood of books on various parts of the eastern Mediterranean, it is rare to find one written with more authority or marked by greater conciseness and first-hand observation. It is entirely unpolitical, and consists of a series of short essays on various towns and districts, including Mount Athos, Salonika, Adrianople, Cyprus, the Holy Sepulchre, Petra, and the cities of Transcaucasia. The chapters on Cyprus are among the most vivid in the book, and recall the charm of the island. There is a quaint and sufficient map, and the illustrations are well chosen. The coloured frontispiece of Mount Ararat is excellent.

Letters to the Editor.

(The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.]*

Specific and Latent Heats of Iron and Steel.

IN a letter on this subject published in NATURE of April 19 (vol. 113, p. 566) it was shown that if the *temperature* of the metal is raised continuously, the resulting expansion plotted in terms of time appears as a smooth curve exhibiting no peculiar features.[1]

If, on the other hand, *heat* is supplied in the same way, the variation of temperature, and therefore of expansion, is dependent on the specific heat of the

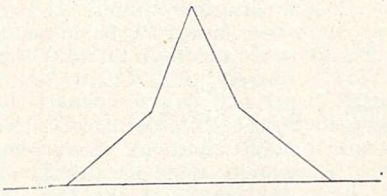


FIG. 1.—Diagrammatic representation of the extension of a material when heat is supplied and withdrawn at a constant rate; and the specific heat changes at a definite temperature.

material so that the rate of extension is (*cæteris paribus*) inversely as the specific heat.

If the rate at which heat is supplied is uniform, and if the only change in the metal at the critical temperature is in the specific heat, the curve representing the extension during a cycle of heating and cooling would be four straight lines as in Fig. 1.

If, however, in the change from the low to the high temperature state, heat is rendered latent,[2] and provided that the change can be brought about by an infinitesimal excess of temperature above the critical value, the extension diagram will be of the form shown in Fig. 2.

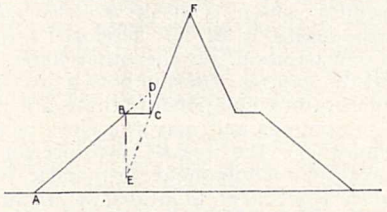


FIG. 2.—Conditions as in Fig. 1, except that heat is rendered latent at the temperature of the change of specific heat. The quantity of heat which becomes latent is equal to that which would raise the temperature sufficiently to cause the extensions CD or BE, according as the specific heat is taken as that belonging to the branch AB or CF.

The latent heat is that which would cause an expansion CD or BE, according as the specific heat is taken as having the low or high temperature value. When, as in my experiments, the variation of temperature in heating depends on the excess of heat supplied over that lost by radiation and convection, and in cooling on the difference of temperature between the heated wire and its surroundings, the straight lines in Figs. 1 and 2 become exponential curves, and the typical heating and cooling diagram is similar to that in Fig. 3.

The curved form of the junction between low and high temperature branches shows that the material is in an unstable condition at the critical temperature, and that to start the transition from one state to the other, the critical temperature must be exceeded in heating, or passed in the opposite direction in cooling, but that once started it proceeds in suitable conditions, with sufficient rapidity to reduce or raise the temperature of the wire, and thereby alter its length. To show these effects to advantage the diameter of the wire must be small enough to ensure that the difference of temperature between its surface and interior is small.

In the letter of April 19 previously alluded to, it was shown that the critical temperature was chiefly dependent on the proportion of carbon present in the metal, and it was suggested that in iron free from carbon the critical temperature might be found to be that corresponding to the intersection of the curves appropriate to the two specific heats. A reference was also made to the difficulty of obtaining iron containing no trace of carbon.

It seemed possible that such iron might be prepared by the " Thermit " process, and within the last few weeks I have experimented with wire drawn from an ingot of Thermit iron made at the Davy-Faraday Laboratory from pure materials. Lengths of this wire were heated with graphite for various periods in

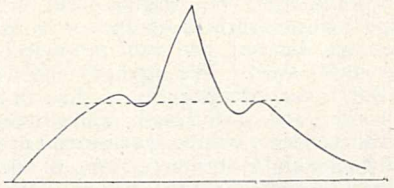


FIG. 3.—Diagram of the extension of the same material as that of Fig. 2, when the net increment of heat is proportional to the excess of heat supplied above that lost in the same time by radiation, etc., and the loss of heat during cooling is proportional to the excess of the temperature of the material above its surroundings.

a combustion furnace, and the results of these trials are shown in Fig. 4.

It should be stated that the analysts find that the Thermit ingot contained something like 0·04 per cent. of carbon, and also that in a sample of electrolytic iron which the National Physical Laboratory were kind enough to supply the carbon percentage was 0·065.

In both cases the origin of the carbon is unknown. An examination of the curve in Fig. 4 shows that even a thirty minutes' heating in graphite causes a slight drop in the critical temperature and some change in the character of that part of the curve which indicates the extension while change of state is in progress.

These changes become more marked as the time of heating in graphite is prolonged, and when this reaches five hours, it is seen that there are two separate pauses at different temperatures in the heating curve and a double reheating during cooling.

All these peculiarities can be explained by supposing that the outer parts of the wire have been converted into a mild steel while the core remains comparatively pure iron: so that each part changes its state at the temperature appropriate to its carbon content.

The diagram Fig. 4, *a*, for the Thermit iron which has not been in contact with the graphite, shows a critical temperature slightly higher than that for the " Armco " iron referred to in my letter of April 19, but in other respects the results are identical; and in

[1] The actual coefficient of expansion of iron at first increases with the temperature, but diminishes as the melting-point is approached.

[2] It is not unlikely that something of the same kind happens with any element which assumes an allotropic form on heating. If a small quantity of sulphur in the plastic state is "chawed," it soon resumes the crystalline form, and becomes gritty in the mouth, with a very sensible rise of temperature.

all the irons and steels I have used, the ratio of the low and high temperature specific heat is very nearly three to one.

In making steel by the cementation process on a commercial scale, I believe that iron bars exceeding 1 square inch in cross-section are heated in charcoal for a fortnight or more; and as the carbon probably passes into the metal by diffusion, it might be expected that in the case of an 0·02 in. diameter wire,

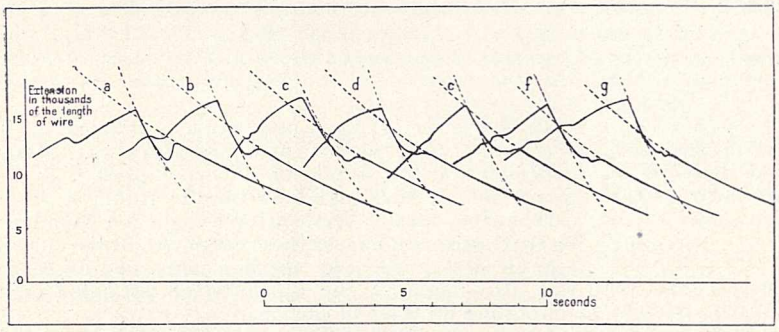


FIG. 4.—Tracings from diagrams of extensions during heating and cooling of wires drawn from "Thermit" iron, the wires being subsequently heated in graphite for the following time:

Diagram.	Minutes.	Diagram.	Minutes.
a	0	*d*	180
b	30	*e*	250
c	60	*f*	320

saturation would be reached in a much shorter time. It would seem, however, judging from the lower of the critical temperature in diagram *f* of Fig. 4, that the five hours' heating has only produced a coating of very mild steel. The temperature at which cementation is carried out probably has an important effect on the rate of diffusion, and further experiments on this subject will be made with purer samples of iron, if such can be obtained.

A. MALLOCK.

9 Baring Crescent, Exeter,
August 8.

The Rotatory Dispersion of Tartaric Acid.

EIGHTY-EIGHT years ago, Biot (*Comptes rendus*, 1836, 2, 542) showed that an *anomalous* rotatory dispersion could be produced by superposing two *normal* partial rotations of opposite sign and of unequal dispersion. This general theory of the origin of anomalous rotatory dispersion can be developed in two ways, according as it is supposed that a partial rotation of opposite sign is produced as the result of a chemical change in the optically-active molecule, or that the presence of two opposite partial rotations is one of its inherent physical properties. In the Bakerian lecture of 1921 (Phil. Trans., 1922, A, 222, pp. 249-308) we adopted, for the case of tartaric acid, the former explanation.[1] This was in harmony with the conceptions of Biot himself, since he attributed the variations in the rotatory power of this acid, *e.g.* in aqueous solutions, to chemical and not to physical causes; this point of view had also been stated in a very precise form by Arndtsen in 1858 (Ann. Chem. Phys., 1858, 54, p. 421). The same explanation has since been adopted by Astbury (Proc. Roy. Soc., 1923, A, 718, p. 527; NATURE, July 26, p. 122) as a sequel to his X-ray examination of the crystals, and by Longchambon (*Comptes rendus*, 1924, 178, p. 951) as a result of his study of their optical rotatory power. There is therefore a strong consensus of opinion amongst all those who have recently worked on the subject, that the anomalous rotatory dispersion of tartaric acid is related very intimately to its ability to undergo a reversible chemical change.

[1] The latter explanation has been adopted in the case of α′-bromocamphor.

Whilst the existence of this chemical change is admitted by all the workers named above, differences of opinion have arisen as to the exact nature of the change. Arndtsen adopted a perfectly general view as to the nature of the dextro- and lævo-rotatory components. In the same way, Longchambon (who identified the lævorotatory component with the ordinary crystals of the acid, and named the two components as α- and β-tartaric acid) offered no opinion as to the nature of β-tartaric acid. In the Bakerian lecture, however, after a careful study of all the available evidence, we felt justified in concluding that the acid exists in two *isomeric* forms of opposite rotatory power. Astbury, on the other hand, postulated a reversible *polymeric* change, depending on "the tendency of the molecules to build themselves up into a lattice . . . even in dilute solutions." This view has been shown to be untenable in the case of ethyl tartrate (Lowry and Cutter, Journ. Chem. Soc., 1924, 125, pp. 1465-1470), where determinations of molecular weight can be made without the complications which would arise from electrolytic dissociation in the case of the free acid; and, although it is perfectly true that "the dextrorotatory system . . . predominates in dilute solutions" of the free acid in *water*, as required by Astbury's hypothesis, dilute solutions in *acetone* are *lævorotatory* (Austin and Park, 1924, unpublished observations). The progressive decomposition of "crystal molecules" into "chemical molecules," which was first put forward by Landolt in 1879 as an explanation of the mutarotation of the sugars, appears then to be equally invalid when brought forward again as an explanation of the anomalous rotatory dispersion of tartaric acid.

Astbury suggests that the individual molecules of tartaric acid contain an *intramolecular* spiral of four carbon atoms, which is *dextrorotatory*, whilst the crystals contain also an *intermolecular* spiral (formed by the juxtaposition of hydroxyl-groups in contiguous molecules) which is itself *lævorotatory*, but *is always accompanied by the fully developed dextrorotatory spiral.* Longchambon, on the other hand, supposes that whilst the *solutions* contain both a dextrorotatory and a lævorotatory component, these are individual chemical compounds and may therefore be separated from one another; the *crystals* therefore contain only the lævorotatory component (α-tartaric acid), the *dextrorotatory component (β-tartaric acid) having been eliminated completely during the process of crystallisation.*[2] These conflicting views can be tested by examining the relevant rotatory dispersions. In the case of aqueous solutions of tartaric acid, the rotatory dispersion can be represented by the equation:

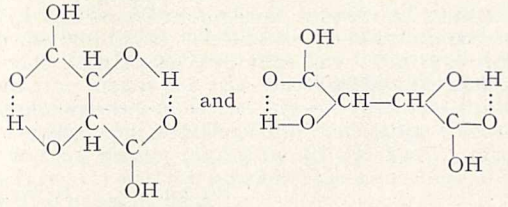
$$\alpha = k_1/(\lambda^2 - 0{\cdot}03) - k_2/(\lambda^2 - 0{\cdot}074).$$

The esters give similar equations but with rather smaller values for the second dispersion-constant. If the lævorotatory crystals of tartaric acid gave only the negative partial rotation of the aqueous solutions (as Longchambon supposes), the dispersion-ratio $\alpha_{4358}/\alpha_{5780}$ would be about 2·2, whereas *larger* values would be given if (as Astbury suggests) the negative rotation were masking a smaller positive term. The ratio 2·14 actually observed by Longchambon is almost identical with the value calculated from our equation, and therefore affords a conclusive

[2] Compare the complete separation of one of a pair of labile isomerides by crystallisation from solutions of α-glucose or of nitrocamphor.

vindication of his claim to have separated the lævo-rotatory component completely from the dextro-rotatory component which is formed from it in solution.

In his original paper, Astbury ascribed the anomalous dispersion of tartaric acid to "strings of molecules, connected together at the hydrogen junctions" of the hydroxyl-groups, which he represents as points of contact between contiguous molecules in the crystals, thus —OH HO . CO—. When it is realised that the X-ray analysis of organic compounds deals only with the orientation and spacing of *molecules*, and gives no information as to the positions of the individual *atoms*, it may be doubted whether there is any experimental foundation whatever for the wholly improbable view that the molecules of tartaric acid are held together *by the mutual attraction of two protons*. The idea that two hydroxyl-groups attract one another is indeed an old one; but since Bragg established the crystal-structure of ice, it has become evident that this action depends on a mutual attraction between the hydrogen of one molecule and the oxygen of another, a view that has recently been developed under the title of "Bivalent Hydrogen" by G. N. Lewis in America, and in Great Britain under the title of "The Co-ordination of Hydrogen" by one of the undersigned. Considerations of this kind have led us to conclude that the anomalous rotatory dispersion of tartaric acid and its esters probably depends on an interaction between the hydroxylic *hydrogen* and the carboxylic *oxygen*, giving rise to internal co-ordination-compounds such as



This conclusion is in harmony with the fact that the anomalous dispersion of tartaric acid persists in its esters, *in spite of the elimination of the carboxylic hydrogens*, which are essential to Astbury's hypothesis; it also agrees with the fact that all the anomalies disappear in the methylene ether (Austin and Carpenter, 1924) in which the hydroxylic hydrogens (but not the carboxylic hydrogens) have been eliminated.

If, as may be gathered from his letter in NATURE of July 26, Astbury is anxious to lay stress on the fact that the forces which produce anomalous rotatory dispersion in solutions of tartaric acid are identical with "the forces which bind the molecules into the crystalline structure," we should be in complete agreement with him; but we should regard these forces as depending on the simultaneous attraction of a proton for two oxygens, rather than of two protons for one another.

T. M. LOWRY.
P. C. AUSTIN.

Spiral and Structureless Nebulæ.

IN "Our Astronomical Column" of NATURE of August 2, reference is made to Prof. Perrine's letter on Prof. Lindemann's spiral nebula hypothesis which appeared in the *Observatory* for July. As Prof. Lindemann's hypothesis was based to some extent on photographic observations of my own, perhaps I may be permitted to make a few comments on the matter generally.

Prof. Perrine's criticisms on the supposed reflection of light from the Galaxy are not new, and are practically covered by my paper on Prof. Lindemann's theory which appeared in the Monthly Notices of the R.A.S. for May last year. The observational facts are entirely against this part of the hypothesis, and I think I am not misrepresenting Prof. Lindemann when I say that he does not attach so much importance to the *source* of reflection as to the probability of reflection being the cause of the colour distribution. There are considerably more grounds for assigning the source of reflection (if any) to the bright central nucleus of the spiral itself. I found, for example, that the curve of light distribution in the nucleus of the Andromeda nebula (N.G.C. 224) was a near approach to the curve $(x+1)^2y = \text{constant}$; and Hubble has recently derived much the same result for a series of bright amorphous ellipsoidal nebulæ of non-galactic type, which have been photographed with the 100-inch reflector at Mt. Wilson. This applies to the amorphous or uncondensed type of spiral nuclei, but it does not apply to the condensed type of spirals where numerous condensations appear and the nucleus is weakened by continued outflow of matter along the spiral arms. In the latter case the peak of the curve is considerably flattened, and the non-luminous matter at the periphery of the nebula is taken up into the condensations.

