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The Position of Scientific and Technical Officers in the Civil Service.

On various occasions during the past few years claims have been made on behalf of professionally qualified scientific and technical workers in the Home Civil Service for improved salaries and other conditions of employment. It has been pointed out that the qualifications normally demanded by the State as a condition of appointment to junior scientific and technical posts imply that candidates for them must have had just as long a training and attained at least as high a level of intellectual attainment as candidates for junior administrative posts. It is asserted also that the burden of responsibility of such officers on behalf of the State is probably greater than that of their corresponding numbers on the administrative side of the service. On these grounds alone it is contended that their general conditions of service should be at least equal with those of the administrative classes. Furthermore, it is denied that a high degree of specialisation and outstanding specialised knowledge of science necessarily unfits a man for the assumption of the highest administrative office. If, therefore, the State wishes its service to possess the utmost attractiveness to men of outstanding scientific ability, it should either put an end to the existing disparity between the initial pay and prospects of its scientific and its administrative officers in their respective spheres, or give more favourable consideration to the claims of its specialist officers for the highest posts in the administration.

Most of these points were made by leading men of science in their evidence in 1913 and 1914 before the Royal Commission on the Civil Service, but the intervention of the War prevented due consideration being given to them at the time. After the War a new body was constituted, the Civil Service National Whitley Council, the general objects of which were " to secure the greatest measure of co-operation between the State in its capacity of employer, and the general body of Civil Servants in matters affecting the Civil Service, with a view to increased efficiency in the public service combined with the well-being of those employed ; to provide machinery for dealing with grievances, and generally to bring together the experience and different points of view of representatives of the administrative, clerical, and manipulative Civil Service." Apparently professional civil servants were included in these categories, for the Institution of Professional Civil Servants, all the members of which are

professionally qualified, the Society of Civil Servants, and the Civil Service Confederation, both of which embrace a number of professional men, were given representation of the staff side of the Council.

At the second meeting of this National Council it was decided to consider the reorganisation of the Civil Service in the light of the recommendations of the Royal Commission. The clerical classes were first reviewed, and a report on the duties, method of recruitment, and scales of salary of the clerical, executive, and administrative grades was issued early in 1920. Immediately after this report was issued, the Chancellor of the Exchequer appointed a Committee consisting of the late Lord Asquith, Lord Colwyn and Lord Maclay to consider "the question of the remuneration which should attach to the principal posts in the Civil Service as exemplified by a Permanent Under Secretaryship of State." This Committee recommended that the basic salaries of these officers, most of whom had been in receipt of £2000 a year, should be raised to £3000 a year. This recommendation was put into immediate effect. Without suggesting that these classes were too generously dealt with, it is undoubtedly a fact that their salaries were considerably improved.

Unfortunately, the National Council did not proceed at once to deal with the professional classes in the same comprehensive way. These were left for the time being to a Treasury Committee, to be considered piecemeal, and then only in a few departments. One or two departments were dealt with fairly generously. The British Museum staffs, for example, were given a salary scale of £250 to £800 for the entry grade, subject to an efficiency bar at £540. In striking contrast, this range of salary covered five different grades among the scientific staffs at the National Physical Laboratory, promotion from one grade to another depending on the occurrence of vacancies. Eventually the official side of the National Council consented to the appointment of three special sub-committees to deal with certain grades of professionally qualified persons. This was in 1922. By that time the post-War boom in trade had given place to trade depression, and financial stringency had produced the 'Geddes Committee' with its so-called economy proposals. In this atmosphere the staff side representatives on the three sub-committees had to conduct their negotiations with the representatives appointed by H.M. Treasury. To make matters worse, during these negotiations the Government appointed a Committee under the chairmanship of Sir Alan Anderson "to inquire into the standard of remuneration and other conditions of employment of the various classes of State Servants employed in the Civil Service," and this Committee expressed itself thus:

"It has been represented to us on behalf of this [the professional] group, that the pay of Professional men in the Civil Service has not been increased as much as the pay of administrative grades, and that it will not in the future attract candidates of the right quality. . . . We do not share this view, nor do we agree that there is any direct relation between the pay of the Administrative Officer and the Professional men who advise him as occasion arises. We have already said what we think about the former; the latter should, in our judgment, relate his pay and position with those of his professional brethren in the outside world. . . . As the present scales of pay attract good candidates to-day we see no reason for an increase."

This pronouncement reflected the view of the Treasury, so that it is not surprising that the results of the negotiations on behalf of the scientific and technical staffs were disappointing in the extreme. Even the plea that junior scientific assistants should be given established posts on entry to the service and confirmed in them within a two years' probationary period was dismissed, although in the Reorganisation Report on the Clerical Classes the National Council had already stated:

"We have found ourselves in entire agreement with the views expressed by the Royal Commission of the Civil Service regarding the evil effects of employing temporary clerical staff on permanent work. Our intention is that all classes proposed by us should be employed on a permanent and pensionable footing."

Considering the nature of the duties of junior scientific officers, particularly their access to, and participation in, work of a highly confidential character, one might be justified in assuming that the principle laid down for clerical classes applied with far greater force to them. The fact remains that there are still large numbers of professionally qualified scientific officers employed in a temporary capacity in various Government departments, although the work upon which they are engaged is permanent in character.

The sequel to this treatment of professional civil servants is illuminating. On Oct. 8 the *Times* published an article from its Civil Service Correspondent dealing with the failure of certain departments to attract men with the necessary scientific and technical qualifications to fill appointments in the Civil Service. Before the War, for example, an ample supply of candidates for assistant examinerships in the Patent Office was available. In 1910 no fewer than 157 candidates presented themselves for nine appointments. To-day, conditions are

entirely changed. An examination has just been held for six appointments, but only thirteen candidates presented themselves, out of which number six were already in the Civil Service. It is also established that the superior attractions of outside employment open to men with scientific qualifications is resulting in a loss to the service of men who started their careers in the Civil Service. The Patent Office has lost quite a number of men in this way; during the present year four members of the examining staff have resigned to take up industrial occupations. The peculiar knowledge required in the course of their official duties enhances the examiners' usefulness for the purposes of certain industrial firms, and there is a danger here, as in the United States, that the Patent Office may become a training ground for men who look to industry for their ultimate careers.

Such a result might have been foreseen. The growing complexity of industrial processes adds to the difficulty of establishing an indisputable right to a patent. It behoves industrialists, therefore, to employ the keenest intellects in this particular branch of their work, and it is an obvious economy to pay well for such service. Yet the basic scale of salary of Patent Office assistant examiners is the pre-War scale. The State has neither exercised any foresight in this matter nor has it paid any attention, apparently, to the condition of affairs which arose out of similar circumstances in the United States. In a report submitted in 1920 to Congress dealing with the classification of government officials and the salaries and conditions of service attached to the various classes, emphasis was laid on the increasing difficulty experienced by the United States Government in connexion with the recruitment and retention of professional civil servants. As an example it cited its Patent Office. "As a result of the excessive turnover of staff it has almost ceased functioning."

Other departments in our Civil Service are even worse off than the Patent Office. In spite of the improvement in the commencing salary of cartographers in the Hydrographic Department of the Admiralty, the greatest difficulty has arisen in inducing candidates to come forward. Even greater difficulty has been experienced in recruiting properly qualified persons as assistant surveyors in the Admiralty and Air Ministry. In both these departments there are vacancies which cannot be filled although the required standard of professional competence has been lowered. The demand for well-trained intellects by industrial firms is a comparatively new phenomenon in Great Britain. It is rapidly becoming more marked. Already the State is finding that some of its keenest younger professional workers are transferring their abilities to big industrial combines, where, rightly or wrongly, they imagine they will be given greater scope. The question arises, Will the State fail to deal adequately with the problems arising out of the employment of its professional Civil Servants until, for this class, State service becomes a last refuge? This is what happened in the United States when the big industrialists realised the importance of employing highly qualified professional men and women in their undertakings.

We suggest that a general inquiry into the scope of duties, the scales of salary, and other conditions of employment of all professionally qualified Civil Servants is long overdue. We suggest further, that such an inquiry, including as it must consideration of the relations between professionally qualified and other Civil Servants, should be conducted by those who are entirely removed from any suspicion of bias. We certainly do not consider that the Civil Service National Whitley Council, as it is at present constituted, is capable of undertaking this task. The need would best be met by the appointment of a Royal Commission to consider specifically the problems arising out of the comparatively recent growth within the Civil Service of a large class of workers to which the traditional Civil Service system has still to be attuned.

Magic and Medicine.

From Magic to Science: Essays on the Scientific Twilight. By Charles Singer. Pp. xix + 253 + 47 plates. (London: Ernest Benn, Ltd., 1928.) 25*s*. net.

DR. CHARLES SINGER is well known as one of the very few students in England who pursue the subject of the history of medicine in a critical and scientific spirit. He is well equipped for the work by his knowledge of the classical languages and Hebrew, as well as by his inquiring spirit. He is, too, greatly helped by his wife—Mrs. Dorothea Singer—who has recently published the first volume of a catalogue of Latin and vernacular alchemical manuscripts in Great Britain and Ireland, dating from before the sixteenth century. Nevertheless, we welcome Dr. Singer's volume "From Magic to Science" with somewhat mingled feelings, of pleasure in the first place, because it is very interesting; of regret, that he should have spent so much valuable time in re-editing and adding to a series of essays which

have been published in various readily accessible periodicals. There is still much to be done in tracing the decline in the observational sciences from the intellectual efficiency of classical antiquity to the recovery which began in the twelfth and thirteenth centuries. We grudge every moment that Dr. Singer spends in retracing his steps.

The book contains eight essays on various subjects, and the title "From Magic to Science" applies strictly only to the fourth, entitled "Early English Magic and Medicine." Dr. Singer shows in this essay how Greek medicine in a debased form became known in Europe through Latin translations before the Arabian revival, and so formed the groundwork of early English medicine. The knowledge thus transmitted was scanty enough, but was perhaps more accurate than that obtained a little later when the original Greek had passed through Arabic, which itself was translated into Latin, both versions being frequently made by persons who had an imperfect knowledge of Arabic and no knowledge of the subject with which they were dealing. It is not surprising, therefore, that many of the original Arabic words are still in use. The earlier stage is represented by the charms and spells which are written in corrupt Greek, but not in Greek characters. Dr. Singer shows that the loss of scientific knowledge was gradual, and reached its lowest depth about the end of the fourth century. After this there was a long period of ignorance until the revival began in England in the middle of the thirteenth century with the advent of Robert Grosseteste and the recovery of the works of Aristotle, even though the translations were so bad that Roger Bacon wished they were all burnt.

The essay on the Lorica of Gildas of Britain is written primarily for scholars, as the subject is difficult and somewhat barren. A Lorica is a breastplate or hauberk, and the word was employed metaphorically in the sixth century to mean a prayer the recital of which protected from the devils who, in medieval imagination, were constantly thrusting against the breastplate of good deeds and Christian observance. The Lorica ascribed to St. Patrick expressly states that it is a hymn made for the protection of himself and his monks against the enemies that lay in ambush for the clerics. "When any person shall recite it daily with pious meditation on God, demons shall not dare to face him, it shall be a protection to him against all poison and envy; it shall be a guard to him against sudden death; it shall be a Lorica for his soul after his decease." The interest of the Lorica of Gildas lies in the language in which it is written—a characteristic form of Latin known as 'Hisperic' or 'Hibernian' which was used, Dr. Singer says, in south-west Britain and Ireland in the sixth and seventh centuries. Anglo-Saxon copies of the Lorica were made, but the language was so unintelligible that glosses had to be freely supplied.

There is an excellent chapter on herbals, in which Dr. Singer directs attention to the fact that palæolithic man left few drawings of plants in comparison with the number of animals he depicted; the explanation offered being that the paintings were of a magical character to bring animals into the power of the hunter, whilst plants required no hunting. He also points out that the herbals originated in the south of Europe, for the pictures nearly always represent southern species. The Bury St. Edmunds Herbal, written about 1120, is an exception, for its author was a lover of the plants he saw around him.

Dr. Singer's views on the visions of Hildegard of Bingen are well known. The drawings illustrating the Scivias, one of her great mystical works, were produced under her personal direction and are in colour. They show undoubtedly that she suffered from attacks of typical migraine with teichopsia. The condition is now well known; it is very painful, it incapacitates during the attacks, but has no effect on longevity. Hildegard herself was born in 1098 and lived until 1179 or 1180.

There is a final essay on the school of Salerno and its legends.

The book is well illustrated throughout, and the coloured plates, often copied from manuscript herbals, are especially pleasing. The date of the birth of Dr. William Harvey is incorrectly given on page 65, but the mistake is not repeated on page 108 where it is correct.

The Quantum Theory.

Die neuere Entwicklung der Quantentheorie. Von Prof. Dr. A. Landé. (Wissenschaftliche Forschungsberichte, Naturwissenschaftliche Reihe, Band 5.) Pp. xi+180. (Dresden und Leipzig: Theodor Steinkopff, 1926.) 12 gold marks.

THE rapid advances in recent years in the various fields of physics make it increasingly difficult for the physicist to keep abreast of the remarkable developments in his subject, and for other men of science to keep in touch with current physical ideas. A series of publications such as the "Wissenschaftliche Forschungsberichte" thus serves a

valuable purpose in presenting in relatively short compass an authoritative statement of the present position in one or another branch of knowledge. By assuming the reader's familiarity with the elements of his subject, an author is enabled to give width and depth to his treatment, the result being a volume which is useful both to the advanced student and to the research worker. In the present case the editor of this series of monographs has been particularly fortunate in securing the services of a physicist who is noted alike for his eminence in the subject dealt with, and for his ability to write in a clear and attractive manner. The earlier edition of the book was familiar to most earnest students of the quantum theory, and the appearance of a second edition four years later gave the author the opportunity of thoroughly revising it, whereby prominence was given to the question of the nature of radiation. Moreover, a full list of the relevant references to the literature is included.

In the first chapter the quantum theory of radiation is treated in paragraphs dealing with light-quanta, statistics of light-quanta, radiation by matter, the stationary quantum states, the correspondence principle, and virtual radiation. The spectroscopic aspects of the theory are presented in the following two chapters on systems with one electron, and systems with several electrons, and adequate space is devoted to the consideration of multiplets, a topic to which the author himself has contributed extensively, and in a manner which is in large measure responsible for later theoretical developments, already foreshadowed in the present volume. Succeeding chapters are concerned with the magneton, band spectra, and molecule formation, the quantum theory of aggregate states, including Einstein's theory of gases, the mathematical methods of quantisation, and applications to the hydrogen atom.

In his concluding paragraph Landé enters wholeheartedly into the spirit of the new quantum mechanics initiated by Heisenberg, Born, and Jordan whilst the book was in preparation. Classical mechanics required Newton's calculus of fluxions; the general theory of relativity required Riemann's covariant tensor analysis; and the quantum theory likewise calls for the application of special mathematical methods for its complete elucidation. Much has already been accomplished in this direction, and we shall look forward eagerly to the early appearance of the third edition of this delightful book, where we may confidently expect to find the new quantum theory expounded in the author's inimitable way.

The Water Supply of Towns.

The Water Supply of Towns and the Construction of Waterworks: a Practical Treatise for the Use of Engineers and Students of Engineering. By W. K. Burton. Fourth edition, in 2 volumes, by J. E. Dumbleton. Vol. 1: *Collection and Purification Works.* Pp. xvi + 137 + 31 plates. 25*s.* net. Vol. 2: *Works for Distribution.* Pp. xv + 160 + 10 plates. 25*s.* net. (London: Crosby Lockwood and Son, 1928.)

THE appearance of the fourth edition of a technical work is unmistakable evidence that it has met with an appreciable degree of acceptance and that it has established itself in the estimation of professional circles. Mr. Burton's treatise on the water supply of towns, recently reissued in two new volumes under the editorship of Mr. Dumbleton, is thoroughly deserving of the reputation which it has gained, and clearly will continue to act in the future as a trustworthy preceptor for the student, as well as a serviceable reference book for the practitioner.

The scope of the work is fairly wide, though it will be admitted that in a number of respects it is far from exhaustive. Mr. Burton, who was at one time professor of engineering in the Imperial University of Tokyo and held a government post in Japan, wrote, not unnaturally, with an eye to the special needs of the country in which he lived and practised. This is evident from the series of remarks to be found here and there, usually in the form of footnotes, which are intended for the enlightenment and instruction of the Japanese student. The incidence of earthquakes, and the influence on the purity of supply of such special forms of culture as ricefields, are two notable examples of factors which do not affect water supply practice in Great Britain. Prof. Milne's short monograph on the special precautions to be adopted in earthquake countries, which forms the first of two appendices at the end of vol. 2, is full of much practical knowledge and competent advice.

Mr. Dumbleton has rightly respected the authority and experience of Mr. Burton, and while embodying the results of modern progress and research, has endeavoured to maintain unimpaired the general character of the original work. The alterations which have been made in the present edition mainly concern the purification of water, water softening, rapid filtration and pumping plant, in regard to which advances of a striking character have been made in recent years.

In a work which covers so many and varied

aspects (chemical, topographical, engineering, and statistical) of the subject of water supply, within the relatively modest compass of 297 pages, it is obvious that in places the treatment will inevitably be slight and general. The design of dams could in itself furnish matter for a good-sized book, such as Wegmann's well-known treatise, to which the author himself directs attention. In the chapter on the flow of water in pipes and channels, there is a reference to a formula of Eytelwein's, but no cognisance is taken of several other equally authoritative formulæ, all originating in the basic equation of Chézy, notably Gangouillet and Kutter's classic expansion, which is in quite common use, and generally held to be one of the most exact. However, for the purposes of a general review of the subject, the treatment is reasonably adequate and the book does not profess to be encyclopædic. The student will find fuller information as he widens his reading.

Under the heading of quantity of water required per head of population, the author, while mentioning the remarkable consumption (or should it be waste ?) recorded in certain American towns, states that 30 gallons per head per day is a very ample mean supply. Most engineers will agree, but there has been observed of late years an upward tendency which is worthy of note. Perhaps the increasing popularity of the motor-car has something to do with it, since cars are responsible for the use of a good deal of water for such purposes as washing down, and the number of vehicles now so treated is much greater than it was a generation ago.

In discussing reinforced concrete, the author states that the stress in the steel (presumably in pure tension) should be limited to 12,000 lb. per square inch. This is a somewhat low value, and in view of modern developments in the manufacture of steel, it may be exceeded by at least 25 per cent without incurring undue risk. The London County Council regulations permit a working stress of 16,000 lb. per square inch. Curiously enough, the author does not specify any limiting compressive stress for concrete.

It would be unfair, however, to allow such minor points to outweigh the general impression of excellence in the work as a whole. The two volumes are well printed and the production is entirely creditable to the publishers. There is a large number of diagrams, all very clearly and excellently reproduced. A somewhat unusual feature is the inclusion at the end of each volume of numerous trade advertisements by firms specialising in appliances connected with water supply. We do not know how far such a practice is to be understood to convey the approval and recommendation of the author concerned in respect of the advertiser's announcements, but it suggests a question of some interest to readers. BRYSSON CUNNINGHAM.

Insect Societies.

The Social Insects : their Origin and Evolution. By Prof. William Morton Wheeler. (International Library of Psychology, Philosophy, and Scientific Method.) Pp. xviii + 378 + 48 plates. (London: Kegan Paul and Co., Ltd.; New York: Harcourt, Brace and Co., Inc., 1928.) 21*s.* net.

THIS book is a publication in English form of the course of twelve lectures delivered in 1925 by Prof. Wheeler at the University of Paris. The treatment here given of the evolution of the social insects—wasps, bees, ants, and termites—is as careful and thorough as would be expected of so eminent an authority.

It is obvious that in each of these various groups their peculiar structure and habits are closely interconnected, and their evolution is fully dealt with by the author from both points of view. The termites he considers to have arisen from among the Protoblattoids, possibly as early as the Permian; their evolution having been mainly conditioned by the diet of cellulose and the use of symbiotic protozoa. The Aculeate Hymenoptera, deriving their origin from unknown Phytophaga through primitive Terebrants and Bethyloids, have similarly been influenced in their development by the character of the food and by the specialisation of the female sex. It is interesting, as Prof. Wheeler remarks, that "essentially the same type of social organisation and behaviour has been independently attained by at least a dozen different groups of insects."

The author considers the possibility of comparing the societies of insects with those of man, and in the first place he notices the question as to whether societies composed of individuals are comparable with the individual organism considered as a colony of cells. He is willing to admit that such a comparison is legitimate, and he holds further that insect societies constitute an intermediate stage between the solitary metazoon and the societies of man. The evident distinction between a community of free individuals where each member expects advantages in excess of his personal inconveniences, and an association of cells reduced to the mere constituents of a whole the life of which is their sole object, does not of course escape his attention. From some rather uncalled-for remarks

on civilised society, we gather that Prof. Wheeler would not be unfavourably disposed towards the adoption of certain ruthless methods of social adjustment employed by the lower animals.

Dealing with the reproductive activity of insect colonies, the author remarks that the Aculeate societies are frankly female, the male being reduced to a merely temporary fecundative agency. The development of castes and polymorphism has followed as a direct consequence of the extreme preponderance of the reproductive function. In regard to the formation of castes, such terms as degeneration are misapplied; the peculiar traits exhibited by the queens, workers, soldiers, etc., are more appropriately recognised as specialisations. It is nevertheless true that the social habit does to some extent lead to regressive behaviour. Thus the worker honey-bee dies in a few hours if isolated from the colony, and the same dependence on its fellows, though to a less degree, has been observed in the worker ant. In theory, communal life should lead to a degeneration of its constituents if this should further the interests of the society as a whole; but it may be doubted whether the author's comparison of Achilles or Hector with Foch and Pershing, not exactly to the advantage of the latter, will bear critical investigation. It is also questionable whether his anticipation of the eventual disappearance of all solitary organisms, not domesticated by man, before the assaults of their socially organised enemies, is likely to be justified by the event. But whatever value may be attached to the author's speculations, there can be no question of the interest and importance of his book as a whole, or of the excellence of the illustrations with which it is plentifully furnished. F. A. D.

Our Bookshelf.

The Theory and Practice of Radiology: with a Synopsis of Radiography and Radiotherapy. A treatise in 4 volumes. By Bernard J. Leggett. Vol. 1: *Electrical Theory Applied to Radiology.* Pp. xii+238+21 plates. 18*s*. net. Vol. 2: *The Physics and Measurement of X-Radiation.* Pp. xi+308+56 plates. 25*s*. net. Vol. 3: *X-Ray Apparatus and Technology.* Pp. xi+550+144 plates. 42*s*. net. (London: Chapman and Hall, Ltd., 1928.)

THE author has set himself a big task and, so far as may be judged from the three volumes which have been published, he has succeeded in doing it extremely well. Volume 1 is a book of 238 pages devoted to electrical theory applied to radiology, the various chapters including the dielectric, electric and magnetic circuits, varying currents, electromagnetic machinery, and the electron theory.

Volume 2 consists of 308 pages devoted to the physics and measurement of X-radiation. Here are found chapters on the origin of X-rays, X-ray spectroscopy, the properties of X-rays, the measurement of quality and intensity of X-rays, and one on protective methods in the use of the rays.

Volume 3 consists of 550 pages dealing with X-ray apparatus and technology. The scope of this volume may be inferred from the following chapter contents: the production of high vacua, the technique of X-ray tubes, the methods used for generating high potential electrical energy; the remainder of the volume, apart from appendices, being devoted to a description of screening stands and couches, accessory diagnostic apparatus, and the general lay-out of radiological departments.

From the foregoing it will be seen that the author has aimed at providing radiologists with a combination of theory and technical information. He is evidently familiar with the subjects on which he writes. He interprets the word radiology as the study of X-rays to the exclusion of other forms of radiation, such as ultra-violet, beta, and gamma radiation used by radiologists, for only very brief mention of these is made. There appear to be singularly few mistakes in the text; μ is, however, found above instead of below the line in Coulomb's expression.

Hitherto English readers have, we believe, not enjoyed anything like such a comprehensive work, and although no expression of opinion on the work as a whole is possible until the completion of Vol. 4, there is no doubt that, as it stands, it will be of the greatest service to radiologists. The publishers have done their part of the work well; the letterpress is excellent and the diagrams, including many half-tone reproductions, are well reproduced. S. RUSS.

A Guide to the Constellations. By Prof. Samuel G. Barton and Prof. Wm. H. Barton, Jr. (McGraw-Hill Astronomical Series.) Pp. x+74. (New York: McGraw-Hill Book Co., Inc.; London: McGraw-Hill Publishing Co., Ltd., 1928.) 12*s*. 6*d*. net.

THIS atlas is compiled for the benefit of those who, with Carlyle, require someone to "teach me the constellations, and make me at home in the starry heavens." It is quite elementary, being devoted exclusively to naked-eye observational astronomy, and achieves its simple purpose more successfully than could be done in a popular text-book or more detailed atlas such as Norton's.

The principal charts are twelve in number, representing the sky as seen in latitude 40° at 9 P.M. during each month of the year. An unusual feature of these charts is the allowance for effects of atmospheric absorption on the magnitudes of stars at different altitudes, thus giving a more accurate representation of actual conditions. Only stars of magnitude 4·5 or brighter (after correcting for altitude) are entered. Some additional charts are also given, showing circles of right ascension and declination and constellation boundaries.

The letterpress is devoted mainly to explanation

of the charts and to such relevant astronomical information as should interest those wishing to use them intelligently. The information is concise and mainly accurate, though a slip appears to have been made in the paragraph concerning the apparent magnitudes of planets (p. 16), where Saturn is said to be always fainter than some of the bright stars, and Aldebaran is "ever brighter than Saturn." Useful descriptive notes are given of the constellations and of naked-eye objects visible therein. The usual table is also supplied whereby the most suitable chart may be chosen for any hour of the night.

Beginners wishing to familiarise themselves with the constellations should find this book useful, though expensive, and are given suggestions for further reading in a short bibliography.

An Introduction to Oceanography: with Special Reference to Geography and Geophysics. By Prof. James Johnstone. Second edition, completely revised. Pp. xi+368. (Liverpool: University Press of Liverpool, Ltd.; London: Hodder and Stoughton, Ltd., 1928.) 15*s.* net.

IN this new edition the author has incorporated the outlines of many of the modern advances, particularly in geology and geophysics. The early chapters deal with the character and origin of the oceans, the depth and nature of the sea-bottom. The origin of the earth is first considered. This is done clearly and in an interesting way. The chapter on the chemistry of sea-water is disappointing. The account of phosphate and nitrate changes in the sea is very meagre. There are some rather unguarded statements. Hydrogen ion concentration is not determined by conductivity (p. 160); and the account of buffer action on the same page is incorrect. The warnings against taking routine observations of *p*H (pp. 161 and 200) are strange; much invaluable information is gained from them, both oceanographical and biological. On p. 314 *g* is not a force.

The importance assigned to de-nitrifying bacteria seems rather exaggerated in view of the work of Gran. Certainly they can scarcely be effective agents in carbonate precipitation (p. 85): photosynthesis is the most potent factor here. The last chapter of the book gives a good history of the geological changes the ocean has undergone. There are a few misprints: "Rhubidium" for rubidium (p. 131); "more" for "less" (p. 156, line 25); $1/10^{-7}$ for $1/10^{7}$ on p. 160; Fig. 33B for Fig. 33A, paragraph 2, p. 187; 1·0025 for 1·025 (pp. 193 and 317).

There is a short guide to the literature, and a good index.

Die Geschichte unserer Pflanzennahrung von den Urzeiten bis zur Gegenwart. Von Prof. Dr. A. Maurizio. Pp. xx+480. (Berlin: Paul Parey, 1927.) 32 gold marks.

THIS is a painstaking, erudite, and apparently exhaustive survey of the history of plant foods, their collection, harvest, and conversion from prehistoric times (as deciphered in the palæontological records) to the present day. The author makes the astonishing statement that in historical times, however much man may have improved plants serving as food, no plant fit for that purpose has been brought into general use that was not already known to prehistoric peoples.

The history is laboriously traced from a period prior to cultivation, when prehistoric man searched for and gathered the yield of wild plants, and an appendix lists more than 750 such plants exclusive of fungi. Later followed agriculture, from its simplest form to our present methods—from the simple pointed stick through the hoe to the plough. Chap. 11 of Part I. is of particular interest, for it deals with food-plant remains found in geological strata referred to the later stone and bronze ages —*i.e.* from 2000 to 800 B.C.—among which are recognisable the seeds of wild grasses that have remained unaltered, except under cultivation, to the present day. The earliest men must, of course, have eaten the food raw as collected, but later came the preparation of victuals by boiling, roasting, baking, and fermentation. It is pointed out that, though cultivation now has superseded collection almost entirely, yet the latter still goes on among aborigines and elsewhere in times of stress and also in specific instances nearly everywhere, as in the collection of edible fungi.