It may be inferred from this that reflection as a cause of illumination is a possibility in the amorphous type but is definitely ruled out in the condensed type. This has led me to doubt the validity of the photographic observations on which Prof. Lindemann's hypothesis was based. The photographs which Prof. Seares obtained at Mt. Wilson with the 60-inch reflector were comparative—one with an unscreened ordinary plate and the other with a yellow screen and an isochromatic plate. These showed quite definitely for the condensed type a stronger image of the nucleus in the isochromatic than in the ordinary plate compared with the outer regions of the spiral, the inference being that outer regions of the spirals are deficient in the longer wave-lengths. The same results were found in my photographs of the uncondensed type which were measured with a photo-micrometer, and were also carried down to the red region of the spectrum with panchromatic plates and suitable screens. Some photographs were also obtained of the nucleus of the Andromeda nebula with ordinary plates and a nickel oxide screen to cut out the visual part of the spectrum and transmit the ultra-violet. It is evident, however, that we are dealing with plates having contrast factors which differ with the wave-length, and the variation found may be owing to a combination between the range of spectrum and the plate employed.

This question has been dealt with at some length by Ross (*Astrophysical Journal*, vol. 52, p. 86), who finds that the variation of γ (the contrast factor) along the spectrum is greatest for panchromatic plates and least for orthochromatic plates. He points out also that the depth of image in the ultra-violet is not so great as in the longer wave-lengths, which penetrate further into the emulsion. At the same time, I should not wish to condemn the observations out of hand as untrustworthy, but rather I would advocate the repetition of them under more rigorous conditions, which is quite possible, and would give us definite information on this important point.

J. H. REYNOLDS.

Low Wood, Harborne,
August 14.

The Production of very Intense Magnetic Fields.

In a letter to NATURE which appeared in the issue for April 19 last, I gave a brief outline of a method for producing very intense magnetic fields.

I have now made some measurements which show that magnetic fields of considerably greater intensity may be generated by this method than had appeared at first sight to be practicable. For example, in one test a magnetising solenoid wound with 25·5 turns per cm. was used, and the first peak value of the discharge current obtained when condensers of 700 micro-farads total capacity were used, charged to a pressure of 1850 volts, was found from the oscillograph record to be 12,500 amperes. *This means that an intensity of magnetic field of about* 400,000 *gauss was generated.*

By means of a modification of the apparatus which is now being effected, it is expected that an intensity of magnetic field of about 1,500,000 gauss will be obtained very shortly.

It is useful to examine what considerations govern

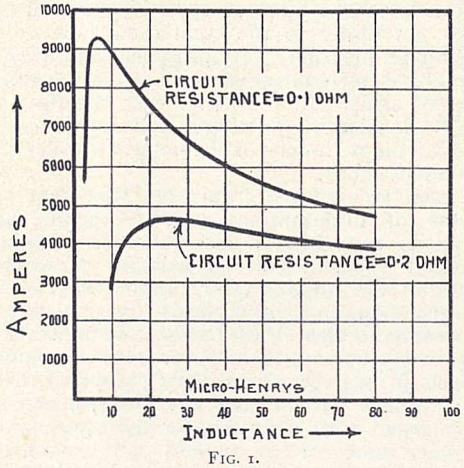


FIG. 1.

the maximum value of the condenser discharge current which can be obtained by this method. The magnitude of the first peak of the discharge current is given by the expression

$$\frac{V}{L\sqrt{\frac{1}{LC}-\frac{1}{4}\frac{R^2}{L^2}}}e^{-\frac{1}{2}\frac{R}{L}T} \text{ amperes,}$$

where

V volts is the pressure to which the condenser is charged.
L henry is the inductance of the circuit.
C farad is the total condenser capacity.
R ohm is the resistance of the circuit.
T second is the time for a quarter-period of the discharge current.
$e = 2{\cdot}718$ and is the base of natural logarithms.

In Fig. 1 the magnitude of the first peak of the discharge current is shown as a function of the inductance when the condenser capacity is 700 micro-farads and the pressure 2000 volts. Two cases have been selected, namely, (i.) for a circuit resistance of 0·1 ohm, and (ii.) for a circuit resistance of 0·2 ohm.

It is important to observe that the maximum value of the first peak of the discharge current is obtained for a definite value of the inductance, and that this maximum value is more sharply defined the smaller the resistance of the circuit.

T. F. WALL.

Edgar Allen Research Laboratory,
University of Sheffield,
August 30.

Absorption of Vapours of Various Liquids by Cotton.

THE familiar absorption of water from the air by cotton has been studied in our laboratories for some years from various aspects. The phenomena are valuable as clues for interpreting the physico-chemical structure of cotton cellulose; and in this connexion we have naturally examined the capillary hypothesis, using Anderson's formula for calculation of capillary radii. We recently initiated a simple series of observations which indicate that this hypothesis is inadequate, by showing that the weight of vapour absorbed is dependent on the chemical nature of the vapour, with a suggestion that there is a constant "low level" group, including definite types of liquids, with which the values are due to simpler causes than with water or acetic acid, the values for the two latter being far higher. As the differences for various liquids are very marked and do not seem to have been previously recorded, the following particulars may be of interest, in spite of the primitive methods used in what was merely a preliminary examination.

Samples of unbleached and bleached twofold Egyptian cotton hosiery yarn were suspended, at room temperatures, in a bottle, in the bottom of which was a layer of the liquid under consideration. The cotton (which before enclosure had been dried for four hours in a water oven and then weighed) was withdrawn, with suitable precautions, at intervals of several hours and weighed in a weighing bottle. Curves were drawn through the plottings of these weight-values in order to show approximately the variation of weight with time for water, alcohol, acetic acid, benzene, nitrobenzene, carbon disulphide, ether and acetone. The following table shows only the saturation values at room temperatures:

Liquid.	Unbleached.	Bleached.
	Per cent.	Per cent.
Water	18 to 20	19 to 21
Glacial acetic acid	18 ,, 20	17 ,, 19
Absolute alcohol	3 ,, 3½	8½ ,, 9
Carbon disulphide	1½ ,, 2	1½ ,, 2
Benzene	1½ ,, 2	1 ,, 2
Ether	7 ,, 7½	7 ,, 7½
Nitrobenzene	1½ ,, 2	1½ ,, 2
Acetone	2 ,, 2½	6½ ,, 7

It is intended to investigate these phenomena further in the Experimental Department of the Fine Cotton Spinners' and Doublers' Association, to which I am indebted for permission to publish this note.

ROBERT C. BRIMLEY.

Rock Bank, Bollington,
near Macclesfield, Cheshire,
August 29.

The Magnetic Resolution of the Scandium Lines.

SEVERAL lines of the scandium spectrum have been classified by Catalán (An. Soc. Esp., 20, 606, 1922, and 21, 464, 1923). According to him, the Sc I. spectrum contains a doublet- and a quartet-term system; the Sc II. spectrum a triplet-system. It is, however, probable that some corrections must be made in his term-scheme. These corrections are obviously also made by Gieseler and Grotrian (*Naturw.*, 12, 438, 1924).

We have made provisional measurements of the magnetic resolution of some scandium-lines. By means of the formulæ given by Landé (*Zeit. f. Phys.*,

15, 189, 1923), it has been possible to calculate the greater part of these resolution patterns from the corrected term-scheme. The observations agree completely with the calculations on the assumption that the ordinary formula for the "separation factor" g of Landé is valid.

The observations of a few other lines make it not improbable, however, that there may be some terms for which the ordinary formula does not apply. It follows also, from some earlier observations of Rybar (*Physik. Zeit.*, 12, 889, 1911) on the related triplet spectrum of lanthanum, that terms with ordinary resolution and terms with unusual resolution are both present.

According to Landé (*Zeit. f. Phys.*, 17, 292, 1923) the ordinary g-formula is only valid if in the atomic rest—that is, the atom without the emitting electron—the electrons of the groups with azimuthal quantum numbers greater than one form closed configurations without moment of momentum.

The neutral scandium atom contains, according to Bohr, one single 3_3-electron. The observed separation patterns show that this single 3_3-electron generally cannot be present in the atomic rest of the excited scandium atom, for it cannot be arranged in a closed configuration. Therefore, it must be the emitting electron. The term-scheme really shows that the lowest energy level is a d-term, and this is also confirmed by the absorption experiments of Gieseler and Grotrian (*l.c.*). In the ionised scandium atom, there is no 3_3-electron at all, or it must be also in this case the emitting electron. The lowest energy level of Sc II. is not yet known.

It should be noted, however, that the facts obtained with the spectra of vanadium and titanium (Gieseler and Grotrian, *l.c.*) show that the term-type determined by means of the term structure and the magnetic resolution is not always (perhaps through the simultaneous action of different outer electrons) the one we expect according to the known atomic structure. It may be possible that something of this kind also happens here.

S. GOUDSMIT.
P. ZEEMAN.

Amsterdam, August 20.

Congenital Eye Anomalies in Albino Mice.

IN papers published in the *Journal of Experimental Zoology* (vol. xxvi., 1918, p. 65, and xxxi., 1920, p. 171) Guyer and Smith have given an account of the transmission, through successive generations, of eye defects which occurred in the offspring of rabbits and mice treated, while pregnant, with lens-sensitised fowl serum. The greater part of the papers concerns experiments carried out with albino rabbits, and in their case alone was the question of heredity considered, but the nature of the defects in both cases appears to have been the same.

Among a large number of albino white mice which are being bred in this Laboratory, a few have appeared recently with abnormal eyes. These have arisen in the course of ordinary breeding. The eyes follow in appearance the description given by Guyer and Smith; they are sometimes reduced in size, and one or both lenses are opaque, so that they are of a colourless, glassy hue instead of the normal red of the albino. So far the abnormality has been noticed in about 1½ per cent. of the mice that have been dealt with, and while it is at present too early to assert that the defect is definitely hereditary, the evidence available suggests that this is so.

I should be very interested to hear whether any others who have been breeding mice have observed this same abnormality. Guyer and Smith could obtain no information from breeders of similar defects arising naturally in *rabbits*, and concluded that "rabbits are stable forms wholly unlikely to develop eye defects unless, as in our work, these have been deliberately induced by the experimenter." It would appear that as regards albino mice, outwardly similar defects may arise without being deliberately induced, which seems to be a fact of some importance having regard to the bearing of Guyer and Smith's experiments on the problem of the inheritance of acquired characters.

EGON S. PEARSON.

Biometric Laboratory,
University College,
London.

The Stark Effect on Fundamental (Bergman) Series.

ACCORDING to the Bohr theory, we should expect that the Stark effect would be strong in the fundamental (Bergman) series. So far as I am aware, the experimental evidence has not been brought forward, as the lines belonging to this series usually appear in the infra-red region. In a paper published by Saunders (*Astrophys. Jour.*, 52, p. 265, 1920) a certain number of calcium lines in the visible and ultra-violet region are ascribed to the fundamental series.

On referring to my previous work with Mr. N. Kokubu (Mem. Coll. of Sci., Kyoto, 3, p. 173, 1918), I find that many of these fundamental series lines are shifted toward the red by an electric field, as shown in the following table.

	Fundamental triplets $(1d)-(mf)$.				Fundamental Singlets $(1D)-(mF)$.		
m	λ in A	Shifts (for E = 68 kilovolt/cm.)		m	λ in A	Shifts (for E = 68 kilovolt/cm.)	
1	4586·1 81·7 78·8	Not measured		1	4878·3	Not measured	
		p-component	*s*-component			*p*-component	*s*-component
2	4098·8	2·7 A	1·2 A	2	4355·4	4·3 A	2·8 A
	95·3	2·3 A	1·5 A				
	92·9	2·2 A	1·4 A				

On meeting Prof. Saunders at Toronto during the sessions of the British Association, he suggested that this fact might be worthy of mention.

T. TAKAMINE.

Photographs of Lightning.

I AM at present engaged in investigating the forms assumed by lightning flashes in different circumstances and for this purpose require to examine as many photographs of lightning as possible. May I appeal to readers of NATURE who have such photographs to be good enough to give me an opportunity of inspecting them? It is not necessary that the photographs should be technically good; any photographs showing the form of the flash will be valuable. I should like especially to see photographs showing flashes from the tops and sides of clouds.

All photographs will be returned, if required, as soon as they have been examined.

G. C. SIMPSON.

Meteorological Office, Air Ministry,
Adastral House, Kingsway,
London, W.C.2,
September 10.

Present-day Problems in Crop Production.[1]

By Sir E. JOHN RUSSELL, F.R.S.

COMPLEXITY OF THE PROBLEM.

THE agricultural investigator is confronted with three closely interlocking agencies—the plant, the climate, and the soil—each of which is variable within certain limits, and each playing a large part in the crop production which it is his business to study.

Confronted with a problem of this degree of complexity there are two methods of procedure: the empirical method of field observations and experiments, in which there is no pretence of great refinement and no expectation that the same result will ever be obtained twice, it being sufficient if over an average of numerous trials a result is obtained more often than would be expected from the laws of chance; and the scientific method, in which the factors are carefully analysed and their effects studied quantitatively; a synthesis is then attempted, and efforts are made to reconstruct the whole chain of processes and results. The scientific method is, of course, the one to which we are naturally attracted. But common truthfulness compels one to admit that up to the present the greatest advances in the actual production of crops have been effected by the empirical method, and not infrequently by men who are really artists rather than men of science, in that they are guided by some intuitive process which they cannot explain, and that they have the vision of the result before they obtain it, which the scientific man commonly has not.

The best hope for the future lies in the combination of the empirical and the scientific methods. This is steadily being accomplished by the recent strong infusion of science into the art of field experimentation, which has much enhanced the value of the field work and the trustworthiness of its results. Modern methods of replication, such as have been worked out at Rothamsted, and in the United States by Harris of the Carnegie Trust (Cold Spring Harbor), Kiesselbach in Nebraska, Myers and Love of Cornell, and others, constitute a marked improvement in plot technique. The figures themselves, besides being more accurate, can be made to yield more information than was formerly the case.

Great advances have been made in the methods of analysing the results. The figures are never the same in any two seasons, since the climatic conditions profoundly affect the yields. A few men, like J. H. Gilbert, have the faculty of extracting a great deal of information from a vast table of figures, but in the main even the trained scientific worker can make very little of them. The reason is that he has been brought up to deal with cases where only one factor is varying, while the growth of plants involves the interaction of three variable factors: the plant, the soil, and the climate. It is impossible to apply in the field the ordinary methods of the scientific investigator where single factors alone are studied; very different methods are needed, adapted to the case where several factors vary simultaneously.

Fortunately for agricultural science, statisticians have in recent years worked out methods of this kind, and these are being modified and developed by R. A. Fisher and Miss Mackenzie for application to the Rothamsted field data. It so happens that this material is very suitable for the purpose, since a large number of the field experiments have been repeated every year for seventy or eighty years on the same crop and on the same piece of land, using the same methods; the field workers also remain the same for many years, the changes being rare and without break in continuity. Although the statistical investigation is only recently begun, mathematical expression has already been given to the relationship between rainfall and yield of wheat and barley under different fertiliser treatments, and precision has been given to some of the ideas that have hitherto been only general impressions. If on an average of years a farmer is liable to a certain distribution of rainfall, it is becoming possible to advise as to fertiliser treatment which enables the plant to make the best of this rainfall.

ALTERATIONS IN THE PLANT.

It is a commonplace among farmers that certain soil conditions influence not only the yield but also the quality of crops. The leaf and root are more easily affected than the seed. The case of mangolds has been investigated at Rothamsted; the sugar content of the root, an important factor in determining feeding value, was increased by increasing the supply of potassium to the crop. Middleton at Cockle Park showed that grass increased in feeding value—quite apart from any increase in quantity—when treated with phosphates. Potatoes are considerably influenced by manuring; increasing the supply of potassium influences the composition of the tubers and also that much more impalpable quality—the cook's estimate of the value of the potato; while we have found at Rothamsted that a high-class cook discriminated between potatoes fertilised with sulphate of potash and those fertilised with muriate of potash, giving preference to the former.

Grain is more difficult to alter by changes in environmental conditions; indeed, it appears that the plant tends to produce seed of substantially the same composition whatever its treatment—with the important exception of variation in moisture supply. Mr. Shutt has explored the possibilities of altering the character of the wheat grain by varying the soil conditions, and finds that increases in soil moisture decrease the nitrogen in the grain. Similar results have been obtained in the United States.

On the other hand, in England the reverse seems to hold, at any rate for barley. This crop is being fully investigated at the present time under the research scheme of the Institute of Brewing, because of its importance in the preparation of what is still Britain's national beverage. Increased moisture supply increases the percentage of nitrogen in the grain, and so also does increased nitrogen supply, though to a much less extent; on the other hand, both potassic and phosphatic fertilisers may decrease the percentage of nitrogen, though they do not always do so; the laws regulating their action are unknown to us.