Contemporary Developments in Chemistry: Lectures delivered at Columbia University in the Special Course in Chemistry given in the Summer Session of 1926 on the occasion of the Opening of the Chandler Chemical Laboratories. Pp. vi+30+13+26+20+20+16+28+20+17+21+8+14+16+12+24+20+14+15+10+19+29+17+22+17+16. (New York: Columbia University Press; London: Oxford University Press, 1927.) 55*s.* net.

THIS collection of lectures provides summaries of fairly recent progress in various branches of chemistry and is of a moderately advanced standard. It should therefore be of special service to those whose attention is of necessity confined to some particular field, but who wish to keep in touch with other branches of their subject.

The scope of the twenty-five sections is indicated by the following: Chemical reactivity, by J. F. Norris; crystal structure in its relation to chemical problems, by R. G. Wyckoff; immunology as a branch of chemistry, by H. Gideon Wells; radicals as chemical individuals, by C. A. Kraus; contact catalysis, by W. D. Bancroft; theory of velocity of ionic reactions, by J. N. Brönsted; reactions in liquid ammonia, by E. C. Franklin. It is scarcely necessary to point out that many of the sections are now somewhat out-of-date: this applies especially to that on the carbohydrates and to that on water-soluble vitamins. Most of the sections conclude with a useful list of references to original sources. It would be more convenient if the page numbering were continuous throughout the book.

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.*]

Fluorescence of Mercury Vapour under Low Excitation.

IN a letter published in NATURE of Aug. 18 under the above title, I described the excitation of mercury fluorescence using wave-lengths much longer than the resonance line λ2537, and even as long as λ3125. This fluorescence shows the well-known visual green with continuous spectrum. I have since found by photography that, at any rate when the vapour is dense, the spectrum shows, besides the visual maximum, the well-known broad maximum at about λ3300 in the ultra-violet. In this experiment excitation was by the iron arc, filtered by a bromine cell combined with vita glass, and the effective exciting wave-length is somewhere about λ3000.

It is important to determine whether the fluorescence thus excited by wave-lengths longer than the resonance line is of long duration—whether, in fact, it can be distilled away from the place of origin, as in Phillips's experiment with excitation by the core of the resonance line. I find, in fact, that such is the case. So far I have succeeded in carrying out this experiment with exciting wave-lengths up to about λ2650, but have not been able to get the effect with much longer waves owing to experimental difficulties. It is hoped to overcome these and to carry the matter further. In the meantime it seems fairly clear that, contrary to views that have often been held, the long duration does not depend on anything that happens only in the immediate neighbourhood of the resonance level of the mercury atom.

RAYLEIGH.

Terling Place, Chelmsford,
Oct. 29.

Higher Hydrocarbons from Methane.

THE importance of the formation of condensation products by thermal decomposition of methane is of interest to chemists and petroleum technologists alike, the latter being confronted with the problem of the better utilisation of 'dry' natural gas. The pyrolysis of ethane, propane, and the higher paraffins to form aromatic hydrocarbons is a well-established fact, while methane has not been found to show similar tendencies to any appreciable extent.

Several recent patents claim very high conversion yields of methane into ethylene, etc., but are still without published experimental verification. Fischer (*Brenn. Chem.*, **9**, 309; 1928) has shown that under conditions of high gas speeds, and hence short heating periods, with temperatures above 1000° C., the use of active catalytic material being avoided, methane can be made to fall into line with its homologues in yielding higher hydrocarobns, although the yield is very poor.

The formation of small amounts of acetylene has been recorded by Bone and Coward (*J.C.S.*, **93**, 1197; 1908), and also by Fischer (loc. cit.), and it is of interest to know to what extent this gas occurs in the gaseous products of reaction.

As the result of work which has been carried out in this laboratory during the past year, we are in a position to confirm Fischer's recent claims, having used a purified methane gas throughout. This we have found to yield, on subjection to passage through a silica tube at 1100° C. (heating duration of 12 seconds), approximately 10 per cent of liquid and solid hydrocarbons (free from carbon black) calculated on the original methane, while, in other experiments, the gaseous products of the reaction contained 0·9 per cent of acetylene as well as olefines. Analysis of the acetylene, regenerated from its metallic derivatives, indicated that there was not an appreciable quantity of its higher homologues present (n in $C_nH_{2n-2} = 2{\cdot}03$).

It would appear impossible to decide at the moment the mechanism of this reaction. The condensation of molecule fragments 'CH,' 'CH_2,' and 'CH_3,' formed by loss of hydrogen, has been suggested by Bone and Coward and also by Fischer, and this theory is probably the correct one.

In a private communication from Prof. Aarts to one of us, a statement was made to the effect that a highly active form of carbon, prepared under special conditions, can combine with hydrogen to form liquid hydrocarbons at ordinary pressure. This has since become the subject of English Patent No. 278,745.

It would be interesting to know whether the carbon formed in this decomposition process, which we have always found in this reaction in increasing quantity, and probably of less activity, with decreasing gas rate, possesses, even temporarily in the nascent state, any such activity sufficient to form higher gaseous hydrocarbons.

This work fills a distinct gap in the recorded behaviour of pure methane on thermal decomposition, and opens up new fields for investigation.

H. M. STANLEY.
A. W. NASH.

Department of Oil Engineering and Refining,
University of Birmingham,
Oct. 30.

Long Wave Radio Reception and Atmospheric Ozone.

I THINK that it is desirable that I should add a note of warning to Mr. Sreenivasan's letter under the above title in NATURE of Oct. 27, as there are two or three points about the ozone values that would probably not be familiar to Mr. Sreenivasan, which make it doubtful whether the relation that he brings out is a real one.

First, the steady decrease in the ozone values during the period that he used is due to the regular annual variation of ozone which we have found every year in regions outside the tropics. It is always dangerous to assume a direct connexion between two quantities where the variations of at least one of them are chiefly due to an annual periodicity, and particularly where the two values show only a steady increase or decrease during the period under review.

Secondly, while our observations have not yet begun in India, the results that we have for other places of low latitude indicate that the annual variation of ozone in these latitudes is very small and the values are very constant all through the year (the monsoon conditions in India may make the ozone variations somewhat abnormal there).

Finally, we have no evidence of any world-wide variations of the amount of ozone, and it appears that the values depend chiefly on the time of year and on the atmospheric conditions in the immediate vicinity. I should not, therefore, expect that there would be any appreciable connexion between the ozone values found in Europe and those found in India. For these reasons it is very desirable to have more confirmation before accepting the connexion between radio signals in India and the ozone values in Europe as a certainty.

It may well be that there is some connexion between ozone and radio reception where both are in the same locality—possibly similar to that between magnetic storms and radio reception—but at present we have not been able to obtain suitable radio data over a sufficiently long period to test this point.

G. M. B. DOBSON.

Robinwood,
Boar's Hill, Oxford.

Diffraction of Cathode Rays by Calcite.

A MONOCHROMATIC beam of cathode rays was directed against a cleavage face of calcite at a grazing incidence, and the diffraction pattern was obtained on the photographic plate placed behind the crystal normal to the incident beam. The energy of cathode rays, which were generated in a gas tube worked by an induction coil, was about 50 kilo electron-volts, the wave-length of the corresponding material waves being about 0·055 A. In the photograph reproduced (Fig. 1) is shown one of the patterns, which was obtained when the incident beam was perpendicular to [110] axis of the crystal and made an angle of 6° with the cleavage face. The photographic plate was placed 6·4 cm. away from the crystal. As will be seen, the pattern consists of a number of bands of different

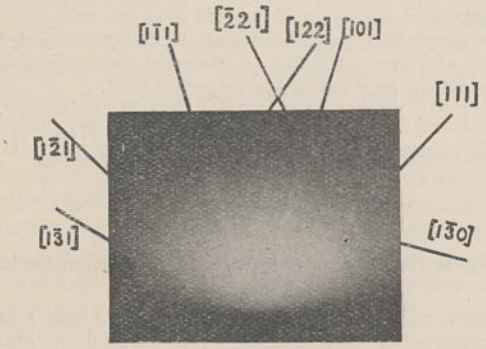

FIG. 1.

widths (for example, [111] in the figure), and also many black and white lines (*e.g.* [13̄0] in the figure), 'black' and 'white' being referred to the negative. It resembles the pattern which is produced when the cathode rays are transmitted through a mica sheet of certain thickness (S. Kikuchi, *Proc. Imp. Acad. Japan*, **4**, 271, 275, 354; 1928). Usually a black line makes a pair with a white line parallel to it. When the distance between the lines becomes small, the pair looks like a band. In fact, one edge of a band is bounded by a black line and the other edge by a white. There is no doubt that the band is nothing but a pair of lines separated by a short distance. Moreover, some of the bands show satellites which may be regarded as other pairs of black and white lines parallel to the main bands (for example, [13̄1] in the figure, though difficult to recognise in the reproduction).

As for the mode of formation of the pattern, a similar interpretation may apply as that already given for the pattern of the fourth type (loc. cit.); namely, if electrons could penetrate into the crystal, undergoing a multiple scattering without an appreciable loss of energy, then the electrons scattered by the crystal atoms will form divergent rays emerging from a point source in the crystal itself. These are regularly reflected by the net planes in the crystal according to the Bragg condition, and the cones of reflected rays thus formed intersecting with the photographic plate should give rise to the black lines, while at the same time white or absorption lines will be produced by the loss of the rays that are reflected. This happens when the intensities of the rays reflected from the two sides of the plane are not equal. Since the probability of scattering through large angles is smaller than that through small angles, white lines should appear nearer to the central spot than the corresponding black line. This is actually proved to be the case. When the net plane is just parallel to the incident beam, it may be expected that the lines should disappear owing to the compensating effect due to the reflection from both sides of the plane. Even in this case, however, there appears still a sort of band, of which both the edges have the same structure.

Corresponding to each pair of black and white lines or each band, we can find the net plane in the crystal that produces it. The intersection of the plane with the photographic plate falls midway between the black and white lines of a pair. The intersections are shown in the figure by the lines prolonged outside of the picture, and the indices of the planes are given in square brackets. The distance between the black and white lines calculated on the above assumption from the wave-length used and the spacing of the corresponding net planes is in good accord with that observed. The satellites of the band can also be explained as due to the reflection of higher orders. Relative intensities of such lines due to different orders show a close similarity with those of X-ray reflection of the corresponding orders. This seems to show an important fact, that the structure factor for X-ray reflection has a similar influence on cathode ray reflection.

The above method would be more useful than the transmission method on account of its possibility of extensive application on many crystals. Besides calcite, cleavage faces of mica, topaz, and zinc blende and a natural face of quartz were tried, and it was found that they also give similar patterns. In some cases, besides these lines above described, spots similar to Laue's were observed on the plates. When the photographic plates were placed on the lateral side of the incident beam, some lines were also observed which must have been produced by the electrons deflected through an angle greater than 90°. When the initial energy of the electrons is less than about 15 kilo electron-volts the patterns were no longer obtainable.

SHOJI NISHIKAWA.
SEISHI KIKUCHI.

Institute of Physical and Chemical Research,
Tokyo, Sept. 17.

Changes in the Form of Mammalian Red Cells due to the Presence of a Coverglass.

IN 1924, Gough described a remarkable change in the form of mammalian red cells which can be observed in suspensions of these cells in isotonic saline (Gough, A., *Biochemical Journal*, **18**, 202; 1924). The normally discoidal cells become perfect spheres, the volume of which can be shown to be the same as that of the discoidal forms. It has hitherto been believed that it is the immersion of the cells in saline which produces this change of form. This, however, is not the case, as the following experiments show.

(1) A suspension of washed human red cells in isotonic saline (0·85 per cent sodium chloride) is prepared. If the cells are examined in a drop without being covered with a coverglass, they show the typical discoidal form with biconcavities. Often a little crenation is present. If the same drop is covered with a No. 0 coverglass in such a way that only a thin layer of fluid is left between the coverglass and the

slide, the cells become perfectly spherical. The distance between the slide and the coverglass is about 10 μ; the diameter of the spherical cells is about 5 μ, and so the cells move about freely between the glass surfaces. If the coverglass is removed and the fluid beneath it examined in a moist chamber, it will be observed that the cells slowly reassume the discoidal form. First they show fine crenations, but remain roughly spherical; afterwards they suddenly become discoidal, the disc usually showing some irregularity of contour. The reassumption of the discoidal form does not occur with the same constancy as does the assumption of the spherical form, and usually takes several minutes. The change from the discoidal to the spherical form is almost instantaneous.

(2) That the change of form is largely dependent on the distance between the coverglass and the slide can be shown in the following way. A No. 0 coverglass, 24 mm. × 50 mm., is supported on a slide to one end of which is cemented a small glass strip about 1 mm. thick. A wedge-shaped chamber is thus formed, which can be filled with the cell suspension. Examination of the end of the chamber at which the slide and coverglass are widely separated shows that the cells are discoidal, while at the narrow end of the wedge, where the distance between the glass surfaces is small, they are perfect spheres. At an intermediate position they are extremely crenated, the crenated form being apparently intermediate between the discoidal and the spherical form. After some time crenation may appear even in the deep end of the chamber, and a few spherical forms may be seen.

(3) The pressure of the coverglass plays no important part in the production of the phenomenon, as may be shown by turning the stage of the microscope at right angles to the table.

(4) If a drop of a suspension of red cells is placed at the edge of a coverglass, the cells in the drop will be seen to be discoidal. As the cells are carried under the coverglass by the flow of the fluid, they become spherical. After some time, sufficient fluid may pass under the coverglass to raise it considerably from the slide (under which conditions the coverglass will slip off the slide if the latter is tilted vertically); the cells passing between the glass surfaces are now discoidal.

These and other similar experiments indicate that the assumption of the spherical form of the cell is dependent on its being in close proximity to two closely opposed glass surfaces. The nature of the surfaces may vary; for example, both slide and coverglass may be paraffined. It is impossible to avoid the conclusion that a force, capable of bringing about a distortion of the cell, exists between the surfaces, and it is possible that this force is related to the molecular fields which exist between two closely applied plates separated by a fluid. Further experiments will show whether or not this explanation is adequate. If it proves to be so, or, indeed, if any such force is shown to exist in general between two opposed glass surfaces, the fact is worthy of the attention of cytologists and of others working with similar preparations.

It should be mentioned that the change of form is not shown by red cells suspended in serum, plasma, hæmoglobin solution, or solutions of many other surface active substances. It occurs, however, in isotonic citrate, in Locke's solution, and in other balanced saline solutions, and in the case of all mammalian red cells which have been examined.

ERIC PONDER.

The University, New York,
and the New York Zoological Society.

Series Limits.

IN a recent letter to NATURE (April 21, 1928, p. 619), I gave evidence that there exist cases of spectral series which undoubtedly depart from the predictions of Hund's theory of the limits of component series. Hund's predictions have been used extensively by many workers in the field of atomic spectra, and have led them frequently into error in dealing with spectra with inverted terms. The question is one of fundamental importance in the dynamics of the atom.

In my previous letter I stated that I had been able to find no flaw in Hund's argument which could lead to any change of the predictions. Recently, however, working from the known cases of the failure of the theory, I have been able to detect a step which renders his whole argument invalid.

The error lies in a failure to realise that a strong magnetic field, in the usual sense, may still be a weak field from other points of view. Actually, the ordinary strong field produces the Paschen-Back effect of each multiple term, but leaves terms of different L and S still separate, that is, the $(L\,S)$ coupling is broken down, and the J's disappear, but the $(l_1\,l_2)$ and $(s_1\,s_2)$ couplings remain intact. Hund compares the atom in such a field with the limit term plus electron in a field so large that all the vectors $l_i\,s_i$ are quantised independently along the field, that is, even the $(l_1\,l_2)$ and $(s_1\,s_2)$ couplings are broken down. Obviously, the two magnetic fields are of different orders of magnitude.

Consider a particular example, the $^3P\ ^1P$ built on a ^2P by the addition of an s-electron. In the ordinary Paschen-Back field, the $^1P_1$ is characterised by the pairs of magnetic quantum numbers $m_l\ m_s$ (1, 0; 0, 0; − 1, 0), whereas in the larger field the corresponding pairs are (0, 1; − 1, 1; − 1, 0), regardless of whether the system is an inverted one or not. If the ^2P limit is regular, ($^2P_{\frac{1}{2}}$ lower) those characteristic $m_l m_s$ pairs of $^1P_1$ can only be built from the $^2P_{\frac{3}{2}}$ part of the limit; and, if the ^2P is inverted, they can only be built from the $^2P_{\frac{1}{2}}$. The latter case will serve to illustrate.

$^2P_{\frac{1}{2}}$.		S-electron.		Resultant.		
m_l	m_s	m_l	m_s	m_L	m_S	
0	$\frac{1}{2}$	0	$\pm\frac{1}{2}$	0	1	$^1P_1$
− 1	$\frac{1}{2}$			0	0	$^3P_0$
				− 1	1	$^1P_1$
				− 1	0	$^1P_1$

This leads to agreement with the empirical data for inverted terms.

In dealing with such cases of the addition of an s-electron to a limit term, the usual rule must be used; that, as the magnetic field increases, sub-levels of the same m must not cross. This rule is sufficient to give correct results for both regular and inverted terms in all the known cases of an s-electron, including $^3P^1P$ on ^2P; $^3D^1D$ on ^2D; $^4D^2D$ on ^3D; ^4F and ^2F on ^3F. But when one applies the rule to the more complicated cases where the series electron is a p or d electron, it is found that the various levels of any actual case may or may not give a co-ordination between the separate ion levels and the series levels. That means that the non-crossing rule cannot be rigidly adhered to. In other words, we do not know how to find the 'super' Paschen-Back effect for the whole set of terms belonging to such an electron configuration. Since the order in which the increasing magnetic field breaks down the various vector couplings determines the final result, it will probably be impossible to find any general rule to cover all cases.

It is a matter of coincidence that Hund's theory gives the correct result for the simplest non-inverted

cases. It is not to be expected that his predictions will agree with fact in any case involving a p or d series electron either for regular or inverted terms.

A. G. SHENSTONE.

Palmer Physical Laboratory,
Princeton University,
Princeton, New Jersey.

The Invention of the Hot Blast in Iron-Smelting.

PROF. BONE'S claim for Neilson of the invention of the hot blast cannot be allowed to pass unchallenged, for the regenerative principle of heating and cooling fluids had been patented by the Rev. Robert Stirling in 1816. After stating how he proposed to apply this principle in general terms, the inventor proceeds to describe his first modification, which was to be applied "to diminishing the consumption of fuel in glasshouse and other furnaces wherever a high degree of heat is required." Stirling's Scottish specification figured as an anticipation in the Neilson trials, but Stirling refused to appear as a witness against Neilson. The English specification was first printed in the *Engineer* for Dec. 14, 1917. I shall be pleased to send a copy of the reprint of this article to any person who applies to me.

E. WYNDHAM HULME.

37 East Street, Littlehampton.

HAVING read Mr. E. Wyndham Hulme's letter, together with a copy of the article in the *Engineer* to which he refers, and the specification of Stirling's Patent No. 4081 of 1816, I cannot see any ground for his supposition that it anticipated Neilson's subsequent invention of hot blast in iron-smelting. Stirling's specification describes and claims what is usually termed the 'regenerative' principle in furnaces, whereby heat from outgoing hot products of combustion is transferred to an inflowing air draught; and there is not a single word in it referring to the use of hot blast in iron-smelting. The central idea of Neilson's invention as applied to iron-smelting was that the use of an air blast preheated by combustion of small coal on a separate grate *outside* the blast furnace would save many times as much fuel *inside* it, which, paradoxical though it may and certainly then did seem, is nevertheless true; it is obviously different, and never could have been forecasted, from the principle of heat regeneration or recuperation. It was, indeed, one of those flashes of inspiration which sometimes come to a man of genius and through him revolutionise human affairs. In applying his idea at the Clyde Ironworks during the years 1829–32, when its success was so triumphantly demonstrated, Neilson did not use the regenerative principle at all, or indeed any means of preheating the blast described or foreshadowed in the Stirling patent; nor did he use any hot gases or products from the furnace for this purpose. The Stirling patent may be held to have anticipated Siemens' later inventions, but certainly not Neilson's process.

Moreover, when one remembers that in 1842–43 the validity of Neilson's patent was vindicated after two most fiercely contested actions at law in both the English and Scottish Courts, during which the Stirling patent was cited and fully examined, it seems presumptuous of Mr. Wyndham Hulme to ask us now to reverse the decision then arrived at in the Courts. His attempt to dim the lustre of Neilson's great achievement by raking up the embers of a past controversy which, after most exhaustive and searching inquiries, was decided in Neilson's favour at least two generations ago in the most decisive manner possible, is to be strongly deprecated. As I said in my article, the scurvy treatment meted out to Neilson by the ironmasters of his day is perhaps one of the most disreputable chapters in the whole history of industry; fortunately, the law which he invoked gave him some material redress as well as a pronouncement in favour of the originality of his invention; and since that time the verdict of the law has become that of history also.

WILLIAM A. BONE.

Imperial College of Science,
South Kensington, S.W.7.

The Dissociation of Pure Mercury.

WITH reference to Mr. Bradley's letter on the dissociation of pure mercury in NATURE of Oct. 13, p. 573, I do not think that experimental evidence on the conductivity of other dilute amalgams confirms his calculation of the number of electrons per cubic centimetre of mercury.

If the amalgam contains c atoms of X to 100 atoms mercury, and if p, q are the average numbers of free electrons per atom of X and of mercury respectively, then

$$n/n_0 = d/d_0(1 + pc/100q)/(1 + cM/(100 \times 200{\cdot}6)),$$

where d, d_0 are the densities of amalgam and mercury, and M is the atomic weight of X. For dilute amalgams the density may be calculated with sufficient accuracy on the assumption that there is no volume change on amalgamation, whence

$$n/n_0 = (1 + pc/100q)/\left(1 + \frac{M}{200{\cdot}6} \cdot \frac{c}{100} \cdot \frac{d_0}{d_x}\right),$$

where d_x is the density of X. Hence the conductivity should be given by

$$\sigma/\sigma_0 = 1 + 2/3\frac{c}{100}\left(p/q - \frac{M}{200{\cdot}6}\frac{d_0}{d_x}\right) - 1/9\left(\frac{c}{100}\right)^2 \left\{(p/q)^2 + 4\frac{M}{200{\cdot}6} \cdot \frac{d_0}{d_x} - 5\left(\frac{M}{200{\cdot}6} \cdot \frac{d_0}{d_x}\right)^2\right\}$$

By comparing the coefficients of c and c^2 with the empirical values, p/q may be estimated. In the case of cadmium amalgams at 14° C., the conductivities of which are represented by a quadratic formula, the agreement between the values of p/q calculated from the 2nd and 3rd terms of this formula is striking. Allowing for the fact that concentrations in E. J. Williams' paper (*Phil. Mag.*, **50**, 599; 1925) are given in parts of cadmium per part of *amalgam*, I find the formula $\sigma/\sigma_0 = 1 + 0{\cdot}0437c - 0{\cdot}000873\ c^2$, whence the calculated values of p/q are 7·44 and 7·46 respectively. This excellent agreement appears, however, to be fortuitous. The following table gives values of p/q calculated from the measurements of Williams (l.c.), Edwards (*Phil. Mag.*, **2**, 1; 1926), and Johns and E. J. Evans (*Phil. Mag.*, **5**, 271; 1928). In all cases where only one value of p/q is given, the experimental results are represented accurately by a linear formula, and the value of p/q that would be given by equating the coefficient of the quadratic term above to zero is very different from that obtained from the linear term.

In	7·24, 3·40	Ce (300°)	10·0	
Mg	10·2, 6·81	Ga (300°)	9·02	
Tl	4·22, (1·23)	Cu (300°)	10·2	
Tl (100°)	4·53	Cd (100°)	7·70	7·55
Ge (300°)	7·92	Ag (15°)	6·69	
Sb (300°)	11·1	Ag (100°)	8·63	
Y (300°)	9·16	Ag (300°)	14·5	7·98

The conductivity of amalgams is probably far too complex a phenomenon for any such simple relation as that given above to be applicable to every case.

E. S. KEEPING.

University College of Swansea,
Oct. 19.

Algæ in Sodium Phosphate Solutions.

WHILE working in chemical laboratories I have often noticed a green colour in the sodium phosphate bottles which did not occur in any other bottle. On examination under the microscope this proves to be due to the presence of unicellular green algæ, either singly or in chains. I should be glad if any biologist would give me any particulars of this plant, and the reason why it prefers sodium phosphate bottles to, say, sodium nitrate. W. R. TROTTER.

School House, Sherborne.

ONE of the algæ which occurs in sodium phosphate bottles is apparently a *Chlorella*, possessing a prominent pyrenoid, cells 3-5 μ in diameter, from each of which four daughter cells may arise. Mr. W. R. Trotter's reference to cells in chains suggests that he may be dealing with a different species, a *Palmella* or a palmelloid state, for example. The *Chlorella* rather resembles a starved form of *C. pyrenoidosis* Chick, but the latter was described as growing in sewage effluents, rich in available nitrogen. Nevertheless, Dr. Chick (*Proc. Roy. Soc.*, **71**, 458; 1903) found that it would grow in solutions containing only ammonium salts, potassium phosphate, and sodium carbonate, and its mineral requirements were thus very low. Algæ growing in sodium phosphate solutions must similarly be able to grow on mere traces of the essential mineral elements. It is of interest to note that *Chlorella*, according to Hopkins and Wann, is one of the few plants which can grow without calcium.

The presence of such plants in sodium phosphate solutions and their absence from solutions of other sodium salts is probably an extreme illustration of a general tendency among the smaller green algæ to prefer dilute culture solutions in which phosphates are abundant or in excess. Calcium salts, and particularly nitrates, on the other hand, favour the development of small diatoms. So far as is known, however, diatoms are never obtained in culture by inoculation from the air, although green algæ may at times be obtained from this source. The diatoms have usually a higher salt requirement also, which equally will prevent their growth in solutions nominally of one salt. W. H. PEARSALL.

The University, Leeds.

Oils, Greases, and High Vacua.

IN the course of some work (which I hope shortly to publish) on the evaporative distillation of petroleum derivatives, I became aware of the possibility and advantages of using oil in place of mercury as working fluid in condensation pumps. I was distilling lubricating oil in an apparatus similar in principle to that used by Brönsted and Hevesy to separate the isotopes of mercury. The saturation pressure of the oil vapour could be deduced from the observed rate of distillation and the estimated molecular weight of the oil: in a particular case the saturation pressure was about one dyne/cm.^{2} at 118° C., that is, about the same as the saturation pressure of mercury at room temperature. No decomposition could be detected. Clearly, if this oil could be heated until its vapour pressure was, say, 100 dynes/cm.^{2}, without decomposition, it could be used as working fluid in a condensation pump and might be expected to give a performance, without artificial cooling, comparable with the performance of a mercury condensation pump with a cold trap 100° C. below room temperature. I therefore prepared by fractionation a quantity of this oil and evacuated ionisation gauges (large and small thermionic valves), on oil condensation pumps. I have been unable to measure the lower limit of pressure reached by these pumps. 10^{-3} dynes/cm.^{2} has been reached without ovening the glasswork: when the glass was ovened, the ionisation current could not be detected with the instruments available —the pressure probably did not exceed 10^{-4} dynes/cm.^{2}.

Not all oils can be distilled to dryness in the evaporative still. Decomposition usually begins at 320-340° C. I was able to prepare a grease with a vapour pressure of not exceeding 1 dyne/cm.^{2} at 320° C. (as deduced from distilling speed): this grease was used to lubricate the ground joint between the ionisation gauge and the pump in the above experiments. Mr. J. D. Cockcroft, at the Cavendish Laboratory, found the vapour pressure of this grease to be less than 10^{-3} dynes/cm.^{2} at 70° C. As was to be expected, it was too small to be detected by the evaporation method used. Joints made with this grease may in fact be employed freely, even at temperatures as high as 70° C. (This substance is not a 'grease' in the sense used by the oil technologist, *i.e.* it does not contain a soap, but is simply a petroleum jelly residue.)

It has been customary to regard with grave suspicion the introduction of oil or grease into systems in which high vacua are to be produced. This attitude represents a generalisation which must now be subject to many reservations. C. R. BURCH.

Research Laboratories,
Metropolitan-Vickers Electrical Co.,
Trafford Park, Manchester.

Rayleigh's 'Radium Clock.'

Two years ago a 'radium clock' was constructed for the Chicago Radium Institute similar to the original one described by Strutt (*Phil. Mag.*, 1903). Three milligrams of radium sulphate, contained in a thin-walled glass tube, was used as the activating source. A platinum wire sealed into the tube made metallic connexion with the gold leaf support. The containing tube was of pyrex glass and was fitted with a ground joint at the top to allow the removal and adjustment of the parts. A carefully cleaned glass rod was sealed into the upper half of the ground joint which served as a support for the source and gold leaves and provided sufficient insulation for the operation of the clock. A chemical deposit of silver made the inner walls of the tube conducting, with the exception of a small opening left for observation. Due to this silver coating, the tube was not baked out but was exhausted with mercury diffusion pumps.