[1] From the presidential address delivered to Section M (Agriculture) of the British Association, Toronto, August 11.

The practical importance of these problems of regulating the composition of the plant lies in the fact that the farmer can control his fertiliser supply, and also to some extent his moisture supply, so that it lies within his power to effect some change should he wish to do so.

In agricultural science one sometimes thinks only of the crop and the factors that affect its growth. But in agricultural practice there is often another partner in the concern: a pest or parasite causing disease. The amount of damage done by pests and diseases to agricultural crops is astounding; in Britain it is probably at least 10 per cent. of the total value of the crops and the loss is probably some 12,000,000*l.* sterling per annum; in some countries it is considerably more. Indeed, the number of insect pests and of harmful fungi and bacteria that skilled entomologists and mycologists have found in our fields might almost lead us to despair of ever raising a single crop, but fortunately the young plant, like the human child, grows up in spite of the vast number of possible deaths. The saving fact seems to be that the pest does harm only when three sets of conditions happen to occur together: the pest must be present in the attacking state; the plant must be in a sufficiently receptive state; and the conditions must be favourable to the development of the pest. It is because this favourable conjunction of conditions comes but rarely that crops manage to survive; and this gives us the key to control if only we knew how to use it. Complete control of any of these three conditions would end all plant diseases. Unfortunately, control is never complete even in glasshouse culture, still less out of doors. But even partial control would be very helpful. All these pests go through life cycles, which are being studied in great detail all over the world, and especially in the United States. Somewhere there occurs a stage which is weaker or more easily controlled than others, and the pest would become harmless if the chain could be broken here or if the cycle could be sufficiently retarded to give the plant a chance of passing the susceptible stage before it is attacked.

The plants themselves, as we have just seen, are in some degree under control, and if they could be pushed through the susceptible stages before the pest was ready, they would escape attack. Barley in England is sometimes considerably injured by the gout fly (*Chlorops tæniopus*). The larvæ emerge in spring from the eggs laid on the leaves and invariably crawl downwards, entering the young ear if, as usually happens, it still remains ensheathed in leaves. J. G. H. Frew, at Rothamsted, has shown that early sowing and suitable manuring cause the ear to grow quickly above the track of the larvæ, and thus to escape injury. E. A. Andrews, in India, has found that tea bushes well supplied with potassic fertiliser escape attack from the mosquito bug (Helopeltis) for the rest of the season, apparently because bushes so treated become unsuitable as food to the pest. Further, the conditions are alterable. H. H. King, in the Sudan, has effected some degree of control of the cotton thrips (*Heliothrips indicus*) by giving the plant protection against the drying north wind and so maintaining a rather more humid atmosphere—a condition in which the plant flourishes more than the pest. Tomatoes in England suffered greatly from Verticillium wilt until it was found that a small alteration of temperature threw the attack out of joint. They are also much affected by stripe disease (*B. lathyri*), but they become more resistant when the supply of potash is increased relative to the nitrogen. It has recently been maintained, though the proof is not yet sufficient, that an altered method of cultivating wheat in England will afford a good protection against bunt. These cultural methods of dealing with plant diseases and pests offer great possibilities, and a close study jointly by plant physiologists and pathologists of the responses of the plant to its surroundings, and the relationships between the physiological conditions of the plant and the attacks of its various parasites, would undoubtedly yield results of great value for the control of plant diseases. Again, however, the plant breeder can save a world of trouble by producing a variety resistant to the disease; or there may fortunately be found an immune plant from which stocks can be had, as in the case of the potatoes found by Mr. Gough to be immune to the terrible wart disease.

Control of Environmental Factors.

It thus appears that, if only plant breeders and plant physiologists could learn to alter existing plants or to build up new plants in such a way that they should be well adapted to existing soil and climate conditions, and not adapted to receive disease organisms at the time the organisms are ready to come—if only they could do this, all agricultural land would become fertile and plant diseases and pests would become ineffective: at any rate until the pests adapted themselves to the new plants. Although no one can set limits to the possibilities of plant breeding and plant physiology, we cannot assume that we are anywhere near this desirable achievement or that we are likely to be in our time.

There will always remain the necessity for altering the environmental conditions to bring them closer to the optimum conditions for the growth of the plant. No attempt is yet made in the field to control two of the most important of the factors: the light and the temperature, though it is being tried experimentally. There is a great field for future workers here; at present plants utilise only a fraction of the radiant energy they receive. At Rothamsted attempts have been made by F. G. Gregory to measure this fraction; the difficulties are considerable, but the evidence shows that our most efficient plants lag far behind our worst motor-cars when regarded as energy transformers for human purposes. One hundred years ago the efficiency of an engine as a transformer of energy was about 2 per cent.; now, as a result of scientific developments, it is more than 30 per cent. To-day the efficiency of the best field crops in England as transformers of the sun's energy is about 1 per cent.:[2] can we hope for a similar development in the next hundred years? If such an increase could be obtained an ordinary crop of wheat would be about 400 bushels per acre, and farmers would feel sorry for themselves if they obtained only 200 bushels. But we are only at the beginning of the subject. Increases in plant growth amounting to some

[2] The remaining energy being largely used up in transpiration. This figure refers to the total radiation received by the leaf, and not to the fraction received by the chloroplast surface. For this latter the value is much higher.

20 or 25 per cent. have been obtained by V. H. Blackman in England under the influence of the high-tension electric discharge, which presumably acts by increasing in some way the efficiency of the plant as an energy transformer. Possibly other ways could be found. It needs only a small change in efficiency to produce a large increase in yield. Much could be learned from a study of the mass of data which could be accumulated if agricultural investigators would express their results in energy units as well as in crop yields as at present.

Interesting results may be expected from the attempts now being made in glasshouse culture both in Germany and at Cheshunt to increase the rate of plant growth by increasing the concentration of the carbon dioxide in the atmosphere.

Control of the Soil Factors.

The soil factors lend themselves more readily to control and much has been already achieved. Water supply was one of the first to be dealt with. Civilisation arose in the dry regions of the earth, and so far back as 5000 years ago, irrigation was so advanced as a practical method that it came into the ordinances drawn up by the great Babylonian king Hammurabi. The chief problems at the present time are to discover effective means of economising water and to ascertain, and if possible control, the relationships between the soil, the water, and the dissolved substances in the water.

Inseparably bound up with water supply are the questions of cultivation and of drainage, which affect not only the water but the air supply to the roots. The former subject is now attracting considerable attention: the great need is to discover means for expressing cultivation in exact physical and engineering units. The measurements of Keen and Haines at Rothamsted, and the chemical work of A. F. Joseph, N. Comber, and others on clay, and of Odén, Page, and others on humus, indicate the possibility of finding exact expressions and of effecting co-operation with the workers in the new fields of agricultural engineering.

Another soil factor which readily lends itself to some degree of control is the amount of plant nutrients present. The possibility of increasing this by means of manure has been so frequently explored in field trials that it has sometimes been regarded as almost a completed story; indeed, Rothamsted tradition affirms that Lawes himself once gave orders to have the Broadbalk field experiments discontinued because they had nothing further to tell; it was only the earnest persuasion of Gilbert that caused him to countermand the order. So far from the subject being exhausted, it still bristles with problems. The new nitrogenous fertilisers, resulting from War-time activities in nitrogen fixation; the need for reducing the cost of superphosphate; the change in character of basic slag; and the Alsatian development in potash production, are producing changes in the fertiliser industry the full effects of which are not easy to foresee. Economic pressure is driving the farmer to derive the maximum benefit from his expenditure on fertilisers, lime, farmyard manure, and other ameliorating agents, and is compelling a more careful study of possibilities hitherto disregarded, such as the use of magnesium salts, silicates, and sulphur as fertilisers, and, above all, a much more precise diagnosis of soil deficiencies than was thought necessary in pre-War days.

There are, however, more fundamental problems awaiting solution. It is by no means certain that we know even yet all the plant nutrients. The list compiled by Sachs many years ago includes all needed in relatively large amounts, but Gabriel Bertrand has shown that it is not complete and that certain substances—he studied especially manganese—are essential, although only in very small amounts. Miss Katherine Warington, working with Dr. Brenchley at Rothamsted, has shown that leguminous plants fail to develop in the so-called complete culture solution unless a trace of boric acid is added. Mazé has indicated other elements needed in small amounts.

Another problem needing elucidation is the relationship between the quantity of nutrients supplied and the amount of dry matter produced. Is dry matter production simply proportional to nutrient supply, as Liebig argued, with the tailing off beyond a certain point, as demonstrated by Lawes and Gilbert, or is it always less than this, as indicated by Mitscherlich's logarithmic curve; or is the relationship expressed by one of the more complex sigmoid curves as there is some reason to suppose? We do not know; and the problem is by no means simple, yet it governs the "diminishing returns" about which farmers now hear so much.

Again, very little is known of the relationship between nutrition and the period of growth of a plant. One and the same quantity of a nitrogenous fertiliser, for example, may have very different effects on the plant according as it is given early or late in life; not only is there a difference in quantity of growth, but also in the character of the growth. Late dressings cause the characteristic dark-green colour to appear late in the season, and thus affect the liability to fungoid diseases; they increase the percentage of nitrogen in the grain and they may give larger increases of crop than early dressings.

Investigations are needed to find the best methods of increasing the supply of organic matter in the soil and its value for the different crops in the rotation.

All these problems will sooner or later find some solution. But there remains a greater problem of more importance than any of them: the linking-up of plant nutrition studies with those of the soil solution. As our cousins in the United States were the first to emphasise, the fundamental agent in the nutrition of the plant is the soil solution, and they have made a remarkable series of investigations into what appeared at one time a hopeless proposition—the physico-chemical interactions between the soil and the soil water. A great advance in crop production may be expected when the soil chemists have discovered the laws governing the soil solution, when the plant physiologists can give definite expression to the plant's response to nutrients, and when some one is able to put these results together and show how to alter the soil solution so that it may produce the maximum effect on the plant at the particular time. The new soil chemistry will yet have its triumphs.

THE SOIL MICRO-ORGANISMS.

It is now more than forty years since the discovery of the great importance of micro-organisms in determining soil fertility. Practical applications necessarily lag far behind; but already three have been made each of which opens out great possibilities for the future. The long-standing problem of inoculation of leguminous crops with their appropriate organisms has already been solved in one or two of its simple cases, chiefly lucerne on new land, and the new process has helped in the remarkable extension of the lucerne crop in the United States and in Denmark. We believe at Rothamsted that the more difficult English problem is now solved also. Interesting possibilities are opened up by the observation that a preliminary crop of Bokhara clover seems to facilitate the growth of the lucerne.

The organisms effecting decomposition are now coming under control, and are being made to convert straw into farmyard manure (or a material very much like it) without the use of a single farm animal. The process was worked out at Rothamsted, and is being developed by the Adco Syndicate, which is now operating it on a large scale and is already converting some thousands of tons of straw annually into good manure.

The third direction in which control of the soil organisms is being attempted is by partial sterilisation. This process is much used in the glasshouse industry in England, and it has led to considerable increases in crop yields. The older method was to use heat as the partial sterilising agent, and this still remains the most effective, but owing to its costliness, efforts have been made to replace it by chemicals. Considerable success has been attained; we have now found a number of substances which seem promising. Some of these are by-products of coal industries; others, such as chlor- and nitro-derivatives of benzene or cresol, are producible as crude intermediates in the dye industry.

THE NEED FOR FULLER CO-OPERATION.

Looking back over the list of problems it will be seen that they are all too complex to be completely solved by any single worker. Problems of crop production need the co-operation of agriculturists, plant physiologists, soil investigators, and statisticians. Even plant breeding necessitates the help of a physiologist who can specify just what the breeder should aim at producing. This gives the key-note to the period of agricultural science on which we have now entered —it is becoming more and more a period of co-operation between men viewing the problem from different points of view. Good individual work will of course always continue to be done, but the future will undoubtedly see a great expansion of team work such as we know from our experience at Rothamsted is capable of giving admirable results in agricultural science.

With fuller co-operation both of men and of institutions we could do much to overcome the present difficulty in regard to utilising the information we already possess. In the last thirty years an immense stock of knowledge has been obtained as to soils and crops. It is stored in great numbers of volumes which line the shelves of our libraries, and there much of it rests undisturbed in dignified oblivion. In the main it consists of single threads followed out more or less carefully; only rarely does some more gifted worker show something of the great pattern which the threads compose. But even the most gifted can see but little of the design; the best hope of seeing more is to induce people to work in groups of two or three, each trained in a different school and therefore looking at the problem from a different point; each seeing something hidden from the rest. Unlike art, science lends itself to this kind of team work; art is purely an individual interpretation of Nature while science aims at a faithful description of Nature, all humanistic interpretation being eliminated. There is certainly sufficient good will among the leaders of agricultural science to justify the hope of co-operation; there are probably in existence foundations which would furnish the financial aid.

This leads to my last point. What is the purpose of it all? Team work, co-operation, the great expenditure of time and money now being incurred in agricultural science and experiment—these are justified only if the end is worthy of the effort. The nineteenth century took the view that agricultural science was justified only in so far as it was useful. That view we now believe to be too narrow. The practical purpose is of course essential; the station must help the farmer in his daily difficulties—which again necessitates co-operation, this time between the practical grower and the scientific worker. But history has shown that institutions and investigators that tie themselves down to purely practical problems do not get very far; all experience proves that the safest way of making advances, even for purely practical purposes, is to leave the investigator unfettered. Our declared aim at Rothamsted is "to discover the principles underlying the great facts of agriculture and to put the knowledge thus gained into a form in which it can be used by teachers, experts, and farmers for the upraising of country life and the improvement of the standard of farming."

This wider purpose gives the investigator full latitude, and it justifies an investigation whether the results will be immediately useful or not—so long as they are trustworthy. For the upraising of country life necessitates a higher standard of education for the countryman; and education based on the wonderful book of Nature which lies open for all to read if they but could. How many farmers know anything about the remarkable structure of the soil they till, of its fascinating history, of the teeming population of living organisms that dwell in its dark recesses; of the wonderful wheel of life in which the plant takes up simple substances and in some mysterious way fashions them into foods for men and animals and packs them with energy drawn out of the sunlight—energy which enables us to move and work, to drive engines, motor-cars, and all the other complex agencies of modern civilisation? No one knows much of these things; but if we knew more, and could tell it as it deserves to be told, we should have a story that would make the wildest romance of human imagination seem dull by comparison and would dispel for ever the illusion that the country is a dull place to live in. Agricultural science must be judged not only by its material achievements, but also by its success in revealing to the countryman something of the wonder and the mystery of the great open spaces in which he dwells.

Recent Work at Stonehenge.

By Lieut.-Col. WILLIAM HAWLEY.

CONSIDERABLE progress has been made during the last two years in the work of excavation which is being carried out at the site of Stonehenge, and although nothing giving any clue to the age and purpose of the monument has yet been discovered, many places in the area surrounding it have yielded matter of much interest and importance.

In order to find out the conditions of the Avenue and its relation to the place, an excavation of the ditch around the circular rampart was begun about 40 feet from where it would approach the south bank of the Avenue. The ditch was 6 feet deep where digging began, suddenly rising soon afterwards to a level 3 feet higher, but gradually returning to nearly the former depth as it went onwards. When the line of the Avenue bank was reached, there was no trace of it meeting the ditch, which passed on for about 25 feet beyond the spot and ended against a very upright bank of solid chalk about 5 feet high, widening and taking a roughly circular form with a flat bottom. An excavation, in the line of the ditch, made about 50 feet beyond this obstruction revealed a similar solid side. The intervening portion, which was 40 feet wide, proved to be a causeway of natural chalk which crossed the ditch and afforded an entrance to the circular enclosure. The ending of the ditch on the west was roughly circular like that on the east side, but here it formed a large wide pit 7½ feet deep communicating with another beyond it through a narrow opening. Both bore traces of fires at the bottom, and scattered around them were horn picks, bones of animals, and quantities of flint flakes.

The surface of the causeway was very remarkable as it was studded with 58 holes, more or less in regular lines, occupying the entire length and width of it. These were probably of the same age as the ditch, and with it seem to have been for defence and resisting combined attack, pointing to the place in its early history being one of defence.

In the entrance and in line with the rampart crest a large stone hole was found close to another previously excavated, the latter being the one the "Slaughter" stone is thought to have stood in.