At the lowest attainable vacuum (less than 10^{-5} mm. of mercury) the period of the clock was about 29 seconds, but after twenty-four hours would increase appreciably, due to the accumulation of gas from the walls of the tube. After several days' pumping the tube was sealed and set up under a bell jar. The ground joint at the top was carefully sealed with red sealing-wax. After several days the period of the clock increased from 29 seconds to 43 seconds, indicating either a leak or a slow emission of gas from the walls of the tube. However, the period remained approximately constant at 43 seconds for several months and was assumed to be in equilibrium. Small changes in period were noted, apparently due to changes in room temperature.

No observations were made of the period of the clock for more than a year, when it was noted that the period had decreased and now has a value of 34 seconds. Since any leakage of air into the tube would increase the period of the clock, it was thought that perhaps some 'clean up' action due to the β- and γ-rays was taking place within the tube. It scarcely seems possible that any changes in the gold leaves

could account for this much change in the period. There would be some increase in charge on the walls, but this would be practically equalised each time the leaves discharge in contact with the case. Whatever the explanation may be, the observed fact was thought to be of sufficient interest to put on record.

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Processes of Colour Photography.

OWING to the fact that my article on "Processes of Colour Photography" (NATURE, Nov. 3, p. 687) was written some months ago, and to the fact that progress in this branch has suddenly become rapid, some of my statements are already out-of-date.

The commercial production of another 'tripack,' which it is also intended to market as a triple roll film, has just been announced by a new firm called Colour Snapshots, Ltd., as distinct from Colour Photographs, Ltd. It is reported that these latest packs will be available to the public within a month or two, and should prove of very considerable interest, since they are based on entirely novel principles which have previously been considered impossible. However, examples which I have seen are very promising, and there is little doubt that they will prove a great success.

The novelty is that the red sensitive film or blue printer negative is placed in the front, then the green sensitive, and finally the blue sensitive or yellow printer at the back of the pack, that is, farthest from the lens. This order fits in exactly with the requirements of any printing process, since the blue image, which gives the 'drawing' of the picture, is critically sharp.

With this pack filters of only very low factor are required, and emulsions of high sensitivity can be used so that a very rapid combination can be produced, at least as fast as the average roll film. With the more normal type of pack discussed in my article, only relatively low speeds are obtainable with the types of emulsions at present available.

When it has definitely been proved possible to take a set of three colour separation negatives which even approximate to theoretical accuracy with an instantaneous exposure, then an enormous field will have been opened up, not only for amateur snapshot work in colour, but its effects are also likely to be felt very soon in the world of colour printing and illustration and in colour kinematography.

F. J. TRITTON.

32 Lawn Crescent,
Kew Gardens, Nov. 5.

Habitats of Araucarias and Changes of Climate.

IN *Science News-Letter*, Feb. 18, 1928, referred to in NATURE of Aug. 18, p. 257, the statement is made, on the authority of Dr. R. W. Chaney, that "the living Araucaria species all prefer cool, rather dry habitats." This statement was the main reason given for the conclusion that the Gobi region of Manchuria had a dry, rather cool climate in the Cretaceous period when the dominant trees were Araucarias.

In a letter to Dr. Chaney I pointed out that the two species indigenous in Australia, *A. Cunninghamii* and *A. Bidwillii*, occur in tropical or subtropical latitudes in regions of heavy rainfall, and that other species of the genus occur in New Caledonia and Norfolk Island, which can scarcely be described as cool and rather dry.

In reply, Dr. Chaney has written: "I find that I stated that the present-day habitat of Araucaria was in cool dry regions, a statement which should have been qualified to apply to the more common species of South America. Such errors are particularly misleading in connexion with palæo-ecology, and I greatly regret being responsible for this one."

W. B. ALEXANDER.

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Post-War International Scientific Meetings in Germany.

IN the "News and Views" columns of NATURE of Oct. 20 reference is made to the annual autumn meeting of the Institute of Metals planned for September 1929 at Düsseldorf as "the first occasion that any British scientific society has held a meeting in Germany since 1914."

On the occasion of the joint meeting of the Society of Glass Technology and the Deutsche Glastechnische Gesellschaft at Aachen in May last, attended by some 450 persons, our German colleagues, some of whom are prominently connected with other German scientific societies, stated publicly, and with considerable pride, that the meeting of the two glass technology societies was the first fully representative international meeting of two scientific societies to be held in Germany since the War.

The experience of our Society at this meeting was such as to lead us to believe that any other British scientific organisation arranging to meet in Germany can look forward to pleasant and fruitful results.

W. E. S. TURNER.

(Hon. Secretary, Society of Glass Technology.)
The University, Sheffield.

The Unit of Velocity.

IT is only by some such device as that suggested in Sir Oliver Lodge's letter in NATURE of Oct. 13, p. 573, that the Stroud system of units can take its place in a rational scheme of mechanics.

Multiplication and division are primarily operations with numbers; in algebra we write $2x \times 3x = 6x^2$, where x denotes a number. We may, however, in certain cases give a conventional meaning to the result of multiplying symbols which denote physical quantities; thus, if (a) denotes the unit of length, we may take the product $2(a) \times 3(a) = 6(a)^2$, provided we interpret $(a)^2$ as denoting the unit of area.

So in mechanics we may divide distance by time and take the quotient 6 ft. ÷ 2 sec. = 3 ft./sec., provided we interpret ft./sec. as being the unit of velocity. We cannot, however, do this unless velocity be regarded as a fundamental concept, for the unit of which it is advisable to have some such name as is suggested.

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Continued Self-pollination in Cotton.

IN NATURE of Sept. 1, 1928, p. 314, Mr. G. L. Kottur distinguishes between "the deterioration of a selection due to selfing" and "the hybrid vigour of the F_1 plants." Surely, on whatever theory we interpret hybrid vigour, both phenomena are manifestations of it. To attribute to hybrid vigour the greater yield of a variety over its pure line selected for yield is therefore illogical if it is maintained that there is no reduction in vigour on selfing.

J. B. HUTCHINSON.

(Assistant Geneticist.)
Empire Cotton Growing Corporation,
Cotton Research Station, Trinidad,
Sept. 25.

Problems of the Ocean.[1]

THE International Permanent Council for the Exploration of the Sea has issued, as a jubilee volume, a record of all that the contributors think most worthy in the performance of their respective thirteen nations during a quarter of a century of international exploration of the sea. It is thus not only a record of national accomplishment and co-operation, but also an up-to-date epitome of oceanography with the highest authority. He who will know the latest views as to the movements of the Atlantic may read Otto Pettersson on the Gulf Stream and E. Le Danois on the seasonal *va-et-vient* of Atlantic waters, while Everdingen recounts the Dutch observations on the velocity of currents in the North Sea. Of nitrifying and de-nitrifying bacteria and the variation of phosphate and nitrate content, K. Brandt gives a brief but clear account; salinity and its relation to freezing, alkalinity and its relation to carbonic acid, are expounded in an attractive essay by W. E. Ringer: Gran considers the response of the plankton to all these varying conditions, and Ostenfeld its geographical variation (see also the obituary notice of Cleve), with consideration of the extent to which herrings select from it or feed omnivorously. Hjort's souvenir of s.s. *Michael Sars* is a compendium of the salient facts as to drifting of spawn and the good and bad years of fish production, and the latter question can be followed further in the short summaries by Borley of Miss Thursby-Pelham's work, and by A. C. Johansen of the investigations of Johansen and Kirstine Smith. The general reader, the geographer, and the legislator will find here, in 270 pages of fairly easy reading, the cream of a generation's hard work on the problems of the ocean.

Most instructive of all, and rightly made prominent, is the well-known story of the eel. In 1904, on the Danish research ship *Thor*, Schmidt discovered a single glassy, fish-shaped larva of the common eel, in mid-Atlantic, west of the Faroe islands, lat. 61° 21′, long. 10° 59′. With what patience and success Dr. Schmidt followed up that discovery, and the fascinating story of migration which he revealed—from the English or Danish mill-dam to the Caribbean Sea, and from the Caribbean Sea to the Danish or English mill-dam—this is now knowledge spread through the world. From that single larva discovered by the *Thor* has resulted not only the romantic life-history of the common eel with its intense biological interest, but also light on the movements of Atlantic waters, a considerable piece of evidence as to the theory of continents, and a thriving industry of eel-culture in Germany (with a base on the Severn) estimated by H. Lübbert to have produced already more than 2000 tons of valuable food worth upwards of £200,000. So little is it possible to foresee what will be the actual results of systematic research, or of scientific curiosity and skill. Similarly John Murray showed that, from his examination of one sample of rock from Christmas Island, the British Treasury received in royalties on phosphates and consequent taxes considerably more than the total cost of the *Challenger* Expedition.

Sir John Murray's portrait greets us on p. 15 of the "In Memoriam"; in which obituaries to the colleagues who have passed are prefixed to the national contributions. Preceding the obituaries are the *Procès-Verbaux* of the Conferences, and the book opens with a page of preface by the able president of the International Council, Mr. H. G. Maurice. Each national contribution contains the summarised history of that nation's entrance into the work. France begins with Belon and Rondelet, Scotland with Edward Forbes, and Ireland with Turton, but England follows the more rigid rule adopted by Germany and Denmark, and deals with nothing that happened before 1899. Yet, without calling in Ray, or even Couch, we must go earlier than 1899 to appreciate the English narrative, and must consider how it came to pass that in 1902, as Mr. Borley truly says, "The complex of investigations constituting the sea work was delegated to the Marine Biological Association of the United Kingdom, under the direction of Dr. E. J. Allen. It was thus placed in hands of proved competence."

The history of English fishery research may be said to begin with the International Fisheries Exhibition at South Kensington in 1883, when Huxley's inaugural address startled the unlearned among his countrymen. "Once in a year, an acre of good land carefully tilled, produces a ton of corn, or two or three hundredweight of meat and cheese. The same area at the bottom of the sea yields a greater weight of food to the persevering fisherman every week of the year." Edward Forbes, a generation earlier, had used eloquence and reason in vain, but with the Prince of Wales and the Duke of Edinburgh to help, and with a charming open-air café where all London made its summer evening parties in the new electric light—at length Huxley, Avebury, and Lankester, aided by Spencer Walpole, Norman, and many others, attained success. For the first time some hundreds of the English people were convinced that they who rule the waves and feed from them may profitably attempt to understand them.

With Huxley as president, the Marine Biological Association of the United Kingdom was formed in March 1884, and while the iron was hot Lankester took up the task of making the Association a reality. It was a heavy task, but it is pleasant to know that Sir Ray Lankester sees now the great outcome from those labours of forty-five years ago. He collected nearly £10,000 from more than a hundred donors (besides annual subscriptions) and the Treasury gave a grant of £5000: from these funds £12,000 was spent in building and fitting the Laboratory, finished in June 1888. By 1890 the income, though precarious, exceeded £1200 a year, including £120 from annual subscribers, £500 from the Treasury, and £400 from the Fishmongers' Company. This

[1] "Conseil Permanent International pour l'Exploration de la Mer. Rapports et Procès-Verbaux des Réunions." Vol. 47: Rapport Jubilaire (1902–1927). Pp. iv+274. (Copenhague: Andr. Fred. Høst et Fils, 1928.) n.p.

last was in addition to a princely gift of £2000 towards the initial expenses.

The young biologist, hunting for a post, will be interested now to read page x of the first volume (N.S.) of the Association's *Journal*, issued at the end of 1890. "The Resident Director . . . receives £200 a year and a residence. A naturalist has also been appointed at a salary of £250 a year, whose duties are confined to the study of food-fishes, and provision has been made for an assistant to the Director. These are the only salaried officers of the Association." Yet the pioneer-work done by Cunningham, Heape, Garstang, Weldon, G. C. Bourne, Fowler, Allen, Holt, Todd, and many others was of the greatest value. They each laid their labour on the foundations of Huxley and Lankester, and so helped in enabling their Association, after eighteen years, to be equal to the responsibility of the North Sea investigations.

There were many who helped; for, thirty and forty years ago, three out of four of British zoologists did what they could for the Plymouth Station. But two especial notes must be made. The Worshipful Company of Fishmongers has aided the Association from its beginning with capital, with annual income, with moral support and countenance, and with hard work on the governing Council. It is not too much to say that without the Company's enlightened generosity and kindness there would have been no body in England in 1902 fit to undertake the English share in the North Sea investigations. The other essential element in the history of English marine biology has been the thirty-three years' directorship of E. J. Allen. Four able men, carefully chosen, preceded him in that position, each helping, each creating; but it was from Dr. E. J. Allen's advent that the difficult and halting advance of the Laboratory became a steady progress. Income increased very slowly, but the work done with it increased incredibly, alike in volume, in variety, and in co-ordination. To the scientific eminence and administrative ability of the Director is due the fact that the nearly deserted laboratory of 1893 was able in 1902 to organise with success the North Sea investigation, and that in 1928 it is the focus of biology in England.

The North Sea investigation was entrusted to the Marine Biological Association against the bitter opposition of the Department of Fisheries in the Board of Trade. There was, of course, the perfectly legitimate desire to improve the status of the Department by increasing its revenue, but there was also an old standing quarrel which need only be lightly touched here, though many developments may be read at large in blue-books (*e.g.* Cd. 4304, pp. 290-291 and *passim*; 1908). The trouble was characteristic of the relations between science and Government officials in the nineteenth century, and we may perhaps see signs of the first chapter of its genesis in a letter of Huxley's ("Life," vol. 2, p. 243):

"The *idée fixe* of the British public, fishermen, M.P.'s, and ignorant persons generally is that all small fish, if you do not catch them, grow up into big fish. They cannot be got to understand that the wholesale destruction of the immature is the necessary part of the general order of things."

The chief fisheries official of the Board of Trade took the view here ascribed to the British public: the naturalist of the Marine Biological Association arrived at the conclusion which had been reached by Huxley. The naturalist, being called upon to give evidence before a Parliamentary Committee, said what he thought; the chief official said that this was a departure from discipline; because the Bill had been prepared by the Department, and since the Association received some Government money it must be considered as belonging to the Department; therefore the naturalist should not have given evidence disagreeing with that of his superior official and with a Departmental doctrine of biology. Until the official's retirement, nine or ten years later, this anti-departmental evidence was never forgiven either to the naturalist or to the Association.

However, the Treasury offered the North Sea investigation to the Association, with £1000 for initial expenses and £5500 a year to cover the hire and expenses of a research vessel at sea and of a laboratory on land as well as the salaries to the naturalists. Dr. Allen dared to face even this budget, and, in the event, its two ends were made to meet. This was mainly due to the self-sacrificing habit, among zoologists at that time, of undertaking any kind of biological work at the wages of manual labour. In the 'blue-book' already cited the salaries of biologists at Lowestoft were criticised for their extravagance by a representative of the Department:

7388 . . . "the work of the Association on these lines—this plaice work—has taken the whole time of one naturalist, supplemented to some extent by that of another, whose salary is £200 a year. . . ."