Excavation afterwards included the portion of the Avenue between the entrance and the fence at the high road. The small side banks and ditches of it begin 10 feet from the main ditch, showing that the Avenue was independent of it and probably of later construction. Formerly it was believed that the Avenue entered Stonehenge, but it is now seen that the actual entrance was over the causeway, mentioned above, and only about half as wide. The Avenue is 70 feet wide where it begins, but the ditches are irregular in their alignment, carelessly dug, and of a variable depth of about 3 feet.

The ditches have a layer of silt upon the bottom, reaching half-way up, which contains nothing of the Stonehenge period, but the stratum over it does, so it might be inferred from this that the Avenue preceded Stonehenge by a considerable interval. Evidence of the Stonehenge period is gained from a stratum which varies from an inch or two to 15 inches in depth and is distributed with very fair evenness over the whole surface of the place. It contains the mason's chips and things that belong to and after that period alone, and therefore is a most useful guide for determining periods which precede and those which follow after the making of the monument, helping also to show that it is of Neolithic age. It has been necessary to make this digression in order that the context may be more clearly understood.

There were two large holes found near the Helestone, and there can be little doubt that they once held stones, and their filling of loose chalk was that which fell back when they were extracted. Over one of them there was a dump of nearly four thousand sarsen chippings and sandy debris, showing that a stone had been dressed on the spot, and no doubt taken from the hole and, after preparation, used for the monument. It seems from this that there may have been a certain number of rough sarsens already *in situ* here before Stonehenge was built. Each of the stones was 40 feet from the Helestone and suggest that a little group might have stood there independently of anything that might have been standing within the circle at the time.

A trench 4 feet wide was found around the Helestone, but only a part was excavated, as the remainder is covered by the high road. Like the small ditches, it had been half filled with silt, which had chips in the filling over it, but not in it, thus showing an earlier origin than Stonehenge.

Three large post holes occurred westward from the Helestone, with distances equally divided. They resembled those on the causeway and were certainly of early date, as the Avenue bank on the west covered two of them. The remainder of the Avenue was quite barren of anything of interest and had been much eroded by a medieval coach road and country traffic.

Excavation was afterwards transferred to the interior of the circular enclosure, and a systematic search began of the land within by cutting trenches in close succession over it from the rampart nearly up to the standing stones. Last year 107 trenches were opened and the N.E. quadrant accounted for, and this year it is hoped to complete the S.E. quadrant. The trenches were mostly over shallow ground and, on the whole, not very productive, but some of them certainly afforded places giving much information and interest.

The first line of trenches was directed towards the entrance at the standing stones, and, after proceeding a little way, holes were come to of a sharply cut, rectangular, oblong form, measuring about 5 feet long by 3 feet wide at the top, tapering in a wedge shape to a narrow bottom. These were found to extend in a regular succession in two rows around the outer circle, the holes of each new circle being exactly opposite standing stones. It was afterwards ascertained by sounding that similar cavities exist around the present outer circle, indicating that there were once two extra circles to the monument. For the sake of reference they have been called Y and Z circles. The first holes of the former began at 38 feet from the standing stones, and the latter 10 feet distant. Their side intervals are

regular but they are not concentric with the standing circle nor in relation to themselves. The distance from the outer circle gradually diminishes from where they begin at the entrance until No. 8 is reached, after which they take up the original distance; this applies to both circles. Some confusion was noted where the irregularities terminated; No. 7 hole had been only partly dug, and Z8 was found not to exist.

It can be clearly proved that these holes were made in the Stonehenge period, because the mason's chips were present in the filling and even upon the bottom. The first four holes excavated occur in the fairway from the entrance, and it may be safely said that they never held stones. Although dug for the purpose, consideration afterwards led them to leave the holes empty, as the stones would have been inconvenient in the fairway. Their sharpness and undisturbed condition showed there had been no insertion and extraction of stones; moreover, one of them contained five stag antlers and another a single antler, showing absence of stones. The other holes showed disturbances caused by extracting stones. Soil had fallen back, partly filling the holes, and over it was a more recent stratum bearing objects from the time of extraction to the present day. Romano-British objects were found in the upper stratum, and in one hole, about 18 to 20 inches from the top, there was dirty soil mixed with wood ashes and some natural flints arranged apparently as a temporary hearth, and on the same level were 42 pieces of a Romano-British pot. A little below this level were three pieces of fine, gritty pottery belonging to the "La Tene" period. This gives the impression that the stone was extracted at that time, and that spoliation on the site might have begun at quite an early date.

Where the irregularity occurred at No. 8, a considerable area was opened out to try to discover a reason for it, but with not much success. A great many post holes were met with, and, since then, a still greater number have been found extending from this spot towards the rampart, some of them taking the form of parallel lines; these are now in course of investigation. They are evidently of quite early date, as the Stonehenge stratum passes over them and they contain nothing of that period. Eleven of them, about 6 feet apart, formed a long row, the last two holes at one end having been united by digging to form a grave at a time when posts no longer stood there, the holes and loose matter affording less trouble in digging one. A skeleton found in it proved to be that of a person belonging to a long-headed race existing shortly before the Roman occupation. Owing to insufficient length and capacity of the grave (barely 3 feet deep) the remains were much crushed, but have nevertheless been reconstructed.

Remains of the Bronze age do not occur until after the erection of Stonehenge and are found in the upper stratum consisting chiefly of foot-worn fragments of pottery. With a cremation of that period there was found a beautifully ground and polished mace head of the "cushion" type. The stone is hornblendic gneiss and probably came from Brittany. Eight other specimens are known to exist of that type, now in collections, five of them coming from Scotland and three from the Thames and its neighbourhood, and they are regarded as ceremonial maces of that period. With another cremation a very fine bone pin 7 inches long was found. It had been burnt with the body and was much twisted by heat and broken in three places, but was easily mended. The cremated remains are usually found but a short distance below ground, most of them actually without cists in the loose chalk rubble at the foot of the rampart; sometimes the remains are found clinging to a turf when it is cut and turned over. This shows that the rampart conditions cannot have been very different then from what we see them now. The impression created during the continuance of excavation here makes one aware that a long succession of events is being dealt with which have covered a vast number of years. The silting of the main ditch alone is a proof of this. This process must have taken a very long time, for sometimes there are 6 feet of it and not a vestige of the Stonehenge era occurs in it, and is only met with as a narrow stratum below the turf and abruptly divided from it. Unfortunately, none of these matters have as yet given any information as to the date of the monument, but there is yet a great deal of ground to be opened, and by more time and diligent search it is hoped eventually to arrive at some clear conclusions.

Circumnavigation of the Earth by Aeroplane.

ON April 6, four U.S.A. aeroplanes left Seattle on an air voyage of circumnavigation of the world. Five months later, on September 6, two out of the four arrived at Boston. Flying took place on 48 days out of 153 days thus consumed. The actual flying hours were 288; the distance covered was 21,500 miles. About every third day on the average was therefore a flying day of 6 hours flying at 75 miles per hour, giving a flying day's run of 450 miles.

The flight falls naturally into four stages, floats being fitted for stages 1 and 3, wheels for 2 and 4. New engines were fitted at the start, and in Japan, at Calcutta, and at Hull. New wings were fitted at Calcutta, and numerous subsidiary repairs and replacements were carried out. Cruisers, supply ships, and flotillas of destroyers were employed in the improvised organisation along the sea routes. Existing permanent organisations were available along the land routes.

In stage 1 the route runs along the Pacific Coast of Canada and Alaska, and crosses the northern entrance of the Pacific Ocean by the Aleutian Islands; thence it runs by Kamchatka and Japan round the Chinese and Burmese coast to Calcutta. The Aleutian Islands, in which aeroplane No. 1 fell out, are subject to fogs, squalls and blizzards, the Chinese seas to typhoons, and the southern arc, Saigon—Rangoon, to tropical heats. There is no permanent airway organisation in the first part of this stage, and in the second part the Japanese, French and British organisations are not continuous. In this stage as a whole, flying took place only on 22 days out of 82, 11,000 miles being covered in 158 flying hours.

At Calcutta 4 days were spent in fitting new engines, new wings, and wheels for the overland stage Calcutta—

London. Leaving Calcutta on July 1 and arriving at Hull on July 17, the aeroplanes flew on 15 days out of 17, covering a distance of 6500 miles in 74 flying hours. The advantage of a permanent ground organisation is evident, and to this is added the inherent advantage of wheels over floats in both weight and air resistance.

At Hull 11 days were spent in overhauling the aeroplanes and in fitting new engines, and floats for the passage of the northern entrance of the Atlantic by way of the Orkneys, Faroë Islands, Iceland, Greenland and Labrador. Leaving Hull on July 30, and arriving at Boston on September 6, the aeroplanes flew on 11 days out of 39, 4000 miles being covered in 56 flying hours. Aeroplane No. 3 fell out between the Orkneys and Iceland. The remaining stage is from Boston via New York to Washington, thence due west to Salt Lake City, and so back to Seattle. Fitted with wheels, and using a homogeneous national air organisation, there is high probability that the two surviving aeroplanes will complete expeditiously the circumnavigation of the earth by air, except in so far as they are detained by the hospitality of their countrymen at the landing places.

In drawing technical conclusions from the flight, no account can be taken of the great personal effort of the pilots and mechanics in thus facing successfully every sort of condition along 24,000 miles of route, unknown to them. The quasi-sporting condition that the same aeroplane bodies should circle the earth albeit with new engines, wings and other parts is also irrelevant. In a strictly utilitarian organisation fresh machines and pilots familiar with the route would be available for each 5-hour stage, and two such stages a day would be feasible. When it is found possible to maintain permanent airway organisation along such regions as the northern entrances of the Atlantic and Pacific Oceans, it may become possible, flying 10 hours a day at 100 miles per hour, to circumnavigate the world by air in about 24 days as a matter of routine travelling.

Obituary.

Mr. Hartley Lupton.

BY the death on September 6 of Mr. Hartley Lupton, at the early age of thirty-two years, physiology has lost a research worker of great industry and promise, his pupils a teacher who won their respect by his care and keenness and their affection by his simplicity and kindness, his friends at Manchester and at University College, London, a generous and devoted colleague. For generosity, simplicity, and devotion were the keynotes of Lupton's life. Stricken with a fatal illness in June, he spoke continually of returning to his beloved apparatus in a few weeks. Only a month before his death, at a time of great discomfort and distress, he read with appreciation and delight the manuscripts of three papers shortly to appear in the Proceedings of the Royal Society, describing the results of three years of devoted work. Rarely, until his last illness had completely incapacitated him, was he absent from the laboratory: he arrived first in the morning, he left last at night; he was always ready for any new experiment, any new enterprise, any extra work.

Lupton had an extraordinary capacity for friendship with young men, a capacity which served him well as a tutor at Dalton Hall, Manchester, and later in his physiological research work, where he continually needed "subjects" for his experiments. All who knew him will recall the pleasant and humorous picture of Lupton engaged in some experiment on severe muscular work, either on himself or some friend whom he had induced to take (at any rate temporarily) a sufficient interest in physiology to act as the subject of his—often rather strenuous—experiments. His own personal devotion can be gauged from the frequent entry "Subject, H. L. postabsorptive" in his records.

Lupton obtained a first-class honours degree in physics at the University of Manchester: the outlook of the physicist remained with him in his later work, and led to the scrupulous accuracy which is seen in all the records of his observations. His first independent scientific task was the routine work with radium at the Manchester Royal Infirmary. His experience there led his questioning mind to ask for the reason why radioactive bodies should have the effect they do on living tissues: the next step was to decide to take a medical degree, and it was as a student of physiology that the present writer first made his acquaintance. His teachers soon realised that Lupton was a person of rather singular interests and capacity, and an early opportunity occurred of starting him on physiological research. Working for the Medical Research Council, he took up the study of muscular exercise in man, based on the results of recent investigations of the isolated muscle. The subject proved fertile beyond expectation, and the results of it are contained in several papers published in the *Quarterly Journal of Medicine*, the *Journal of Physiology*, and the Proceedings of the Royal Society. When he began this work, three years ago, little was known of the connexion between the physiology of the muscle and that of human muscular exercise. Three years of continual labour—years probably the happiest of his life, for he was never so happy as when "going all out"—have discovered and explored a new subject, the important one of the recovery process after muscular effort in man. To the physiological world the subject will remain, one may hope, associated with his name: to his colleagues it will always recall the unceasing devotion and the simple kindness of their friend. A. V. H.

Prof. B. I. Slovzov, professor of biochemistry in the University of Saratov, and later in the Medical School for Women, Petrograd, whose death is announced, was a pupil of A. Kossel and A. Danilevsky and is known mainly for his contributions to the study of tissue enzymes. Another Russian man of science who has died recently is Prof. N. P. Kravkov, professor of pharmacology in the Medical Academy, Petrograd. Prof. Kravkov was a pupil of Schmiedeberg, and his chief work was performed on isolated organs which he used mainly for investigating the action of drugs upon blood-vessels. His method of the isolated rabbit's ears for testing vasoconstrictor and vasodilator substances is known universally and used in every pharmacological laboratory. Lately he contributed interesting observations upon the coronaries of the human heart and the isolated human fingers. He had been interested in the past few years in the action of drugs in highly diluted solutions.

Current Topics and Events.

WE are glad to learn that Mr. Jowett, First Commissioner of Works, has now definitely refused to permit the sect of Latter-Day Druids, or "Church of the Universal Bond," to make use of Stonehenge for the burial of the ashes of their dead. In a letter to Lord Crawford, Mr. Jowett says, "I have decided that under no circumstances can any burials be permitted within the precincts of Stonehenge in the future." When the proposed desecration of the national monument became known, strong protests were raised against it, and in our issue of September 6, p. 364, we expressed the resentment generally felt in regard to the claims and intentions of the sect which contemplated such action. It would probably be difficult to prevent members of the sect from scattering ashes of certain of their dead members within Stonehenge, but we assume that no formal assembly for this purpose will be authorised. In his reply to a question in the House of Commons in July, Mr. Jowett said that no objection would be raised to the use of the national monument for the proposed burial of such ashes, provided that there was "no serious disturbance of the ground," and the sect announced that no such disturbance was intended, as there would be "nothing in the nature of an interment." It is not yet clear whether the sect may hold a service within the precincts of Stonehenge and formally scatter the ashes of their dead upon the ground.

AN interesting event took place at the house of the Royal Photographic Society, 35 Russell Square, on Saturday afternoon, September 13, when a memorial tablet to William Henry Fox Talbot was unveiled in the Library by Dr. G. H. Rodman, a past president of the Society. A distinguished company included Miss M. Talbot and Mrs. Stewart, grand-daughters of the distinguished investigator whose memory was honoured. Dr. Rodman, after referring to the historical collection of experimental apparatus used by Fox Talbot and presented by Miss M. Talbot to the Museum of the Royal Photographic Society, reviewed Talbot's photographic researches, which appear to have been commenced in 1834. In that year, on the lines of Schutze, Scheele, and Wedgwood, Talbot produced sun prints of lace and leaves on paper treated with silver nitrate and sodium chloride; in 1835 he secured an image on moist sensitised paper in the camera obscura on a bright day with an exposure of ten minutes. The results of his researches were communicated in 1839 to the Royal Society in two famous papers on photogenic drawing. In 1840, by the use of paper impregnated with silver iodide and gallo nitrate of silver, Talbot secured results in ten seconds. The process, which he termed the calotype process, was patented in 1841 after a means had been found to obtain positive prints from the negatives. Dr. Rodman paid an eloquent tribute to the value of Fox Talbot's contribution to science through these researches, upon which the modern practice of photography is based. The memorial, by Messrs. George and Fred Hawkings, consists of a finely modelled portrait of Fox Talbot, executed in bronze, with decorative surroundings upon a marble background, and bears the inscription—"William Henry Fox Talbot, 1800–1877. This Memorial was erected by public subscription of photographers, 1922."

THREE years ago, the Notgemeinschaft der Deutschen Wissenschaft was formed for co-ordinating all help received in Germany for the learned staffs of universities, technical high schools, and other institutions. The third report of this society has been issued and can be obtained from the offices situated in the Schloss, the former residence of the Kaiser, Berlin, C2 Schloss, Portal 3. It seems that 1923–4 was a year of very real need indeed; the period lasting until November 1923, when a very adverse rate of exchange existed, making foreign purchases impossible, was followed by a period of great want of money, making not only foreign but also internal purchases difficult. In 1923, the Reichstag made three grants of money, although it was not in a position to pay immediately. The most valuable of these was made in October and consisted of 500,000 gold marks (approx. 27,000*l*.). It was not possible to continue the programme of buying the most important journals published during the War until the fall in the mark had ceased. The sum of 46,000 gold marks (2500*l*.) was expended on the libraries of 23 universities, 11 technical high schools, and 300 larger institutions. Twenty-five copies of the Paris *Comptes rendus* had to supply all these institutions. Foreign periodicals were cut down to one-fortieth of pre-War supply, and journals in covers were circulated for two months at a time to the individual universities. It was only possible to buy sixty foreign books of average value 15 marks, for each institution, but this number was increased by gifts from Switzerland, Sweden, Norway, U.S.A., Spain, and Great Britain. During this period it was possible to publish 117 periodicals and 103 books in all fields of knowledge on the funds of the association. Many German firms helped the funds by providing apparatus for special researches. Hajime Hoshi, of Japan, provides 2000 yen monthly for the period of three years for chemical research. The General Electric Company of America provided 12,500 dollars, to which German electrical firms added 1250 dollars, for electrophysical research under a committee consisting of Planck, Laue, Franck, Haber, Nernst, and Wien. In all faculties it was possible to make grants to 100 people of 25 to 100 dollars for special researches and journeys. It is hoped that the financial situation this next twelve months will be such that Germany will be able to buy foreign periodicals and books and resume the international exchange of academic thought.

THE low temperature carbonisation of coal excites at the present time the widest interest. The intelligent member of the general public hears much of it as a solution of the smoke problem and that of the supply of liquid fuel. The truth is often difficult

to get, especially by those desirous of appraising the validity of inventors' claims. The information conveyed in a circular just issued by the Department of Scientific and Industrial Research will therefore attract widespread interest. The offer is made that the Fuel Research Staff of the Department will undertake to test, without fee, approved plant and processes for low temperature carbonisation, under certain conditions. Application must be made on forms obtainable at the offices of the Department, 16 Old Queen Street, Westminster, S.W.1. The gist of the conditions may be summarised as follows. Applicants are to furnish full information and facilities for prior inspection by officers of the Department to permit of a decision as to the justifiability of a test. If undertaken, the test will be made under the supervision of a member of the Fuel Research Staff. Applicants will have to provide all requisite facilities, including material, staff, labour and measuring instruments, considered necessary. Applicants may be represented during the test, but the decision as to duration and conduct of the test will rest with the officer of the Fuel Research Staff supervising. The Department reserves to itself the right to publish a report on the results of tests made.

NOT the least important of the departmental exhibits in the British Government Pavilion at the British Empire Exhibition, Wembley, is that illustrating the work of the Imperial Institute in promoting the use of little-known or new raw materials of the Empire. The exhibit directs attention to the principal branches of the Institute—the scientific and technical department, the technical information bureau, and the exhibition galleries—and illustrates by series of specimens and publications the nature of the work carried out by the departments and technical committees. A collection of British Empire timbers includes samples of little-known woods recommended for use in Great Britain by the Timbers Committee of the Institute and fully tested in the timber laboratory. The fibre exhibits include samples of cottons from Irak and Tanganyika, and an important exhibit of silk cocoons, reeled and thrown silk and fabrics woven therefrom, illustrates the endeavours of the Institute's Silk Committee to extend the production of raw silk within the British Empire. There is an interesting display of new materials suitable for paper-making, and of papers made from them. The investigations of plantation rubber, carried out in connexion with the Ceylon Rubber Research Scheme, are also illustrated. Other sections relate to the work on oil-seeds, essential oils, tobaccos, resins, tanning materials, and drugs; and there is a collection of economic minerals including tropical African coals; materials for pottery, brick, and cement manufacture, illustrated by specimens of products made from them at the Institute; and radio-active and other minerals. A free pamphlet describing the exhibits and the departments of the Institute has been issued and may be obtained at Wembley, or on application to the Director, Imperial Institute, London, S.W.7.

WE have received from Messrs. Thomas Firth and Sons, Ltd., a statement containing some of the essential features of their exhibit at the British Empire Exhibition. A very wide range of products has been gathered together. Firth's stainless steel is now so well known amongst engineers that considerable attention will doubtless be focussed on this branch of their manufactures. A selection of many different types of turbine blading is shown, including twelve blades removed from a 2000 KW. Westinghouse turbine (steam pressure 200 lb., superheat 200° F.). Nine of these are of 5 per cent nickel steel, the remainder are of Firth's stainless steel. The actual hours run were 12,809 in six cases and 29,989 in the remainder. All the nickel steel blades show very marked signs of erosion, being very rough and pitted; the edges also show distinct signs of fraying. Those which have given longest service are quite worn out. The stainless steel blades, on the other hand, are as bright and as unaffected as the day on which they were inserted; the edges retain their initial sharpness and no signs of wear are apparent anywhere. Turbine engineers will doubtless take note of this remarkable difference in properties. A pump rod of similar steel which has been in use in an ammoniacal liquor pump is also shown. The life of carbon steel rods is never more than about six months. The stainless steel rod is worn only about $\frac{5}{64}$ths of an inch. Moreover the surface is smooth and polished and not badly scored as it is in the case of carbon steel rods. A rake end is shown which has been in use in a roasting furnace for treating zinc concentrates containing 28-30 per cent. of sulphur. This has already been in use for three months, whereas the total life of a similar article made of mild steel is only three weeks. Various other products are shown which indicate the superior service given by Firth's stainless steel.

THE *Weather Map* of the meteorological service of the Dominion of Canada for July has recently been received. It shows the mean temperature and the total precipitation for the month, and graphically the difference of temperature from the normal and the comparative amount of rain over the whole of Canada. Part of July was exceedingly hot in southern British Columbia and very warm in the North-western Provinces. There was a deficiency of temperature amounting to 4° F. or more in eastern Manitoba, northern Ontario, and north-eastern Quebec. The precipitation varied considerably in different parts. The Edmonton district of Alberta and parts of Manitoba, as well as the northern coast of the Pacific, received from 4 to 6 inches or more of rain; some regions in Quebec had more than 5 inches. In the maritime provinces the general average was less than 2 inches. On the southern coast line of Nova Scotia, moisture from abundant fogs mitigated to some extent the drought, where rivers and streams are said to be very low and wells are drying up. At the back of the *Weather Map* the highest and lowest temperatures and the precipitation, with brief comments on the weather and the state of the crops, are given for each station, the latter being of considerable interest generally.

THE first conference of the Pathological and Bacteriological Laboratory Assistants' Association was held on September 1-5, in the Department of Pathology of the University of Edinburgh. The attendance was exceedingly good, there being members present from all parts of Great Britain and also from Africa. The local organisation was in the hands of a committee appointed by the Scottish Division of the Association. Lectures and demonstrations in laboratory technique were held, an exhibition of laboratory work and apparatus was on view, and places of interest in and around Edinburgh were visited. Members of the Scottish Division of the Association were responsible for the exhibition, while the London Division showed objects of tropical interest and demonstrated specimens illustrating the life history of parasites and their insect hosts. At the dinner on Friday evening, September 5, the president, Prof. A. E. Boycott, made the presentation of the first Woodhead medal to Mr. Albert Norman together with an address. This medal has been established by means of funds collected among members of the Association in memory of the late Sir German Sims Woodhead. In all, 141*l.* has now been received and the subscription list is soon to be closed. According to the regulations governing the award which have now been drawn up, it is to consist of a prize and medal, the former being open to members of the Association only. Awards may be made annually or at longer intervals at the discretion of the Memorial Committee.

IT is stated in *Science* that Dr. E. S. Dana, emeritus professor of physics and curator of mineralogy at Yale University, has been elected a corresponding member of the Vienna Academy of Sciences.

APPLICATIONS are invited from honours graduates in physics or electrical engineering for two junior assistantships in the National Physical Laboratory, Teddington. The necessary form of application may be had from the Director of the Laboratory, and returned to him not later than September 27.

THE autumn presidential address to the Radio Society of Great Britain will be delivered at 6 o'clock on Wednesday next, September 24, at the Institution of Electrical Engineers, by Prof. W. H. Eccles, who will deal with the latest developments of the position of the scientific amateur under the Wireless Telegraphy Regulations.

THE twenty-first anniversary of the School Nature Study Union will be celebrated on Saturday, September 27, in the Common Rooms of the London Day Training College, Southampton Row, High Holborn. There will be a reception by the president, Dr. P. Chalmers Mitchell, and an address by Mr. G. H. Gater, Education Officer, London County Council. The general secretary of the Union is Mr. H. E. Turner, 1 Grosvenor Park, Camberwell, London, S.E.5.

APPLICATIONS are invited for appointments as temporary assistant chemists at the Government Laboratory. Candidates must possess the degree of B.Sc., with not less than second-class honours or equivalent, and should have, if possible, experience in investigative work. A form of application is obtainable from the Government Chemist, Clement's Inn Passage, W.C.2. The latest date for its return is September 30.

THE twenty-eighth autumn fungus foray of the British Mycological Society will be held at Bettws-y-Coed, N. Wales, on September 22-27. Mr. J. Ramsbottom will deliver his presidential address, entitled "The Taxonomy of Fungi," on September 24. Other papers to be read at the meeting are by Dr. Harold Wager on an aldehyde reaction in the tissues of fungi, and by Mr. A. W. Bartlett on a new species of Urophlyctis producing galls on *Lotus corniculatus*. Particulars of the foray can be obtained from the General Secretary of the Society, British Museum (Natural History), London, S.W.7.

THE Riga correspondent of the *Times*, in a message dated September 12, states that news had been received from Moscow announcing the arrival at Urga, Mongolia, of Mr. Roy Chapman Andrews, leader of the Third Asiatic Expedition of the American Museum of Natural History, who is seeking permission for the exploring and excavating work which it is proposed to carry out in 1925. This seems to dispose of the fears which were entertained in New York as to Mr. Andrews' safety. It was known there that he was on his way from Peking to Urga, and some anxiety was felt in view of the political disturbances which have been reported recently in Urga.

A LARGE individual of the loggerhead turtle, a tropical and sub-tropical species, was found alive near Dunvegan, Skye, on December 13, 1923. In recording its occurrence (*Scottish Naturalist*, 1924, p. 99) Dr. James Ritchie states that it measured 4 ft. 5 in. in length, weighed 309 lb., and was a female. It contained more than 1000 eggs, and is being mounted for exhibition in the Royal Scottish Museum, Edinburgh. Previous occurrences of the loggerhead turtle in Scotland date back to 1861, when two or perhaps three young specimens were found on the mainland about the same time; a small individual, recently dead, was washed up on North Uist in 1898.

THE British Research Association for the Woollen and Worsted Industries announces the following awards for the year 1924–25: Research fellowships to Mr. R. Burgess, of Nottingham, to enable him to continue his research at the University College, Nottingham, on the bacteriology and mycology of wool; and to Mr. J. E. Nichols, of Edinburgh, to conduct research at the Animal Breeding Research Department of the University of Edinburgh on the relationships between the wool fibres of various breeds of sheep: an advanced scholarship to Mr. H. Maldwyn Williams, tenable at the Scottish Woollen Technical College, Galashiels.

THE following awards for the year 1924–25 have been made by the Salters' Institute of Industrial Chemistry and approved by the Court of the Company:—Fellowships are renewed to Dr. W. G. Sedgwick, Armstrong College, Newcastle-on-Tyne, and Oxford, Fellow, 1923–24, and to Mr. W. Randerson,

Imperial College of Science and Technology, Fellow, 1922–23, and Hon. Fellow, 1923–24 (during tenure of Albert Kahn Travelling Fellowship). Fellowships are awarded to Mr. H. H. Evers, University of Liverpool; Mr. K. Knight Law, University College, Nottingham; Mr. H. S. Pink, University College, Nottingham, and Oxford; and Mr. V. E. Yarsley, Birmingham University. The Salters' Institute has also awarded seventy-two grants in aid to young men and women, employed in chemical works in and near London, to facilitate their future studies.

DURING the forthcoming winter, Mr. H. V. Garner, the guide demonstrator of the Rothamsted Experimental Station, Harpenden, will be available for lectures to Chambers of Agriculture and Horticulture, Farmers' Clubs, Agricultural Societies, etc., on the Rothamsted experiments in regard to the manuring of various crops, the management of farmyard manure, and on chalking and liming. For Students' Societies and similar bodies, lectures could be arranged dealing with the field and laboratory work at Rothamsted. No fee is charged for Mr. Garner's services, but any association engaging him would be expected to defray travelling expenses. All communications regarding lectures should be addressed to the Secretary, Rothamsted Experimental Station, Harpenden.

THE next meeting of the American Association for the Advancement of Science is to be held at Washington on December 29–January 3, and local committees have been appointed. Great efforts are being made to deal with the question of wide publicity for the meeting. Authors of papers are being asked to prepare abstracts of their contributions, and Science Service is again to co-operate with the Association's publicity committee in preparing material for the Press. The meeting will open with the address of the retiring president, Dr. C. D. Walcott, and it is hoped that the President of the United States will also address the Association and the associated societies. Another general meeting will be held on December 31, when Prof. A. S. Eddington will speak on "Relativity." In connexion with the meeting, an exhibition of scientific apparatus, methods, books, and products is being arranged as in previous years. Reduced railway fares have been arranged for members of the Association travelling to Washington from any part of the United States, or from places in Canada east of and including Armstrong, Fort William, and Sault Ste. Marie, Ont.

A DIRECTOR of research is required for the Forest Products Research Laboratories of the Department of Scientific and Industrial Research which are being provided to deal with pure and applied scientific research called for by the practical needs of the using industries and departments of state. The researches will be specially concerned with home-grown and Empire-grown timbers and other forest products. Candidates should possess good scientific qualifications, and a broad experience of the origin and use of forest products. Width of knowledge in forest economy, in the technology and practical problems of the wood-using industries, and in the bearing on these problems of scientific and industrial research, is considered of first importance. The latest date for the receipt of applications (which should be sent to the secretary of the department, 16 Old Queen Street, Westminster, S.W.1) is December 1.

Our Astronomical Column.

MERCURY A MORNING STAR.—Mercury will reach its greatest elongation west (17° 52′) on September 27 and be favourably visible as a morning star. The planet may be seen shining over the eastern horizon about an hour before sunrise. Its position will be in Leo, about 28° E.N.E. of the brilliant planet Venus. On the day of its elongation the planet will rise at $4^h\ 12^m$ A.M., G.M.T., or $1^h\ 43^m$ before the sun.

Apart from the morning stars—Mercury and Venus—the zodiacal light will be strongly visible on clear mornings towards the end of September and the beginning of October, when the moon will not offer any impediment to observation.

STUDIES OF ALGOL VARIABLES.—Studies of the details of the light-curves of these variables, combined with spectroscopic measures of their radial velocities, are of importance from the information they give about stellar masses, diameters, and the degree of darkening of their limbs from atmospheric absorption. Mr. R. S. Dugan is undertaking an extensive investigation of their light-curves by photography at Princeton University Observatory. No. 6 of the Contributions of the Observatory contains researches on five variables. SZ Herculis is interesting from the slight degree of limb-darkening; the slight loss of light at secondary minimum, and the considerable masses, 4·6 and 1·4 of the sun, the spectral types being B8, B9. R Canis Majoris is the only naked-eye star among the five, its normal light being 5·3 mag., and the loss of light at primary and secondary minimum, 0·56 and 0·06 respectively. The masses are small: assuming a mass-ratio of 3 to 1, they are 0·14 and 0·05 of the sun; the spectral type of the primary is FO. Two of the five stars, Y Camelop and RY Aquarii, give indications of limb-darkening. The most conspicuous loss of light at secondary minimum is that of SZ Herculis, 0·24 mag., as compared with 1·83 at primary minimum.

ENCKE'S COMET.—Several photographic positions of this comet were obtained in August by Mr. G. Merton with the 30-inch reflector at Greenwich. They indicate that the date of perihelion will be close to Oct. 31·437 G.M.T., which is 0·008 day later than that predicted by L. Matkiewicz. The comet should be an easy telescopic object at the end of September. The following ephemeris by Matkiewicz is for Greenwich noon.

	R.A.	N. Decl.	log r.	log Δ.
Sept. 21.	$8^h\ 1^m\ 32^s$	35° 12′		
,, 23.	8 20 52	34 12	9·9699	9·8918
,, 25.	8 40 25	32 57		
,, 27.	8 59 58	31 28	9·9372	9·8810
,, 29.	9 19 21	29 46		
Oct. 1.	9 38 23	27 51	9·9004	9·8782
,, 3.	9 56 54	25 44		

Research Items.