7393-4 . . . "and for ourselves £156 for the salary of a biologist and £130 for material, a total of £286."

7395 "(Mr. Gardiner) What do you pay your biological assistant?" [Answer]—"£156 per annum, or £3 a week. It is only a weekly engagement; there is a liability to dismissal at any week."

Fortunately, the Ministry of Agriculture and Fisheries is not bound by the precedents of the Department of the Board of Trade, and Dr. E. S. Russell, in his able conduct of its investigations, is not content to pay £3 weekly wages for a cardinal piece of research. The Ministry, the Association, and independent biologists now work harmoniously in mutual assistance and profitable co-ordination, and Borley's historical account shows the excellent work which has been done in the North Sea both under the Association and under the Ministry (the main defect in his summary is that it scarcely mentions the important researches made by Mr. J. O. Borley). But the stigma of altruism clings to biologists, and in all branches of the Civil Service the first class man who is a biologist is still paid less than the second class man whose value is not depreciated by such knowledge.

What have we gained by these researches? We know the life-history of the plaice as the life-

history of no other wild animal is known in sea, air, or land. We are steadily compiling the life-history of other food-fishes. In 1902 the North Sea was an opaque grey mystery, in which the Admiralty had charted tidal streams and the Scottish Fishery Board had recorded unrelated surface-drift. In 1928 we know it a mosaic of moving blocks of water the individualities of which have been traced many hundreds of miles in their orderly processions. They are recorded, for the years of international observation, in progress up the Channel or round Scotland, along the 'broad Fourteens' or across by the Dogger, in movements as definite as those of spring Manitoban or American winter wheat, and with comparable economic significance. The vitamins that cure rickets and consumption have been followed from sunlit algæ, through protozoa, crustaceans, and small fish, to the cod which yields them to man. The unexpected history of phosphorus has been shown, with the vast unused hoards of the deep sea, stirred by beneficent storms until our herring are fed, twisted up by the Humboldt current so that the gulls of the South Pacific are able to make guano for English fields. In twenty other aspects of sea-life order now appears where a generation back we knew only curious detached facts and baffling anomalies. Best of all, perhaps, the research has yielded new discovery of curious detached facts and baffling anomalies, among which the labours of the next twenty-five years shall introduce new order, unlooked-for knowledge, and new material for the researches of generations to follow.

Of still wider interest is the achievement of these important results by team-work of united nations. In the continuance of this we are encouraged to look forward to further solution of scientific and economic problems which can be attacked successfully by no single nation. In the extension of such team-work may come regeneration of the world. G. P. B.

The Fixation of Shifting or Blown Sand.

IN the *Scottish Forestry Journal* (vol. 42, pt. i.) Mr. J. F. Annand discusses the progress of the planting work on Culbin Sands, Morayshire. In the *Annales de l'École Nationale des Eaux et Forêts* (*Nancy*) *et de la Station de recherches et expériences forestières* (Tome 2, Fascic. 1, 1928) Monsieur H. Perrin, of the French Forest Service, deals with the same subject in a monograph entitled "La Fixation des Dunes maritimes en France." Since the world's classic example of this type of work was commenced in France a century and a half ago, a brief résumé of the French methods will be first given. The chief area dealt with by M. Perrin (he mentions others of a lesser importance) is the region on the western coast of France between the mouths of the Loire and the Adour, a stretch of fine white sand some 400 kilometres in length extending along the shores of the Bay of Biscay, forming an almost uninterrupted chain of dunes; the most important area lies to the south of the Gironde in Gascony between the latter river and the Adour, a distance of 231 kilometres, with a breadth of from 3 to 7 kilometres.

In 1804, Brémontier estimated the total area of the sand dunes in France at 155,000 hectares, of which 120,000 hectares were in Gascony. It was in this latter area, which owing to its importance and the damage the sand was causing in its march inland by covering up valuable agricultural lands, where the first studies were made some century and a half ago in this matter.

Some controversy has taken place on the subject of the power of shifting sand to continue its advance and destruction indefinitely. Brémontier more than a century ago held that the sand dunes continued an implacable advance in the direction of the prevailing winds, submerging everything in their passage at a rate of 20 metres per year. Others now hold that the sand is unable to advance beyond a certain distance from the coast; that when the wind from the sea lessens in force the sand is either blown back by the land winds or the dunes become stabilised and eventually covered with vegetation. Examples of old dunes of this kind are said to exist in Gascony. Nevertheless it is an established fact that a century and a half ago villages, vineyards, and forests were being gravely menaced in this region by the advance of the shifting sand; and further, the mouths of the rivers were blocked by bars resulting in their waters being held up, large areas of unhealthy marshes being formed just inside the coast line. In fact, at the period when the treatment of the sand was first undertaken the whole locality was malarious and the scanty population wracked with fevers.

The work to be briefly described has completely changed the countryside, which now contains a forest of great pecuniary value covering some 600,000 hectares and affording employment to a large healthy and wealthy population; though it should be remembered that the work in its inception was purely protective. The vegetation of the dunes before treatment and fixation consists in Gascony of the following: *Psamma arenaria* (the commonest species), *Convolvulus soldanella*, *Eryngium maritimum*, *Ononis repens* var. *maritima*, *Cakile maritima*, *Euphorbia paralias*, *Galium maritimum*, *Linaria thymifolia*, *Silene Thorei*, etc. Partial stabilisation brings in *Carex arenaria*, *Helichrysum Stœchas* and *Aira canescens*. When some soil has commenced to form on the sand the following make their appearance—*Erica scoparia* and *cinerea*, *Salix repens*, *Cistus salviæfolius*; *Scirpus holoschœnus*, *Carex trinervis*. On old-established dunes the forest appears, consisting of *Pinus pinaster* (the maritime pine) and several oaks (*Quercus Ilex*, *Tozza*, *pedunculata*, and in the south *Q. Occidentalis* and *Suber* (cork oak), with as undergrowth *Polypodium vulgare*, *Pteris*

aquilina, *Osmunda Regalis*, and, occasionally, *Rubia peregrina*.

This association of plants is of interest, because at the outset in the newly created forests of *P. pinaster* only a thin soil covering of mosses and lichens exists as undergrowth, some of the above species only appearing with the improvement of the soil. It is for this reason that two leguminous plants were introduced with the young pine crops, namely, the broom, *Sarothamnus* (*Cytisus*) *scoparius* and *Ulex europæus* (gorse).

One hundred and fifty years ago this region in Gascony afforded a scanty pasturage to a few troops of half wild cattle and horses. A few scattered areas had been sown up with the seed of *Pinus pinaster*, but the problem of stabilising the sand had not been solved. In 1774 the Abbot Desbiey presented to the Academy of Sciences at Bordeaux a monograph dealing with the fixation of the dunes, but it was not published and was lost. In 1779, Colonel Baron de Charleroix-Villers, Inspector of Fortifications and Works, drew up a memoir, which is now a classic, on the fixation of the dunes and draining of the marshes. His views were approved by the Government, but effect was not given to them. The method of approaching this work was by that time understood, and had been already applied in Holland and Denmark. It was Brémontier, Chief Engineer of Roads and Bridges, who secured the Government's acceptance of his proposals, on the lines of Charleroix-Villers, and started the work in 1787. Brémontier was associated with Peyjehan, a resin merchant who had already sown up some of the sand areas on his own account.

The work was successful from the outset, and it was continued until 1793, by which time 94 hectares had been sown. The work was then interrupted owing to the disturbances due to the French Revolution. It was restarted in 1801 under a 'Commission of the Dunes,' the work being divided between the Roads and Bridges and the Forest Departments. It was carried on in this fashion until 1862, when the business was placed entirely under the Forest Department. By 1864, so far as the fixation of the dunes and the protection thereby gained, the work was completed; 79,000 hectares (out of more than 100,000) had been stabilised and placed under forest at a total expenditure of 9,600,000 francs (122 francs per hectare, or about £2 per acre).

The success led to the recognition of the value of the recovered lands, and private proprietors took up the planting work and claimed some 21,000 hectares of the area which Government had thus brought under a valuable crop, claims which were admitted. What was commenced as a purely protective work has turned out a great financial success, the pine not only providing timber but also a resin which is more lucrative than the timber.

The work on the Culbin Sands in Morayshire will now be considered. These sands extend for about 4 miles along the coast of the Moray Firth. If Maviston Sand Hills, on the borders of the counties of Moray and Nairn, are included, the length of the coast line occupied is about 6 miles, and the breadth of the dunes varies from $1\frac{1}{2}$ to 3 miles. Local tradition ascribes a sudden origin to the existing conditions, asserting that a large tract of once fertile land was overwhelmed and buried beneath the sand. Mr. Annand is probably correct in considering it as more probable that the process was a gradual one, going on more or less regularly or intermittently for centuries. It is, however, a historic fact that the final calamity took place in a great gale in January 1694, when the estate of Culbin, reputed so fertile as to be known as 'The Garden of Moray,' was invaded and overwhelmed in the great sand storm.

The Culbin area may be divided into three zones; (1) Towards the south or landward edge it is rather flat, with a sandy covering of moderate depth, intermingled with stretches of pebbly sand and small shallow marshes; (2) a middle zone consists of low sand dunes with partially fixed surface; (3) farthest to the north and seawards a series of high dunes rises to a height in some instances of 120 feet or more, the dunes being unstabilised and destitute of vegetation. Stretches of flat shingly ground occur also throughout most of the higher dune zone.

The flora of the Culbin sands has been studied by Patton and Stewart (*Trans. Bot. Soc. Edin.*, session lxxix, 1914–15). As is the case in France, the moving sand is fixed by planting marram grass (*Ammophila* [*Psamma*] *arenaria*). When the sand is partially fixed various grasses and weed growth gradually establish themselves, all tending to bind the surface and, says Annand, "ultimately make it fit for tree-planting. Weed seeds have also been sown to hasten the process." Hair grass (*Aira caryophyllea*), Brome grass (*Bromus* sp.) and Yorkshire Fog have been tried with considerable success. *Carex arenaria*, *Lotus corniculatus*, *Viola canina*, are amongst species which establish themselves naturally at the earlier stages of fixation. Thereafter *Calluna* and *Erica* are plants which come in and help to complete the process.

During the last century a considerable part of the ground on the landward zone had been reclaimed from the sands and planted with trees. During the War the greater part of this timber was felled and removed. The task of replanting this area—the Forestry Commission acquired the area in 1922—has proved comparatively easy, the only difficulty having been the draining of the flat marshy parts where the sand dunes had interfered with the natural drainage, a similar state of affairs to that formerly existing in Gascony. More than 1000 acres of ground, mainly of this description, have already been planted.

As regards the work in connexion with the fixation of the moving sands, it is being carried out on somewhat similar lines to the French methods. Space unfortunately precludes a detailed description here of the latter methods, which are now well known or can be readily ascertained by consulting the two monographs here dealt with.

The vital difference between the two is, however, that the French sow the tree seed *in situ*, whereas

at Culbin planting is resorted to. From the earliest French attempts as soon as the sand was sufficiently stablished, in other words on the landward areas where the sand was not in active movement, they sowed a mixture of the seed of the maritime pine with the two leguminous plants, the broom and *Ulex*, the two latter having proved indispensable in assuring the successful development of the young pine. This method has been in force for 150 years, and its success in the case of the sands in Gascony is beyond dispute; and it is cheap. The original species planted last century at Culbin was the Scots pine. Corsican pine appears now to offer prospects of heavier crops of timber, and is to be used extensively.

Whether the experiments so far carried out justify the change from the indigenous species is at least open to doubt; and the same applies to *Pinus contorta* var. *Murrayana*, also supposed to be a rapid timber producer. But all these species are planted. Mr. Annand writes, "The process of fixation of the moving sand is somewhat slow, and three to four years must usually elapse before tree planting can be safely commenced. The work already done, however, appears to provide sufficient evidence that the afforestation of even the most mobile of the dunes can be successfully accomplished." As a matter of fact, this latter problem has not been in doubt for the last century or more. But it would not unlikely prove of easier solution if sowing on the well-tried French lines were resorted to. As regards costs, no comparison between the French and British expenditure is possible, as no data on this head are given for Culbin. Successful sowing is, however, infinitely cheaper than planting.

Recent Excavations at the Cheddar Caves.

By R. F. PARRY.

OWING to the increasing number of visitors to the famous caves at Cheddar, Somerset, it became advisable in the winter of 1927–28 to enlarge the entrance. When the cave was first discovered by the late R. C. Gough some thirty years ago, access to the inner portions was obtained by making a cutting through the debris which blocked the cave immediately inside the entrance. This cutting left standing banks of untouched cave earth on either side to a height of 4 ft. 6 in. against the cave walls. While this original work was in progress, many pieces of ancient pottery and flint tools were found, and when in 1903 a cutting was made for drainage purposes a little farther inside the cave, other finds were made, including the skeleton known as the 'Cheddar Man,' part of a *bâton de commandement*, and numerous flint implements.[1]

These earlier finds were made without any pretence to the keeping of any record that could be of use to scientific workers, and it was with the hope of throwing some light on these that the recent necessary work of excavation was carried out in a systematic manner: the excavations were carried down to a depth of 12 ft. 6 in., or 8 ft. below the level of the path; at this depth rock bottom was reached. The soil was removed in 6-in. layers (numbered from the top downwards), and passed through a fine sieve. A careful record was kept of all finds, so that it is possible to refer any specimen to both its horizontal and vertical position in the deposits.

The cave is the course of an underground stream which in olden times flowed from the present cave mouth, but when the water found the lower level that it pursues to-day the cave became a shelter and was inhabited by man.

The stratification was as follows: The upper 2 ft. 6 in. was composed of the well-known red cave earth so common in the Mendip caves; this was followed by 5 ft. 6 in. of a mixture of cave earth and sand, the proportion of sand increasing with the depth. The layers here showed in section a laminated appearance, bands of clayey cave earth alternating with bands of almost pure sand. At 8 ft. 6 in. a bed of gravel 3 ft. thick was reached; it was composed of waterworn limestone pebbles with a few of sandstone, with a filling of red cave earth and sand. This was no doubt the old river bed, and the upper layers also indicate periodical flooding by the river—an event by no means unknown in recent times. Below these layers came 6 in. of sand and clay, with very few pebbles, and at depths varying from 12 ft. to 12 ft. 6 in. the rock bottom of the cave was exposed.