ABORIGINES OF THE MALAY PENINSULA.—In vol. xii, pt. 1 of the Journal of the Federated Malay States Museums, Mr. Ivor H. N. Evans gives an account of an expedition to Mt. Gunong Benom, Pahang, undertaken in March and April 1923 for the purpose of verifying a statement made by Wilkinson in the 1911 Census Report that "the wild tribes on Gunong Benom spoke a distinct dialect of their own . . . and it is not possible at present to say whether this distinction is accompanied by any racial or cultural differences." As a result of his investigations, Mr. Evans is doubtful whether the census enumerators visited the mountain or induced the inhabitants to come down from it. He himself was unable to find any traces of aborigines or of their occupation, and, with the exception of two Sakai-Jakun, no aborigines were found on the western side. On the way down to Kuala Krau an aboriginal settlement was reached at Galong, near Kuala Krau, and the inhabitants there, who were Jakun speaking a Sakai dialect, informed him that there were no aborigines on Gunong Benom, though Negritos (Batek) of Ulu Cheka visited it to collect Ipoh poison. Mr. Evans also obtained information of two divisions of aborigines on the Lompat river, of whom one, the So-ben, is very wild, lives in shelters, does not cultivate the soil, and uses stone knives for cutting and splitting wood.

THE ART OF THE PAL EMPIRE IN BENGAL.—In a communication to the Royal Society of Arts which is published in the Society's Journal of August 22, Mr. J. C. French points out that the mounds which mark its buried cities and its art are the only relics we possess of the Pal dynasty. This dynasty reigned in Bengal from the eighth to the eleventh centuries of our era, when it was overthrown by the Sena dynasty —an event which marked the decline of Buddhism and the establishment of a new caste system. The rise of the Pal dynasty with the first king Gopala, described as "sea-born," ended a period of anarchy. The art of this early period was marked by simplicity, dignity, and an immanent sense of life and vitality. In the succeeding reign of Devapala flourished Dhiman and his son Bitpala, the only two artists whose names have been preserved. They founded the Eastern School and the School of Magadha respectively. Early in the eleventh century, Pal art had reached its zenith and began to show signs of decline in its more florid style. In the orthodox Brahmanical period which succeeds the Pal dynasty, the art is harder, stiffer, and more conventional, with over-elaborated decoration. The inspiration of the artistic representation of orthodox Hindu deities in the earlier period would appear to be derived from Buddhism and to have declined with it. The importance of the art of the Pal Empire, notwithstanding its local character, lay in its influence on other, and also on later schools of Indian art.

THE BRACHYCEPHALIC SKULL.—Prof. F. G. Parsons has published the results of his study of the brachycephalic skull by means of dioptographic sketches and by the method of reduction of a series to composite sketches from three points of view, together with the detailed measurements, in the Journal of the Royal Anthropological Institute, vol. 54, Pt. 1. It would appear that the length of the dolichocephalic skull depends upon increased growth in its posterior part, while the greater breadth of the brachycephalic skull is due to growth in its temporal regions. The short European skull is usually more prognathous than the dolichocephalic skull. It is also more broad-nosed, and its orbital height is not so great when compared with the whole area of the face. Both as regards width and height, the orbital measurement would appear to be of considerable racial importance; in the Nordic race the orbit is very high, while in both the Mediterranean and the Long Barrow races it is very low. In the brachycephals it comes between, but is closer to the Long Barrow race than to the Nordic.

THE GREAT BARRIER REEF.—The first report of the Great Barrier Reef Committee of the Royal Geographical Society of Australasia is published in the Queensland *Geographical Journal* (vol. xxxviii.). The work of investigation included in this report was mainly of a general nature, but it indicates some of the problems which it is hoped to solve. Attention was particularly devoted to those parts of the reef between Cairns and Thursday Island. Attention paid to the form and size of cays and reefs fully confirmed previous ideas as to the influence of the prevailing south-east wind in developing the forms of coral debris along stream lines more or less parallel to the direction of the wind. Observation did not confirm the contention of Agassiz that "nigger heads" are proof of recent elevation. It appears more likely that the occurrence of these masses of coral is due to the action of hurricanes which tear off portions of the growing reef and wash them to leeward. Another problem of great interest is the origin of the openings through the outer Barrier. The committee discards the theory that these openings mark old entrances to the sea of the present coastal rivers. The evidence rather points to their being coastal valleys of the foundered strip on the edge of which now exists the Great Barrier Reef, although many of the drowned valleys have been silted up to a considerable extent. The sediment from the coastal streams being deposited in the depths of the drowned regions, prevents coral growth in these areas.

GEOCHEMICAL DISTRIBUTION OF THE ELEMENTS.—The distribution of the elements in the earth, considered from the geochemical point of view, is the subject of a series of three papers issued recently by Prof. V. M. Goldschmidt, of Christiania, under the title "Geochemische Verteilungsgesetze der Elemente" (Videnskapsselskapets Skrifter, I., Mat.-Naturv. Klasse; 1923, No. 3; 1924, Nos. 4 and 5.) He regards the earth as having been originally gaseous or molten. On cooling, it passed through a stage in which there were three fluid phases consisting of metal, sulphide and silicate. These three different kinds of molten material separated according to gravity, giving a concentric arrangement, with the metal at the core, next a shell of sulphide matter, and outside this a shell of silicate, around which there was a cover of vapour and gas. The silicate shell separated by crystallisation into heavier and lighter parts, gases escaping from it in the process. In accordance with this supposed differentiation of the materials of the earth into four phases during the process of cooling, he divides the chemical elements into four corresponding main groups, namely, (1) siderophils (Fe, Ni, Co, P, C, Mo, Pt, etc.); (2) chalcophils (S, Fe, Cu, Zn, Cd, Pb, As, Sb, Bi, Ag, Au, Hg, Pd, etc.); (3) lithophils (O, Si, Ti, Zr, Th, F, Cl, Br, I, B, Al, Y, La, Ce, Li, Na, K, Be, Mg, Ca, Sr, Ba, V, Cr, Mn, Nb, W, Sn, etc.); and (4) atmophils (H, N, He, Ne, A, etc.). A further separation of the elements is effected by later differentiation in the lithosphere, during the course of which any residual chalcophils aggregate as sulphide deposits, while

residual atmophils find their way into the atmosphere. According to their isomorphic relationships with the commoner lithophils, the rarer lithophils can be divided into three sub-groups, namely, (1) elements of the first crystallisation, isomorphic with trivalent iron and magnesium, *e.g.* chromium, vanadium, and nickel; (2) elements of the chief crystallisation, isomorphic with potassium, calcium and aluminium, *e.g.* rubidium, strontium and in part scandium; (3) elements of the residual crystallisation, which are non-isomorphic or only weakly isomorphic with the commoner lithophils, *e.g.* lithium in part, boron, niobium, thorium and lanthanum. In the second paper Prof. Goldschmidt deals with the geochemical distribution of the elements in relation to the structure of the atom, while in the third paper he deals with the distribution of the rare-earth metals among minerals.

Weather in West Indies.—A summary of the weather in the West Indies and surrounding neighbourhood for 1923, prepared by Mr. Oliver L. Fassig, Meteorologist in Charge, has recently been published under the superintendence of the Weather Bureau of the U.S. Department of Agriculture. The rainfall was generally deficient, and the annual total was between 25 and 35 per cent. below the normal in Jamaica, Santo Domingo, and Porto Rico of the Greater Antilles, and Dominica and Martinique of the Lesser Antilles. In Porto Rico the total for 1923, 51·63 in., was the smallest recorded in the past 25 years. Rainfall was continuously below normal, over the section as a whole, from January to September and in November. For the three consecutive years—1921, 1922, and 1923—the aggregate deficiencies in rainfall for the area as a whole amounted to 40 inches, and rainfall above the normal was recorded only in 8 months out of 36. Although 1923 was exceptionally dry, October was conspicuous for the frequency of torrential rains. Temperatures during the year were generally slightly above the normal for the area as a whole. The region of the West Indies and Caribbean Sea was remarkably free from cyclonic disturbances. A few errors have crept in, and among those noticed are the statement in the general summary, p. 97, that the October temperature was below the normal; the month clearly should be April. On p. 105 the sea-water temperature at Balbao in the Panama Canal Zone for August is given as 93·1° F., which is clearly 10° too high, and the March temperature given as 69·3° is presumably 10° too low. Monthly Reports are regularly published, based on a large number of observations. These contain, in addition to the ordinary meteorological observations, details of earthquakes which are not summarised in the Annual Report.

Insectan Palæontology.—Entomologists have been following with keen interest Dr. R. J. Tillyard's series of papers on the Mesozoic Insects of Queensland, appearing since 1916 in the Proceedings of the Linnean Society of New South Wales. In his latest contribution to the subject (*l.c.* xlvii. pt. 4) Dr. Tillyard describes further insect remains from the Upper Trias of Ipswich, Queensland. These include a Protorthopteron apparently allied to members of the Upper Carboniferous fauna of Europe, as well as several species of Orthoptera, Odonata, Hemiptera, Neuroptera, and Coleoptera. Among the Hemiptera, both Homoptera and Heteroptera are included, the most noteworthy discovery being a new genus, Triassocoris, belonging to the Cryptocerata—that section of the bugs which comprises our familiar Nepa (water-scorpion) and Notonecta (water-boatman), as well as the large tropical Belostomatidæ to which Triassocoris, though smaller, is nearly allied. In another paper (*l.c.* pt. 3) Dr. Tillyard describes some Permian insects collected at Belmont, New South Wales, by Mr. J. Mitchell. These fossils are of very great importance, as they prove that the late Palæozoic Australian insect fauna included metabolic insects belonging to the living orders of the Mecoptera and the Neuroptera Planipennia, as well as to the extinct Paramecoptera. Dr. Tillyard suggests that this ancient assemblage of insects was part of "a fauna developed in association with the fern *Glossopteris*, in which primitive scorpion-flies took the place of the cockroaches dominant in the Carboniferous and Permian of the Northern Hemisphere." He comments on the comparatively high organisation of these oldest known Australian insects, believing that they immigrated into that region long after the more primitive types had been established in the European area. Two recent short papers by Dr. Tillyard are of interest on account of the remarkable conditions under which the insect-wings described were found. A long-horn grasshopper, probably of late Tertiary age, is represented by a wing-fragment embedded in a large crystal of selenite, enclosed in the actual copper lode worked by the Mount Elliott mine, North Queensland (*Rec. Geol. Soc. N.S. Wales*, x. pt. 2). A new genus of dragon-fly is described (*Geol. Mag.* lx., 1923, No. 706) from wing-fragments discovered by Mr. R. May, of Cambridge, in the matrix of the shell-cavity of an ammonite of Upper Jurassic (Corallian) age, which, washed out of its proper bed, was found in the Boulder Clay of Hertfordshire.

Mechanism of Photosynthesis.—Jaroslav Peklo (*Chem. News*, 129, 1924, pp. 91-94) recently advocates the adoption of Willstätter's scheme as to the rôle of catalase in photosynthesis. The arguments are based on the effect of potassium cyanide on the rate of liberation of oxygen in photosynthesis. This substance (and also hydrogen sulphide and phenylhydrazine) exerts a paralysing effect on catalase action, but not on all other enzyme reactions. The immediate stoppage of photosynthesis on treatment with potassium cyanide is therefore held to show that catalase takes some intimate part in photosynthesis and hence to prove that Willstätter's view is correct.

Fruit Production in Cacao.—In the *Tropical Agriculturist* (lxiii., 1924, pp. 22-26), Prof. S. C. Harland outlines the results of some interesting experiments in Trinidad on the fruit yield of vegetatively propagated cacao plants. A striking feature of the results is the fact that there is no connexion between the average yield of the parent plants and that of their budded offspring. Thus the practice of taking buds from parents of high fruit-setting power apparently has no experimental justification. The author points out that this result is probably paralleled by similar experiments on apple, cotton, and rubber, and he suggests that the ultimate yield of the budded tree must depend not only on the quality of the buds but also on that of the stock on which they have been incorporated.

A High Vacuum Pump.—Report No. 62 of the Research Department, Woolwich, emanates from the Radiological Section and describes a new glass mercury condensation pump for the production of high vacua, designed by Dr. Gilbert West, which has been in use in the Department for some time and is easy to make and clean. The mercury is contained in a glass flask with a long neck, which is kept cool by a water jacket surrounding it. The upper end of the neck is connected to the auxiliary pump, which provides a pressure between an eighth and a thousandth of an atmosphere. A side tube enters the neck

at the lower end of the cooled portion and is bent upwards so as to be within the cooling water jacket. The upper end of this tube is connected to the vessel to be evacuated. The mercury is heated to about 150° C., at which it has been found the pump as designed gives the best results. The vacua obtainable are only limited by the evolution of gas from the walls of the vessels evacuated, and the rate of evacuation is high.

METALLURGICAL MICROSCOPES.—A new catalogue and price list of metallurgical microscopes, outfits, and accessories has recently been issued by Messrs. James Swift and Son, Ltd., of 81 Tottenham Court Road, London, W.1. The microscopes described have been designed specially for metallurgical work, and include the well-known Jackson-Blount model and the Inverted Metallurgical Microscope. In the latter, the design of which is due to Le Chatelier, the objective points upwards and is immediately below the stage on which the specimen is placed. By reason of this design, the necessity for grinding the object parallel or mounting it in wax or using a levelling stage is obviated. The present model is provided with a commodious stage and improved focussing adjustments. The illuminator fitted to both these types of microscopes has a reflector which can be adjusted in and out across the optic axis and can also be tilted simultaneously in two azimuths at right angles to each other, thus allowing efficient and uniform illumination to be obtained. The instruments, optical equipment, and accessories included in the catalogue cover the full needs of the metallurgical microscopist engaged either in regular routine work or in original research.

ELECTRICAL CONDUCTIVITY AND BOHR'S THEORY OF ATOMIC STRUCTURE.—The maximum conductivity of the elements occurs, according to Vegard, when a new electron is added to the structure in a new orbit. Herr O. Feussner, in the *Zeitschrift für Physik*, July 12, gives a table showing the probable electronic structure of elements which are not included in that of Bohr, and compares the combined tables with the graph showing the connexion of conductivity with atomic number. Maxima are found in the case of the alkali metals, including cæsium and rubidium, in which a single electron circulates in the highest orbit group, and the configuration of the inner electrons is that of the preceding inert gas; there are also maxima for Cu, Ag, and Au; the relation between the electron orbits of Cu and the preceding element Ni is assumed to be as follows:

	1_1	$2_1 2_2$	$3_1 3_2 3_3$	4_1
28 Ni	2	4 4	6 6 6	—
29 Cu	2	4 4	6 6 6	1

or very similar to that between the orbits of potassium and argon; a similar relation holds between Ag and Au and the metals which precede them in the table. It is true that the same relation holds for Co and the preceding element Fe, though Co does not show a relative maximum of conductivity. Vanadium is an example of an element with one electron in a 4_1 orbit, which does not show a maximum; it has 12 electrons in the *M* group, while titanium, the preceding element, has 10, and two in the *N* group (4_1); such elements show no maximum. Cr, Mo, and W have relative maxima, though the most probable number of electrons in the orbit group with highest principal quantum number *n* is two. It has been suggested that an examination of the spark spectrum of Cr would decide whether there are one or two electrons in the *M* group.

EVIDENCE OF INTRA-ATOMIC FIELDS IN SPECTRA.—The effect of strong electric and magnetic fields on the mercury spectrum has recently been described in a paper by Messrs. Hansen, Takamine, and Werner (Det Kgl. Danske Viden. Sels., Math.-Fys. Medd. v. 3). The primary object of the investigation was to see if the lines, $1S - 2p_1$ and $1S - 2p_3$, which are forbidden by the selection principle, could be produced under magnetic or electric influence. It was found that while the former was excited in considerable intensity by condensed discharge, the latter could not be produced at all. The general effect of the electric field was the production of new combination lines, of which the relative intensities, state of polarisation, and displacements in the fields were measured. The general features of the effects were in close agreement with the quantum theory of spectra. Some time ago Dingle pointed out that the spectrum of the flame-arc of mercury in vacuum contained lines of the type $2p - mp$, which are disallowed by the selection principle, and Takamine, in a further paper (*Japanese Journal of Physics*, vol. ii., Nos. 3-5), surmising that the explanation lay in the close gathering of the atoms in the narrow flame so that the intra-atomic electric fields came into play, describes further experiments with a vacuum arc provided with a constriction. The spectra of mercury, zinc, cadmium and thallium were examined. It was found that, at the constriction, many lines normally forbidden by the selection principle were produced. The similarity between the broadening of the lines at the constriction and that produced in the Stark effect led to the conclusion that the appearance of the forbidden lines was actually a Stark effect due to the intra-molecular electric field coming from the close gathering of ions and electrons at the constriction.

THE IRON SPECTRUM.—In the *Japanese Journal of Physics*, vol. ii., Nos. 1-2, Messrs. Nagaoka and Sugiura describe some interesting investigations of the iron spectrum, made with the view of detecting regularities in the arrangement of the lines. The lines were sorted into groups by observing their behaviour in an electric field, the simplest of the effects thus produced being "the enhancement of lines with small displacement towards shorter wave-lengths." Lines affected in this way were found to form triplets, quartets, sextets, and sometimes more complex groupings, all of which were similar to the Zeeman patterns ordinarily formed by the components of single lines when produced in a magnetic field. This suggested that the lines were actually Zeeman components, produced by the strong intra-atomic magnetic fields of the atoms. The separations in the groups—which varied, in groups of the same type, over a considerable range—amounted in some instances to several hundred units of wave number. For example, there are six quadruplets in which a separation having a mean value of 362·9 occurs: the individual separations range from 354 to 372. From the ordinary expression, $\Delta\nu/H = 4{\cdot}7 \times 10^{-5}$ gauss^{-1} cm.$^{-1}$, this gives, on the assumption mentioned, an intra-atomic field of 7×10^6 gauss—in close agreement with the value deduced by Weiss from his experiments on the magnetic quality of iron at high temperatures. One difficulty facing the hypothesis is the fact that the lines in question are themselves decomposed by an external magnetic field, whereas they would be expected to be merely displaced if they were already magnetically produced components of lines. It is remarked also that sometimes one and the same line enters into several different groups. The authors suggest that the intricate nature of the spectral lines of ferro-magnetic metals may ultimately be traced to the existence of intra-atomic fields.

Food Preservatives and their Action.

UNDER modern conditions of civilisation, the question of supplying food to large numbers of people who live at a distance from the actual areas of production, has assumed an importance which can scarcely be overestimated. The problem has been attacked along two lines: first, by means of quicker and more efficient transport; secondly, by the introduction of preserved foods, including under this term both those which are sterilised by heat and also those preserved by exposure to low temperatures. Owing to the loss or partial destruction of certain accessory food factors during the process of preservation, it is essential that fresh food, especially vegetables and fruit, should be available for general use, and this is largely ensured by means of efficient transport between producer and consumer. On the other hand, certain articles of diet, especially meats, which must be transported long distances, must undergo some treatment to keep them in a condition fit for human consumption, and there is no doubt that the most suitable method to employ is one which ensures sterility and its maintenance during transport: thus the meat, after *efficient* sterilisation by heat, may be tinned and kept sealed from the air, or it may be chilled or frozen, the low temperature preventing any microbic or similar growth.

Unfortunately, simple chilling of meat at a temperature just below freezing point will not prevent deterioration on a long voyage: freezing at a temperature of 10° F. is, however, successful, but the meat does not compare so favourably with fresh meat. It has, therefore, been suggested that the process of chilling might be supplemented by the addition of a chemical preservative or antiseptic when meat has to be conveyed long distances before consumption. The substance which has been used commercially to a small extent in this connexion has been formaldehyde, and the question at once arises as to the effect of this substance upon the human economy. In the Interim Report of the Food Preservatives Committee,[1] recently published, the use of formaldehyde as a food preservative is considered, both from a general point of view and also with particular reference to the carriage of chilled beef. The Committee is unanimous in condemning its use, both with regard to its effects on the consumer himself and also from the fact that it can be used to conceal incipient decomposition, without, of course, thereby rendering the food fit for human consumption.

Formaldehyde acts as an antiseptic since it is a powerful protoplasmic poison: its action is, however, not specific for micro-organisms only, but it also reacts with human tissues, combining with the proteins: thus its excretion is slow and so its action is probably cumulative. When ingested it irritates the mucous membranes with which it comes in contact, and after prolonged use may cause inflammation of the liver and kidneys. It also combines with the proteins of foods, thus rendering them less digestible. In spite of these drawbacks, its use might perhaps have been thought less objectionable in the case of chilled meat, where the carcasses, after being placed in the refrigerating chamber, are exposed for a short time only to the action of the formaldehyde in the form of vapour; the air in the chamber is circulated by fans, and after about half an hour the vapour is removed by a current of fresh air.

In these circumstances it might have been supposed that any organisms on the surface of the carcasses would be killed and the meat remain fresh at a temperature just below the freezing point. Apart from the fact that the process is uncertain in its action owing to the uneven distribution of the vapour in the chamber, its success also seems to depend on the cleanliness with which the meat is handled before it is put into the chamber. These considerations tell against the method, and when it is also found that traces of formaldehyde may be present in the meat at more than one inch from the surface, it is seen that the consumer may take into his system quantities of the poison which cannot fail, in the long run at any rate, to be injurious.

The Committee concludes, therefore, that formaldehyde should be banned as a food preservative in all cases. This conclusion may be applied also to the use of formaldehyde as an antiseptic in disease. For external application it has its use, but internally any effect it may have upon micro-organisms is counteracted by its simultaneous deleterious actions upon the tissues of the body.

[1] Interim Report of the Food Preservatives Committee on the Treatment of Chilled Beef and other Foods with Formaldehyde. (Ministry of Health.) H.M. Stationery Office. 1924. Price 2*d*.

The Free Atmosphere in India.[1]

THE Memoirs before us are by Mr. J. H. Field, who has succeeded Sir Gilbert Walker at Simla, and by Dr. W. A. Harwood. They are of particular interest from the fact that both authors have been connected with upper-air work in England almost from its first conception.

In the introduction, Mr. Field discusses the methods and instruments that were used, many of which were designed by him especially for the purpose; and he is to be congratulated on the success that has been attained.

Owing to the climate of India the ordinary rubber balloons could not be used, on account of the difficulty of storage, and gutta-percha balloons, made up as required, were substituted for them. Mr. Field describes his semi-graphical methods of working up theodolite observations quickly, and gives some very useful formulæ showing the final error in terms of the errors of observation. He finds that too much trust may easily be placed in the two-theodolite method, and gives an example in which the four angular measurements are perfectly consistent among themselves and yet the height of the balloon is in error by 50 per cent. He adopted the tail method for general use.

The results of some very useful experiments are given, showing the extent of the errors which may occur owing to the heating by solar radiation of the recording instruments, and also by the inevitable lag of the thermograph. The conclusion reached is that the resulting error is small up to a height of six kilometres, and this is confirmed by the good agreement of the mean values obtained by night and by day. Above 10 kilometres the error is increased by the unfortunate necessity in having to use gutta-percha balloons, the rising velocity of which falls off as their highest point is reached; but up to 12 kilometres it does not seem likely that the error exceeds two or three degrees.

Mr. Field has done a most useful piece of work,

[1] "Memoirs of the Indian Meteorological Department." Vol. xxiv., Parts v., vi., vii., and viii.

and his memoir should be read and carefully studied by every one similarly engaged: to such it will give many valuable hints.

In Part vi. Dr. Harwood discusses the observations made with kites and registering-balloons over India and the Arabian Sea. He gives first a summary of the results obtained by Field by means of kites, and then deals with the registering-balloon ascents made in India, chiefly at Agra, during the years 1914–18. In all 237 were sent up, 156 instruments were returned, and 152 of these gave usable records, a result which reflects great credit on Mr. Field and his Indian assistants. The figures were handed to Dr. Harwood, on his return from war service in 1918, to be worked up.

Dr. Harwood has taken every care to ensure accuracy, and being well acquainted with the many possible sources of error, has only used such ascents as may be reasonably supposed to be free from error, especially from the effects of solar radiation, a precaution needful in view of the slow rise of gutta-percha balloons. He gives particulars of the temperature, humidity, and pressure at various heights in the three Indian seasons—the cool, the hot, and in the monsoon—and also annual means for the density. He carries his tables up to 12 kilometres, and it is only to be regretted that the stratosphere was not reached, and that at least the results from Agra are not published in full detail.

It is not possible to comment on the many interesting points discussed, but the following may be mentioned. The mean annual lapse rate comes out as identical up to 9 kilometres with that of nearly all other stations; so also the daily temperature variation in India, as elsewhere, is confined to the first one or two kilometres. The excessive heat of the hot season is found to be confined to the bottom layer; higher up the monsoon season is the hottest. The high correlation between pressure and temperature so noticeable in Europe is absent in India, perhaps because the short period variations of pressure are too small.

Comment is made on the figures for the equator given by the reviewer in the M.O. Geophysical Memoir, No. 13, and the absence of information as to their source. These figures were formed from the smoothed mean values derived from the few data available at that time. Further observations on the equator are necessary to show whether Van Bemmelen's excellent set of results from Batavia, most of which have been published since then, fairly represent the general equatorial conditions.

Parts vii. and viii. discuss the motion of the free air over India as it is observed by means of clouds and pilot balloons. The year is divided into three seasons, and three separate heights are taken: the height of low clouds, 2 kilometres; of middle clouds, 5 kilometres; and of high clouds, 9 kilometres. These are the heights assigned to the different clouds in the International Cloud Atlas, and Dr. Harwood accepts them as correct for India. Many tables are given showing the direction of the wind and the percentage frequencies for each direction at each height for 15 stations distributed over the Peninsula; in some cases separate values for each month are given. It is noted that cloud observations necessarily refer to cloudy weather and that pilot-balloon observations will refer chiefly to clear weather, and there is some evidence that there is a systematic difference between the two, but it does not seem to be large enough seriously to prejudice the results of using them as equivalent. The figures will be of great interest to any one who is endeavouring to elucidate the cause of the monsoons.

In Part viii. the relation of the monsoons to the general circulation of the atmosphere is dealt with, and the similarity of the north-east monsoon to the circulation over the North Atlantic is discussed. Dr. Harwood finds a very noticeable coincidence between the track of storms and depressions, as shown in the Climatological Atlas of India and in the Meteorological Atlas of the Indian Seas, and the monthly mean directions of the upper winds at the cirrus level. If this be more than a coincidence, and it seems to be so, it has an important bearing on the formation and propagation of cyclones, and shows that their source must be sought for in the upper winds rather than in the surface conditions.

The four Memoirs form a very valuable contribution, not to Indian meteorology only, but also to meteorology in general. W. H. DINES.

The Royal Photographic Society's Annual Exhibition.

THE Royal Photographic Society's Exhibition was opened on Monday, September 15, and will remain open until October 25, with free admission, at 35 Russell Square. The Scientific and Technical Section is probably the largest and in a general sense the most interesting that the Society has ever been able to arrange. Among the astronomical exhibits are photographs of nebulæ made at the Mount Wilson Observatory by the 60-inch and the 100-inch reflecting telescopes, illustrating Dr. Edwin Hubble's proposed general classification of nebulæ, and a frame that shows the different degrees of elongation of elliptical nebulæ. Dr. William J. S. Lockyer, director of the Norman Lockyer Observatory, Sidmouth, sends some striking photographs of star spectra, and what is, with little doubt, the most successful photograph of a meteor that has ever been secured. Various forms of clouds and their changes are illustrated by several contributors, and geological work by one exhibit from the National Geographic Society of Washington. Closely allied to this are several "survey and record" photographs from the United States and Canada, a very notable one being a photograph, by Dr. W. H. Wright of the Lick Observatory, of the Sierra Nevada Mountains in the neighbourhood of the Yosemite Valley, taken from the Observatory on Mount Hamilton. The details shown range in distance up to 135 miles, and several comparative details are indicated which clearly demonstrate the effect of the curvature of the earth in depressing the more distant as compared with the nearer hills.

Among the stereoscopic slides, the set of 50 by Mr. Herbert G. Ponting which illustrate China and Japan, and include the manners, customs, and occupations of the people, are specially notable. The new Section of Cinematography has twenty excellent exhibits by three authors. Press photography, commercial stage photography, lantern slides, colour photographs of many kinds, natural history photographs, radiographs (including the C.D.X. dental X-ray apparatus of Messrs. Watson and Sons, and a series of 18 dental radiographs), photographs transmitted by wireless, and so on, are all shown in their latest and most perfect forms.

Photomicrography in the service of technology and scientific investigation is exceptionally well illustrated. The Research Laboratory of the Eastman Kodak Co. shows the fibres, and their characteristics, that are contained in photographic paper pulp, and illustrate a new method of distinguishing rag and bleached wood pulp, presumably by differential staining and photographing through suitable colour screens. Mr. W. S. Gerecke, of the U.S. Rubber Co., has sent a long series that refer to

the manufacture of india-rubber and the changes that it is liable to. The British Photographic Research Association shows some of its latest results. Results obtained by the "Davon super-microscope," which has given rise to so much discussion of late, are illustrated by several photomicrographs by Mr. J. D. Jacobs, ranging in magnification from 1000 to 4000 diameters, each with a statement of the optical means employed.

Mr. P. P. Quayle, of the Bureau of Standards, Washington, shows a series of six photographs of the phenomena at the muzzle of a 0·45 calibre revolver when it is fired, taken by an apparatus that gives no evidence whatever of its presence in the pictures. A very interesting method of determining the effect of various conditions, such as stirring, changes of temperature, and so on, on reaction velocity by utilising the decay of luminescence in the Japanese ostracod, *Cypridina hilgendorfii*, is illustrated and explained by Dr. William R. Amberson. The "Mutochrome," invented by Mr. C. F. Smith, of Messrs. Adam Hilger, Ltd., is shown in action. By its means any pattern or design may be photographed and then projected full size upon a screen with the possibility of varying almost infinitely the colour and depth of tint of the various elements.

In concluding this necessarily incomplete account of the scientific part of the Exhibition, we wish to point out that in the prospectus this section is divided into eight well-defined sub-sections, each with its separate board of judges, and to ask, for the sake of students, that each of these divisions may be as clearly separated and indicated, in future, in the Exhibition itself. As it is, there is much confusion. According to the Catalogue, "Technical Applications" are scattered in eleven different places; some "Astronomical Photographs" are under this heading and some are under "Technical Applications," and so on. We would also add that it is very pleasing to see so rich a collection of work from the United States, and to be able to remark on the very high standard of excellence of all the exhibits.

University and Educational Intelligence.

LONDON.—H.R.H. Prince Arthur of Connaught has consented to undertake in November the formal opening of the Ramsay Laboratory of Chemical Engineering at University College, instituted in 1923 as part of the Memorial to the late Sir William Ramsay. A full course of study in chemical engineering will be provided in the laboratory in the coming session, leading to the degrees of M.Sc. or Ph.D. in chemical engineering. The course is designed to meet the demands of the manufacturing industries for men trained in the application of scientific methods to the design and operation of industrial chemical processes and plant. Special facilities are provided for research. Particulars can be obtained from the Secretary of the College.

SHEFFIELD.—The Council of the British Cast Iron Research Association has appointed Mr. J. G. A. Skerl to take charge of an investigation on moulding sands, to be carried out in the Refractories Department of the University and in the foundries of members of the Association. Mr. Skerl has for nearly three years been research assistant to Prof. P. G. H. Boswell, of the University of Liverpool.

APPLICATIONS are invited, from Egyptians only, for a whole-time lectureship in chemistry at the School of Medicine, Cairo. The applications, with particulars of qualifications, research work, etc., should be sent to reach the Director of the School before October 10.

A DEMONSTRATOR in metallography and pyrometry is required in the metallurgical department of the Royal School of Mines, Imperial College of Science and Technology, South Kensington. Particulars of the duties of the post can be obtained from the secretary. The latest date for applications is September 27.

APPLICATIONS are invited by the Harper Adams Agricultural College, Newport, Salop, for an Advisory Economist and an Advisory Chemist for service in Shropshire, Staffordshire, and Warwickshire. Candidates must hold a degree of a British university and should have, if possible, some agricultural experience. Applications, with copies of three recent testimonials, must reach the principal of the College not later than September 30.