Now going from above downwards the upper layers showed that the cave had been occupied during the Romano-British period followed by Early Iron Age man, who left behind, amongst other things, a fine bone lance head or point very similar to one from Park Brow, Cissbury,[2] and to some from the Glastonbury and Meare lake villages, pottery of distinctive types, and a bronze two-whorl ring. Immediately below these came implements of definitely Palæolithic types. Layers 9 and 10 were somewhat mixed, giving artefacts of both Early Iron Age and Palæolithic date, and showing also a mixture of recent and Pleistocene animal remains. There were no signs of occupation during the Bronze or Neolithic periods, and yet there were no blank layers, and the deposits go without a break from the Early Iron Age into the Palæolithic Age: a decidedly remarkable occurrence.

The first finds of Palæolithic date commenced in layer 7, and continued downwards to the last layer. A large number of flint implements, including knives, scrapers, borers, and burins, were found. In all, 1749 flints were taken from the excavation, 244 of which were definitely worked implements—a proportion of about 14 per cent. The long narrow flake used as a knife of the

[1] Seligman and Parsons, *Jour. Royal Anthro. Inst.*, vol. 44, p. 241.

[2] R. A. Smith, *Archæologia*, vol. 76.

gravette type with the *dos rabattu* back was the most common. The number of flint cores and chips point to the implements having been made on the spot. The raw flint would have to be carried a distance of some 25 miles from the nearest point at which chalk flint would be available. Mr. J. A. Davies, who has reported on the flint implements, ascribes them to the Aurignacian culture developed along native lines and contemporary with the Magdalenian of France.

Perhaps the most interesting find was made in layer 19 (9 ft. 6 in. deep); this was a *bâton de commandement* of reindeer antler. Part of another was found in the same cave in 1903 close to the 'Cheddar Man.' These are the only specimens found in England, though they are not uncommon in some of the French caves. The use of these artefacts is not very clear; some of the French archæologists consider them to be a kind of sceptre carried by the chiefs, but Sir William Boyd Dawkins and Prof. Sollas and others maintain that they were used to straighten arrow shafts.[3] The latter seems to be the more likely theory. The specimen now found has a hole bored through the expanded portion of the antler where a tine branches. This tine has been cut off. The hole is bevelled on either side in a line with the shaft, and the perforation has five lines cut rather deeply on the inside, presumably to give a better grip to the arrow shaft. The instrument is ornamented on either side of the shaft by bands of lines cut lightly and rather roughly into the surface. The lines are not continued right round the shaft, each side having a separate design.

A rod of ivory and numerous bone piercers and points of a rather distinctive type were found between layers 8-15, and layers 9 and 14 gave us two canine teeth of fox beautifully bored at the root ends for suspension as a necklace ornament. There was also from layer 11 a shell of *Neritoides obtusatus* bored for suspension.

Parts of two human skulls were found in layers 10-13. They have been submitted by Dr. N. C. Cooper to Sir Arthur Keith, who assigns them to the same age as the 'Cheddar Man,' that is, some 12,000 years ago.

The animal remains include wolf, bear and reindeer, Irish elk, arctic fox, and English varying hare.

A full account of the excavations will be published in the next volume of the *Proceedings of the Somerset Archæological and Natural History Society*, where the reports of Mr. J. A. Davies on the flint implements, Mr. H. St. George Gray on the bone and antler implements and pottery, Sir Arthur Keith and Dr. N. C. Cooper on the human remains, and Miss D. M. A. Bate on the animal remains, will appear.

[3] W. J. Sollas, "Ancient Hunters," p. 530.

Obituary.

Prof. Wilhelm Wien.

PROF. WILHELM WIEN, of Munich, whose death on Aug. 30 last, at the comparatively early age of sixty-four years, is deeply regretted, was in the front rank of the physical investigators of his time. He was born at Gaffken, near Fischhausen, in East Prussia, where his father was a farmer, and received the earlier part of his education at gymnasia in Rastenburg and Königsberg. He then studied at the universities of Göttingen, Berlin, Heidelberg, and finally at Berlin again, where he was a pupil of Hermann von Helmholtz.

Wien's career, in its outward aspects, was very like that of most successful German men of science. He took his doctorate in 1886 with a thesis on absorption phenomena associated with diffraction. After two or three years as assistant to Helmholtz, he became a 'Dozent' in Berlin in 1892. In 1896 he became professor extraordinary at the Technical High School in Aachen. In 1899 he was appointed professor of experimental physics at Giessen; in 1900 at Würzburg, where he remained twenty years; and finally at Munich.

The immense importance of Wien's contributions to physics was recognised by the award in 1911 of the Nobel Prize. His published papers cover a great variety of subjects, including hydrodynamical researches (no doubt inspired by Helmholtz), electric discharge in rarified gases, cathode rays, positive rays (*Kanalstrahlen*), X-rays, and, most important of all, the theory of black body radiation.

To appreciate properly Wien's work we have to remember that at the time he began as an investigator the Newtonian basis of physics was still held to be something established for all time, and Clerk Maxwell's electromagnetic theory was a new and daring speculation, regarded by many English and most continental physicists with suspicion and distrust. In fact, so far as physical principles and the underlying basis of the science are concerned, physics was thought by many to have reached a state of completion and finality. Among those who prepared the way for the splendid new era in physical science, Wilhelm Wien was one of the most prominent. His greatest achievements are embodied in the two laws of black body radiation which are named after him.

We owe the first serious attempt at a theory of black body radiation to Gustav Kirchhoff, who showed that the character of the radiation in an enclosure, every part of the walls of which has the same temperature, is independent of the nature of the materials forming the walls and is a function of the temperature only. In 1884, Boltzmann deduced from thermodynamic considerations the Stefan-Boltzmann law expressing the total energy density of the radiation in such an enclosure as a function of the temperature. The problem of the distribution of energy among different wave-lengths was still untouched, and Wien's two laws constitute an important advance in the direction of its final solution. His first paper on the subject was

communicated to the Berlin Academy by Helmholtz in 1893 and entitled, "Eine neue Beziehung der Strahlung schwarzer Körper zum zweiten Hauptsatz der Wärmetheorie." In it he showed that the density of the energy associated with the wave-length λ at the temperature T is proportional to the product of the fifth power of the absolute temperature and some function of the product λT. What is usually called Wien's displacement law is an inference from this; namely, that $\lambda_m T$ is a constant, where λ_m is the wave-length where the energy density is a maximum. Experimental proof of it was soon furnished by Paschen and by Lummer and Pringsheim, who found the value of the constant to be approximately 0·29 cm. degree centigrade.

Wien's second great contribution to the theory of black body radiation is contained in his energy distribution formula, published in 1896, according to which the energy density in the neighbourhood of the wave-length λ is proportional to $\lambda^{-5}\exp.(-c/\lambda T)$, where c is a constant. This law agrees with the observations only when the product λT is sufficiently small, and it has not the same sound theoretical basis as the displacement law. It was, nevertheless, of the greatest importance, since it provided Planck with one of the clues he needed for the complete solution of the problem of full radiation. Although it is unlikely that Wien, or anybody else but Planck, dreamt at that time of such a revolutionary innovation as the quantum theory, he certainly contributed to it indirectly.

Scarcely less important than his investigations of the character of black body radiation is Wien's work on the positive rays or *Kanalstrahlen* discovered by Goldstein. In this important line of research he was a pioneer. So far back as the year 1898 he read a paper to the German Physical Society on the electrostatic and magnetic deflection of canal rays. This was the first of a long series of papers on a subject which occupied his attention almost to the time of his death.

Wien was the editor of the *Annalen der Physik*, the greatest and the oldest of the scientific journals devoted to physics in Germany. A fine lecturer and teacher, he was held in high esteem and affection by his students, and they and all who knew him will mourn the loss of Wien the man as much as that of Wien the savant. This brief appreciation and tribute to his memory may fittingly conclude with words which he himself used on the death of the great master Kelvin:

"Now closes a life that was infinitely rich with an inner wealth, a life that it was worth while to have lived."

PROF. P. P. SUSHKIN.

PETER PETROVITCH SUSHKIN was born on Feb. 8, 1868, in Tula, Central Russia. From his early days he was deeply interested in wild Nature, and already as a young student of the University of Moscow made a thorough study of the bird fauna of the Tula, Moscow, and Voronezh provinces and published his first paper, a forerunner of a long series of faunistic studies on birds of various parts of Russia, from the Urals and the Kirghiz steppes to Altai and Mongolia. Explorations of this kind were made possible for him because, as a brilliant student, he received a special research scholarship at the University of Moscow, and in 1901 he was made a lecturer in zoology. In 1910 he was appointed to the chair of vertebrate zoology and comparative anatomy in the University of Kharkov. During the revolution he had to move from Kharkov to the Crimea, where he lectured in the local university for some time, until in 1921 he was elected Keeper of the Ornithological Department of the Zoological Museum of the Russian Academy of Sciences in Leningrad. Two years later he was elected a member of the Academy. His activities in the Academy were numerous, since, besides being in charge of the bird collections of the Zoological Museum, he presided over several permanent commissions, took charge of the newly formed North Dvina gallery of palæozoic vertebrates of the Academy's Geological Museum, and acted as secretary of its physico-mathematical section.

Ornithological science is indebted to Sushkin for his extensive and thorough studies in the faunistics and distribution of birds of the Altai, Kirghiz steppes, Siberia, and Mongolia. In these studies Sushkin always used his unusually wide knowledge of related sciences and tried to apply the distributional data to the solution of general problems of the origin and history of the bird fauna of palæarctic Asia, and his works are of immense value in this respect to every biologist studying any group of animals in Asia. Faunistic work on birds led Sushkin to his attempts to find confirmation of his conclusions with regard to other animals, and he did a considerable amount of work on the distribution of butterflies, since he believed that their distribution follows more or less the same laws as that of birds. Lately, he expanded his views on the history of the fauna of Central Asia so as to include even the problem of the origin of man, and he believed that man originated in the barren mountainous regions of Central Asia.

Apart from faunistic work, Sushkin is well known for his masterly systematic studies of several difficult groups of birds; these papers of his are particularly valuable because of his deep knowledge of the comparative anatomy of birds. Recently, Sushkin undertook a study of palæozoic reptiles and amphibians, and published several important papers on them, but this work has been cut short by his untimely death, which occurred on Sept. 17 last, from pneumonia. He left numerous pupils in Russia and many friends there and abroad, since he travelled in Europe in 1900 and again in 1924 (when he visited also America). A tragic detail, typical of the conditions under which he had to work in recent years, may be added: his flat in Leningrad was broken into during his funeral and everything of value stolen, including some unfinished manuscripts on which he was actually working up to the day of his death.

FRIEDRICH HAYN, extraordinary professor of practical astronomy at the University of Leipzig, died on Sept. 9 at the age of sixty-five years. He was educated at the Dresden Gymnasium and the Universities of Leipzig and Göttingen. He gained his degree with a thesis on the orbit of comet 1862 III. He then obtained a position at Leipzig Observatory, and retained his connexion with that institution in various capacities for nearly forty years. He is perhaps best known for his studies of selenography and the rotation elements of the moon. He also made numerous observations of comets and planets, eclipses of the sun and moon, and carried out triangulations of the Pleiades and the Præsepe cluster. He was also interested in clocks and time-determination. He was appointed professor in 1920; his work as a teacher during the last eight years has been active and fruitful.

WE regret to announce the following deaths:

Sir Hugh Anderson, F.R.S., Master of Gonville and Caius College, Cambridge, a distinguished worker on the physiology of the nervous system, on Nov. 2, aged sixty-three years.

Sir Alexander Kennedy, F.R.S., emeritus professor of engineering in University College, London, and a past president of the Institutions of Civil and Mechanical Engineers, on Nov. 1, aged eighty-one years.

Prof. Theodor Paul, director of the research institute for the chemistry of foodstuffs at Munich and director of the Imperial Health Department at Berlin from 1902 until 1905, on Sept. 30, aged sixty-six years.

Prof. J. G. Pertsch, Jr., professor of electrical engineering, Cornell University, on Aug. 23, aged forty years.

M. Pierre Henri Puiseux, member of the Paris Academy of Sciences, and honorary observer at the Observatory of Paris, and author with Lœwy of a photographic atlas of the moon, on Sept. 28, aged seventy-three years.

Dr. Joseph T. Rosa, Jr., of the branch of the college of agriculture of the University of California at Davis, who had conducted extensive researches on the physiology and genetics of vegetable crops, on Aug. 22, aged thirty-three years.

Dr. Benjamin W. Snow, until 1926 professor of physics in the University of Wisconsin, known for his work on radiation and infra-red metallic spectra, on Sept. 21, aged sixty-eight years.

Sir Charles Tomes, F.R.S., a pioneer in the scientific development of dentistry, who carried out important investigations on the structure and development of the teeth of some of the lower vertebrates, on Oct. 24, aged eighty-two years.

News and Views.

HIS MAJESTY THE KING has approved of the following awards this year by the president and council of the Royal Society in respect of the two Royal Medals: A Royal Medal to Prof. A. S. Eddington, for his contributions to astrophysics; a Royal Medal to Prof. R. Broom, for his discoveries, which have shed new light on problems of the origin of mammals. The following awards have also been made by the president and council: The Copley Medal to Sir Charles Parsons, for his contributions to engineering science; the Rumford Medal to Prof. F. Paschen, for his contributions to the knowledge of spectra; the Davy Medal to Prof. F. G. Donnan, for his contributions to physical chemistry, particularly for his theory of membrane equilibrium; the Darwin Medal to Dr. L. Cockayne, for his contributions to ecological botany; the Sylvester Medal to Prof. W. H. Young, for his contributions to the theory of functions of a real variable; the Hughes Medal to M. le Duc de Broglie, for his work on X-ray spectra.

THE following is a list of those recommended by the president and council for election to the Council of the Royal Society at the anniversary meeting on Nov. 30: *President*, Sir Ernest Rutherford; *Treasurer*, Sir David Prain; *Secretaries*, Sir James Jeans and Dr. H. H. Dale; *Foreign Secretary*, Sir Henry Lyons; *Other Members of Council*, Dr. F. A. Bather, Dr. C. Bolton, Dr. C. G. Douglas, Mr. R. H. Fowler, Prof. E. W. Hobson, Sir Frederick Hopkins, Prof. A. Lapworth, Prof. J. C. G. Ledingham, Prof. F. A. Lindemann, Dr. P. C. Mitchell, Prof. J. C. Philip, Prof. A. C. Seward, Prof. G. Elliot Smith, Sir Thomas Stanton, Mr. A. A. C. Swinton, and Prof. C. T. R. Wilson.