DR. RUDOLF STEINER delivered a public lecture on education on August 30 in London, under the auspices of the Educational Union for the Realisation of Spiritual Values, the chair being taken by Miss Margaret Macmillan. He gave an exposition of his work as director of the Waldorf School at Stuttgart, where his theories of education have been put to the test of experience, and announced that a school on similar lines will be opened at Streatham Hill, London, next January. A principle which he holds to be of fundamental importance is the adjustment of educational methods and curricula to the biological changes occurring in the pupil, and, above all, the changes that take place at the age of puberty. This gives his doctrines a special interest at the present time, when the question of "secondary education for all" is being widely canvassed. It is perhaps a misfortune that he has labelled them with the portentous name "Anthroposophy."

PROSPECTUSES for the year 1924–25 have been received from a number of technical colleges in London and the provinces. The Northampton Polytechnic Institute offers a great variety of courses in mechanical and electrical engineering, optical engineering and applied optics, technical chemistry, horology, and women's trades and domestic economy. The part-time day classes for young persons employed in electrical and optical trades which have, owing to the propaganda work of a well-known electrical firm, been successfully maintained since 1918 despite the discouragement to which continuation classes have been subjected throughout Great Britain, will be continued. The Sir John Cass Technical Institute provides evening classes for persons engaged in chemical, metallurgical, electrical, petroleum, and the fermentation industries, and in artistic crafts and the tailoring trade. Full facilities are offered in the Institute's laboratories for special investigations and research. The Cordwainers Technical College offers both day and evening classes in the technology of the leather-working industries. The former include two-year courses in which the scientific and managerial as well as the more practical aspects of the industry are dealt with. A certain number of free places at the Imperial College of Science and Technology, South Kensington, are available for students who desire to undertake post-graduation study. The Technical College, Bradford, gives particulars of three-year Diploma (Associateship) courses in textile industries, chemistry, dyeing, engineering, physics and, exceptionally, biology. Entrants for these courses are required to pass a College entrance examination of matriculation standard if they have not already passed an examination of equivalent standard. The College offers also shorter courses, both full-time and part-time, and training in methods of research.

IN view of the efforts being made in Great Britain to foster interest in aviation, and of the announcement of Government support for light aeroplane clubs, special interest attaches to the facilities available for the study

of the science of aviation and of the art of flight. In accordance with the opinion expressed by the Committee on Education and Research in Aeronautics that "The Imperial College should become the Central School for advanced study in Aeronautical Science," a Department of Aeronautics was established in 1920–1921 at the Imperial College of Science and Technology, London, with the approval and financial support of the Government and under the direction of Sir Richard Glazebrook. We have received a prospectus of the reorganised department. It is now under the direction of Prof. L. Bairstow, who is Zaharoff professor of aviation, and is assisted by two assistant professors on design and on meteorology, and by five lecturers on airships, on air navigation, on strength of structures, and on engine design. The assistant professorship in meteorology is at present vacant: all the other posts are filled by distinguished exponents of their subjects. As is to be expected, the department is in the main a school for post-graduate work, and its aim is in the direction of the encouragement of research, as well as in the co-ordinating of experimental work carried out by individual workers at experimental stations in different parts of Great Britain. A complete course takes two years, the first being spent in study at the College and the second in research or in experimental work. A special one-year course is also offered for advanced students, two terms at the College and the third term in experimental work at a research station or at the National Physical Laboratory, Teddington. The Department of Aeronautics at the Imperial College has already achieved considerable success: it will no doubt become one of the foremost centres of aeronautical study in the world.

TECHNICAL and evening classes provided by the London County Council opened this week. Last session about 120,000 students attended the evening institutes in London and 51,000 the polytechnic and technical institutes, making all told about 170,000. This was an increase of nearly 7000 over the figures for the previous year. Increases in attendance occurred mainly in the classes for women's subjects and for cultural and commercial education; there was a slight decrease in the numbers attending technical classes. Forty years ago the number attending the "night" schools of the period was 10,000. Despite the increase in numbers since then, the fact remains that, even to-day, only about one Londoner in three continues his or her education beyond the elementary school stage. Among recent developments may be mentioned the teaching of petroleum technology, oxy-acetylene welding, classes for the scale and weighing industry, and for textile distributors, musical instrument making, and an advanced school of rubber technology, science teaching in connexion with commodities and the marketing of commodities, technical optics, and aeronautics. A panel of about 10,000 instructors has been appointed to give the instruction; it is computed that about 80 per cent. of these are actually employed in the trades and professions they teach. The amount spent on vocational and cultural classes of this description in London is about 1¼ million pounds a year. The bulk of this expenditure is met in equal proportions by the Board of Education and the London County Council, the balance being derived from the fees of students and endowments. For the information of parents and older students, an illustrated "Guide to Continued Education in London" has just been published for the London County Council by the University of London Press. This may be obtained from any bookseller at 6*d*. a copy.

Early Science at the Royal Society.

September 21, 1664. Dr. Wren being desired to defer no longer the making of a larger telescopical moon for the Society, promised to do it against his next coming to London; upon which it was ordered that the treasurer should pay for a globe of that size, which Dr. Wren should choose at Mr. Moxon's. Several experiments were made. [Oldenburg, in a letter to Boyle, dated at London, September 22, 1664, gives some account of what passed at this meeting, where, he observes, they had the company of a Parisian academist, recommended to Sir Robert Moray and himself. I dare say (he says) he will extol our institution and proceedings to the sky, whensoever he comes; though I must say we grow more remiss and careless than I am willing to expatiate upon. Yet this I must say to a person, that I am sure hath a concern for our prosperity, that nothing is done with the king for us.]

September 22, 1679. Ordered—that Mr. Hunt take care to have all the instruments of the Society now in the custody of Mr. Flamstead at Greenwich immediately removed to Gresham College; and that Sir Christopher Wren and Mr. Hooke be desired to go thither, and take what care they can in it; and that in the meantime Mr. Hooke write to Mr. Moore about the same, and desire to have them carefully sent home.

September 23, 1663. The president gave an account of the experiment committed to his charge, about the descending of water purged from air, proposed formerly by Mons. Huygens, and several times tried before the Society; which the president affirmed to hold good upon every accurate trial. He was desired to prosecute the experiment with quicksilver, and to bring in the particulars of the whole success in writing, together with the solution of this phenomenon.—There was read a petition of the fishmongers, presented to the Parliament, concerning the annoyances, whereby the fry and brood of fish is destroyed, and the several ways whereby the same may be preserved. This was communicated by Mr. Graunt.—The operator was ordered to have ready against the next meeting the iron balls for the trying of gun-powder and gold-powder; as likewise the compressing engine; and the dog, for the cutting off a piece of his skin.

September 24, 1662. Mr. Winthrop read his paper concerning the conveniency of building of ships in some of the northern parts of America, there being several reasons, that may be propounded, as motives encouraging thereto. Among these, that it is not a new project the building of ships in those parts, for there hath been sufficient experience already made, there having been every year some built (great or small) for above these twenty years. There were this summer divers here at London, that were built over there, whereof two of about two hundred tuns: there is one now of an hundred tuns in this river, that was built there: there have been formerly some of three hundred and four hundred tuns built there. There hath been also, and is daily tar and pitch made; and much experience hath been made of the masts of those parts; many having been brought over hither.

1677. It was ordered that the officiating secretary taking short notes of all that passes at the Society or Council before the rising thereof, read the said notes in order to see that they be rightly taken.

September 25, 1661. Mr. Croune was desired to try some experiments of the weights of liquors: the lord viscount Brouncker to make the experiments of two pendulums: Dr. Goddard to prosecute his trials of sinking bodies under the surface of the water: Dr. Charlton to try the experiment of the freezing of salt water: Sir William Petty, a discourse on clothing.

Societies and Academies.

LONDON.

The Institute of Metals (Autumn Meeting), September 8.—W. M. **Corse** (autumn lecture): Recent developments in non-ferrous metallurgy in the United States, with special reference to nickel and aluminium-bronze. Some account is given of nickel, its occurrence, and smelting, and of the Orford, Mond, and Hybinette processes of refining. The copper aluminium alloy known as aluminium bronze is next described. This series of alloys has found many important uses, such as for worm gear wheels for motor trucks, automobile parts and other structural pieces requiring resistance to vibratory stresses or fatigues. The addition of lead to the standard aluminium bronze has given a new alloy of good wear-resisting properties. The dream of many a foundryman to avoid the use of sand for moulding purposes may come true, if the new Holley "long life mould" process using these moulds made of cast iron proves to be the success that is at present indicated. This applies to mass production work. There are also references to Ambrac metal, Frary metal, and the nickel chromium iron alloys.

PARIS.

Academy of Sciences, August 25.—M. Guillaume Bigourdan in the chair.—MM. **Bigourdan** and **Giacobini**: Observation of the total eclipse of the moon of August 14, 1924, made at the Observatory of Paris.—F. E. **Fournier**: Safety manœuvres, guarding against risks of collisions of two squadrons, in line of file, having to cross routes during fog.—Guiseppe **Belardinelli**: The resolution of algebraic equations.—Michel **Akimoff**: The approximate expression of Fourier-Bessel transcendentals of several variables, which occur in Kepler's problem.—P. **Appell**: Remarks on the preceding communication.—G. **Sagnac**: Classification of double stars.—T. **Batuecas**: Revision of the weight of the normal litre of methyl oxide. The value found, 2·1097, is in close agreement with that obtained by G. Baume in 1908 (2·1096). The atomic weight of carbon deduced from this is too high (12·033) and hence either the data for the compressibility of the gas require revision or the law of limiting densities of Daniel Berthelot is not rigorous for a gas so easily liquefied as methyl ether.—Léon **Moret** and Georges **Carrette**: Discovery of the marine Lutetian at the Roc de Chère (Lac d'Annecy).

SYDNEY.

Linnean Society of New South Wales, July 30.—Mr. R. H. Cambage, president, in the chair.—Marguerite **Henry**: (1) Notes on breeding Entomostraca from dried mud, and their habits in aquaria. The relative prevalence and persistency of the different species and their method of reproduction under artificial conditions are described. (2) Entomostraca collected in the vicinity of Auckland, N.Z. Of the ten species collected by Mr. T. Steel, one is new and is also the first of the genus Brunella to be recorded from New Zealand. Several of the species have hitherto only been recorded from the South Island.—J. R. **Malloch**: Notes on Australian Diptera. No. iii. Notes on some Diptera—Acalyptratæ, in which two genera (one in Chloropidæ and one in Agromyzidæ) and eleven species (five in Chloropidæ, two in Ephydridæ, three in Agromyzidæ and one in Asteiidæ) are described as new.—G. H. **Hardy**: A revision of the Australian Chiromyzini (Diptera). In 1920 the author published a paper revising the tribe Chiromyzini. The Australian species are here considered. The males of four species, hitherto only known from the female, are included, and another is described as a new species.

Official Publications Received.

Imperial Earthquake Investigation Committee. Seismological Notes No. 6, July. Preliminary Note on the Great Earthquake of S.E. Japan on Sept. 1, 1923. By A. Imamura. (Tokyo: Department of Education.)

Illustrated Catalogue of Specimens from Prehistoric Interments found in the North-East of Scotland and preserved in the Anthropological Museum, Marischal College, University of Aberdeen. By Prof. R. W. Reid. Pp. 50+2 maps. (Aberdeen: The University Press, 1924.)

Report on Tests of Miners' Flame Safety Lamps fitted with Open Mesh Gauzes, carried out at the Mines Department Lamp Testing Station, Eskmeals. (London: H.M. Stationery Office, 1924.) 3*d*. net.

National Physical Laboratory. Report of the Advisory Committee for the William Froude National Tank for the Year ending December 31, 1923. (London: H.M. Stationery Office, 1924.) 6*d*. net.

Report of the Aeronautical Research Committee for the Year 1923-24. Pp. 50. (London: H.M. Stationery Office, 1924.) 2*s*. 6*d*. net.

Ministry of Agriculture and Fisheries. Fishery Investigations. Series II. Vol. VI., No. 4. 1924. An Account of Investigations into the Cause or Causes of the unusual Mortality among Oysters in English Oyster Beds during 1920 and 1921. Part II. Chemical Reports (1) by George Stubbs, Andrew More and John Ralph Nicholls, and (2) by Dr. O. L. Brady. Bacteriological Reports by Prof. J. Eyre. Report on Field Work by F. S. Wright. Biological Investigations by Dr. J. H. Orton. Recommendations as to Further Research by Dr. J. H. Orton. Pp. 69. (London: H.M. Stationery Office, 1924.) 7*s*. 6*d*. net.

Apia Observatory, Samoa. Report for 1921. Pp. 62. Report for 1922. Pp. 63. (Wellington: W. A. G. Skinner, 1923.)

A Summary of the Meteorological Observations of the Samoa Observatory (1890–1920). By G. Angenheister. Pp. 56. (Wellington: W. A. G. Skinner, 1924.)

Kungl. Svenska Velenskapksakademiens Handlingar. Tredje Serien. Band 1, No. 2: Researches on the Distribution of the Absolute Magnitudes of the Stars. By K. G. Malmquist. Pp. 77. Band 18, No. 23: A Study of the Properties of Globular Distribution. By S. D. Wicksell. Pp. 16. On the Dissection of Frequency Functions. By C. V. Charlier and S. D. Wicksell. Pp. 64. (Stockholm: Almquist & Wiskells.)

L'Éclipse totale de soleil des 20-21 août 1914. By H. G. Block. Pp. 15. (Stockholm: Almquist & Wiskells.)

Ordnance Survey Map of Roman Britain. Scale 16 miles to 1″. Pp. 8 +map. (Southampton: Ordnance Survey.) 4*s*.

Records of the Botanical Survey of India. Vol. 10, No. 1: The Botany of the Abor Expedition. By I. H. Burkill. Pp. 154. (Calcutta: Supt. Government Printing, India.) Rs. 4, As. 4.

Annals of the Transvaal Museum. Vol. 10. Part 4. Pp. 197-252. (Cambridge: At the University Press.)

Ministry of Agriculture and Fisheries. Fisheries Investigations. Series 2, Vol. 7, No. 2. 1924. Report on Exploratory Voyages to Lousy Bank and Adjacent Areas. By Lt. E. L. Pawsey and F. M. Davis. Pp. 22+2 charts. (London: H.M.S.O.) 3*s*. net.

Australasian Antarctic Expedition 1911-14. Scientific Reports. Series C. Zoology and Botany. Vol. 6, Part 6. Polyzoa. By W. Thorneby. Pp. 22+five text figures. (Sydney: A. J. Kent.) 2*s*.

Astronomical and Magnetical and Meteorological Observations made at the Royal Observatory, Greenwich, in the year 1921 under the direction of Sir Frank Dyson. (London: H.M.S.O.) 1*l*. 15*s*. net.

Cape Astrographic Zones. Vol. 10. Catalogue of Rectangular Coordinates and Diameters of Star Images. Derived from Photographs taken at the Royal Observatory, Cape of Good Hope. Commenced under the direction of Sir David Gill, and completed by S. S. Hough. Zone 50°. (London: H.M.S.O.) 4*l*. 10*s*.

Report of the Aeronautical Research Committee for the year 1923-4. Pp. 50. (London: H.M.S.O.) 2*s*. 6*d*. net.

Department of Agricultural and Technical Instruction for Ireland. Memoirs of the Geological Survey of Ireland. The Geology of the Ballycastle Coalfield, Co. Antrim. By W. B. Wright, with chapters on the Palæontology of the field by E. A. Arber and L. B. Smyth. Pp. 187. (Dublin: The Stationery Office.) 7*s*. 6*d*.

Diary of Societies.

TUESDAY, SEPTEMBER 23.

INSTITUTE OF MARINE ENGINEERS, at 6.30.—E. B. Seymour Norton: An Engineer's Life in Eastern Oilfields.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Capt. P. P. Eckersley: The Development of Broadcasting in Great Britain.

WEDNESDAY, SEPTEMBER 24.

RADIO SOCIETY OF GREAT BRITAIN (at Institution of Electrical Engineers), at 6.—Prof. W. H. Eccles: The Latest Developments of the Position of the Scientific Amateur under the Wireless Telegraphy Regulations. (Autumn Presidential Address.)

THURSDAY, SEPTEMBER 25.

INSTITUTION OF LOCOMOTIVE ENGINEERS (at Engineers' Club, Coventry Street), at 7.—Lt.-Col. E. O'Brien: The Future of Main Line Electrification of British Railways.

FRIDAY, SEPTEMBER 26.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—O. Brockbank: The Wilderness of the Wanderings.

SATURDAY, SEPTEMBER 27.

SCHOOL NATURE STUDY UNION (Anniversary Meeting) (at London Day Training College), at 3.—G. H. Gater: Address.