THE immense practical importance of virus diseases of plants is being increasingly recognised, and it is a pleasure to note that the investigation of their more fundamental aspects has not been lost sight of. Generous provision has now been made for the latter by a grant from the Empire Marketing Board to the Rothamsted Experimental Station. This will allow of the addition to the staff of the Station of a plant physiologist, a cytologist, and an entomologist, together with adequate maintenance, equipment, and laboratory assistance. The grant also provides for the erection of a range of insect-proof glasshouses with special facilities for virus researches. The appointments will be to the Department of Mycology, of which the head is Dr. W. B. Brierley. The chief of the Section of Virus Diseases in the Department is Dr. J. Henderson Smith, whose work in this field is already well known, and the intimate co-operation of a medical bacteriologist, a plant physiologist, a cytologist, and an entomologist in the intensive study of the more fundamental aspects of virus diseases marks a noteworthy step forward in the exploration of this congeries of very difficult and obscure problems. Further, this group of workers will be an integral portion of a research department of mycology, and thus carry out their investigations in the closest association with workers on fungous and bacterial diseases of plants and general plant pathology. The Empire Marketing Board is to be congratulated on its wisdom in making this development possible, and it is hoped that the Department of Mycology at Rothamsted will become an Empire centre for the study of virus diseases of plants where workers from at home and overseas will be welcomed and find facilities unobtainable elsewhere.

THE centenary of the *Spectator*, which again recalls by its name the earlier publication of Addison and Fielding, was celebrated last week by the issue of a voluminous and interesting number, giving both the history of the review since 1828 and general articles by many leading writers in science, literature, and politics. It may well claim an honoured, and even a unique, position among English journals. With the *Times* and *Punch* it probably represents better than any other paper the mental attitude of the English cultivated middle class, which is, in the broad sense, liberal, without being revolutionary, very open to useful new ideas while tenacious of the settled traditions of the country, eager to redress palpable injustice while avoiding sensations and dangerous adventures. The *Spectator*, founded by an ardent and outspoken Scot, R. S. Rintoul, and established by Meredith Townsend and R. H. Hutton, tended during the long editorship of J. St. Loe Strachey rather to the conservative side. This was due, as in so many other cases, to the split over Home Rule, and, the Irish question being now out of the way, it has resumed a more comprehensive attitude. Its circulation has recovered, and is far higher than even in the palmy days of Townsend and Hutton.

IT is pleasing to notice that in this centenary number of the *Spectator* considerable space is given to articles on the progress and prospects of science. Both Sir Oliver Lodge and Sir Alfred Ewing contribute papers. This way undoubtedly lies the best hope of the future, especially for the classes of people who read the *Spectator*. There is great scope and great need for a further admixture, both of the results and still more of the spirit of science, in publications which appeal to the general reader and must perforce give their main space to books and politics. While the scientific journal becomes more specialist, the general aspects of science will need more constant presentation to the non-specialist. We congratulate our veteran contemporary most heartily on its long course so brilliantly executed and the vigour with which it faces the tasks of another century.

ABOUT thirty years ago V. Poulsen of Denmark invented the telegraphone, an instrument for recording sounds in such a way that they can be reproduced. In the case of the gramophone, the recording and reproducing are purely mechanical, but the telegraphone is worked magneto-electrically and can be operated from a distance. The principle on which the instrument acts is that of magnetising in varying strengths the successive points of a thin steel wire as it is moved past the pole or poles of an electromagnet, the winding of the electromagnet being in the secondary circuit of an induction coil connected with a microphone. On speaking into the transmitter, the induced currents in the secondary produce variations in the magnetic field which cause the moving wire to be permanently magnetised in different intensities along its length. If we pass the steel wire magnetised in this way in the same direction as it originally passed the poles of the electromagnet, the receiver produces the original sounds, the loudness, however, being much diminished. It was proposed many years ago to use the instrument for the recording of conversations held over an exchange telephone line. When the subscriber is absent, the ringing of his bell automatically starts and switches in his telegraphone. On the return of the subscriber his telegraphone repeats the caller's message. The sounds heard in the telegraphone were quite clear and were free from extraneous noises, but they were faint, and in most common battery telephone circuits the results were poor.

A CONSIDERABLE step in advance in developing the telegraphone has recently been made by Dr. Curt Stille. According to the *Times* of Nov. 1, a British group of financiers has obtained from a German bank the rights of manufacture for the whole world outside of Germany. It is claimed that the new machine can be used for recording speeches and office letter dictations, the wire 'record' being wound on a spool. It can also be used to record telephone messages. It is claimed that the provincial and foreign correspondents of newspapers will thus be able to transmit news by telephone at a quarter of the present cost. A demonstration of the new apparatus was given in London on Oct. 31. Among the items recorded were a vocal solo, a recitation, and an orchestral selection. After a few minutes' waiting the mechanical process was reversed and the complete programme was reproduced. The reproduction, although the tonal effect was not quite so good as a gramophone, was clear and strong. Some of those present spoke into the machine and heard the reproduction of their voices immediately afterwards.

IN his presidential address to the Institution of Electrical Engineers, delivered on Oct. 25, Colonel Edgcumbe discussed mainly the economics of engineering production. It was encouraging to hear him prophesy that the electrical industry will double, and possibly even treble, its production in about fifteen years' time. There is the important limitation, however, that no industrial upheavals occur in the interval. He touched on more controversial matter when he suggested that the British manufacturer should be protected from foreign competition in the home market, although he modified the suggestion by saying that it should only be for a limited period. He made the proposition very attractive by saying that if the manufactured goods of the value of 100 millions sterling at present being imported into Great Britain were made here instead we could find employment for 800,000 men and thus solve the unemployment question. He does not grudge our foreign friends their orders, but merely regards tariffs as an economic necessity of the moment. He said that when a corporation places an order for £50,000 abroad the chief sufferers are the unemployed, some 500 operators being kept out of employment for about six months. In order that a country may have a high standard of living it is necessary to have a high rate of production per annum. In the United States and in Canada the yearly output per operative is nearly £900; in Great Britain it is only about half this. The relative pur-

chasing power of the hourly wage in America is nearly double that of our own. We think that his suggestion of selling a certain fraction of a factory's output overseas at cost price, or even slightly less, is a sound one. He shows how it might actually bring down the cost to the home purchaser. Electrical undertakings nearly always sell 'power units' at a much cheaper rate than 'lighting units,' and this policy can be justified. It is no easy matter for one manufacturing country to compete with another where working hours are longer, wages are lower, and where also luxury, entertainment, and living are on a much lower plane.

IN his Cameron lecture, delivered to the University of Edinburgh on Oct. 30, Dr. F. G. Banting gave a historical account of the research that resulted in the discovery of insulin. It was exactly eight years previously, on Oct. 30, 1920, that he conceived the idea that, if he ligatured the pancreatic duct and allowed the pancreas to degenerate, he might be able to obtain from the degenerated pancreas an active extract of the islets of Langerhans. He obtained permission to try out this idea in the Department of Physiology in the University of Toronto, and also obtained the services of Dr. Best, who was then a medical student, for help in estimating blood sugars. Work was commenced in May 1921, and the extracts from degenerated pancreases were found to lower the blood sugar and to produce clinical benefit in depancreatised dogs. A more adequate supply of islet extract was found to be available in the pancreases of fœtal calves, and from the material thus obtained something was learnt of the solubility of the active principle. This led to the discovery of a method by which active alcoholic extracts could be obtained from the pancreases of adult cattle.

CONTINUING, Dr. Banting said that in January 1922 the pancreatic extracts were first tried on diabetes patients. The results were sufficiently encouraging to cause Prof. J. J. R. MacLeod to turn a large proportion of his staff to work on the problems of the physiological activity of the pancreatic extract. Very soon the results were such as to attract general attention, and from that time onwards intensive investigations on insulin have been conducted all over the world. Prof. Banting succeeded where many failed, and this fact lends special interest to the concluding words which he addressed to his large audience of students. "I am a firm believer in the theory that you can do anything that you wish in this world, within reason, if you are prepared to make the sacrifice, think and work hard enough and long enough.

> 'There is no chance, no destiny, no fate
> Can circumvent, can hinder or control
> The firm resolve of a determined soul.
> Gifts count as nothing. Will alone is great;
> All things give way before it soon or late.'"

PATENT law, which ought to operate to the encouragement and reward of chemical investigation, frequently exercises a quite contrary effect. Remarking that chemical invention differs in many respects from mechanical invention, Mr. F. H. Carr, the immediate past-president of the Society of Chemical Industry, referred in his recent presidential address to the unsatisfactory state of legislation in this matter, and offered the suggestion that chemists in various countries should endeavour, in some concerted manner, to encourage research, to maintain a truly international spirit in science, and to secure a just reward to the inventor for the improvement in industry resulting from his invention—the reward, moreover, including recognition of the value of researches freely published in scientific journals. Such preliminary action should lead to an improvement in the unification of patent law and avoid the necessity for much of the secrecy which surrounds many important manufacturing operations and investigations carried out in connexion therewith. On one hand, a large number of chemical patent specifications are designed to bar the field of research to other workers, and, on the other hand, many successful inventions yielding large royalties are based on the scientific work of others who have not sought patent protection.

MR. CARR'S stimulating address was not confined to criticism, however justifiable, but discussed the work of the research associations, and referred to some of the major advances of chemistry and chemical industry, naturally with particular reference to those based on researches carried out in Great Britain and the United States of America. Mr. Carr concludes—and few competent judges will disagree—that industrial leadership should be entrusted to those who understand science and are therefore able to judge the value of an invention; further, that amalgamation, whether of firms or of their research departments, should be accompanied by the provision of effective scientific leadership invested with a proper degree of influence in relation to commercial and financial affairs. With Mr. Carr, and with all scientific workers of goodwill, we hope that when the world is finally released from the fear of war and from the fear that our civilisation may suffer destruction through the power of science, nations will combine to promote with greater intensity the objects of science in harnessing the resources of the world to the betterment of mankind.

IN 1781 there was published at Mannheim, on behalf of one Henry Zimmermann, an account of the third voyage (1776–1779) of Capt. James Cook. Not long ago the Alexander Turnbull Library, Wellington, N.Z., prepared and issued a translation of this record, for which we believe Miss Tewsley, of the library staff, was mainly responsible. Much interesting matter is made generally available thereby. Zimmermann's narrative informs readers that in the year 1776 two war-sloops, the old *Resolution* and *Discovery*, were being sent out on an exploring expedition, and he signed on the latter as a common sailor. She had 72 men and 12 guns aboard, and in command, Capt. Charles Clerke. "Fearing," he says, "as indeed proved to be the case, that we sailors would be obliged either to give up, or to destroy, all papers dealing with public matters, I took the precaution to write down briefly, and in the German language, all the principal

events which took place. It is from this notebook and my memory that I have drawn the materials."

ON Thursday last, Nov. 8, occurred the centenary of the death of Thomas Bewick, celebrated for his woodcut illustrations of animals and birds. A north-countryman, he was born at Cherryburn, Northumberland on Aug. 12, 1753, and died at Gateshead on Nov. 8, 1828. Early in his career, and whilst in apprenticeship at Newcastle, Bewick secured the valuable patronage of Dr. Charles Hutton, the mathematician, whose treatise on mensuration was in progress. After working in London for a short time Bewick returned to Newcastle. In 1790 appeared "A General History of Quadrupeds"; in 1797 the first, and in 1805 the second, volume of his "History of British Birds," considered to be his premier work. For R. J. Thornton's "Family Herbal" (1814) Bewick prepared two hundred and fifty-eight engravings exemplifying plants drawn from Nature by Henderson. He also designed the woodcuts in Robert Bloomfield's "The Farmer's Boy" (1800). Bewick rendered distinct service to the science of his time as an interpreter, through spirited and facile engravings illustrative of many branches of natural history in the wild. He did not profess to be other than an observant student, but fine craftsmanship was at his call. To the country gentleman he was an inspiration. Reference to the British Museum Catalogue of Printed Books will show the nature and astonishing variety of his illustrative efforts. His accessories, backgrounds, vignettes, and tail-pieces bore each a story. There is a portrait of Bewick by James Ramsay in the National Portrait Gallery.

THOSE of our readers interested in Prof. Bone's article in the issue of Sept. 1 on "The Centenary of James B. Neilson's Invention of Hot-Blast in Iron Smelting," will be glad to know that the West of Scotland Iron and Steel Institute has recently published in booklet form a short life of Neilson, compiled by Mr. T. B. Mackenzie. Included in this booklet are a portrait of the inventor, a reproduction of the painting showing Neilson, Macintosh, Wilson, and their law agents, made after the great 'hot-blast trial' at Edinburgh, and some sketches showing the early application of the hot blast. Extracts are also given of Neilson's address at the opening of the Workmen's Institution which he founded at the Glasgow Gas Works, and Neilson's own account of the steps by which he was led to his epoch-making invention. The latter is extracted from the reports of the discussion which took place on a paper read by Mr. H. Martin before the Institution of Mechanical Engineers in Birmingham, "On the Construction of Hot Blast Ovens for Iron Furnaces," the paper being read on May 4, 1859, and the discussion taking place on July 27. Neilson undoubtedly belonged to a clever family, and in the brief biographical sketch we are given we see him as a man of quiet, reflective mind, strict in his religious and social duties, unassuming and kind, and invariably actively interested in the welfare of those around him. We are not told what fortune he made or left, but in concluding his interesting review Mr. Mackenzie remarks: "It may be estimated that as a result of Neilson's invention of the hot blast his country has benefited to the extent of about twelve million pounds sterling per annum."

THE destructive winds that occurred in several places in the south-east of England, including a part of London, on Oct. 22, have been the subject of an official inquiry by the Meteorological Office. The request for information from private individuals met with such an unexpected response—264 letters and 217 barograms had been received up to Nov. 3—that the inquiry is still in progress. It has been established, however, that the London storm travelled slightly east of north on a straight path of very narrow width, from near Victoria station to Highgate, but it was diminishing in severity by the time it had reached Euston, and no damage was reported until a fresh access of energy took place at Highgate. Barograms on the storm's path showed a very sudden fall and recovery of pressure, amounting as a rule to two or three millibars. The phenomena observed were similar in character to those of an American tornado, but although the wind was of destructive violence it was less strong than that of a typical American storm. It was unfortunate that it occurred after dark, as this made it impossible to tell whether the characteristic 'funnel cloud' was present. Events of a similar nature took place on the same evening at Bromley (Kent), where a track parallel to that of the London tornado was followed, and near Southampton. It may be recalled that in 1913 a tornado occurred on nearly the same date in South Wales, and resembled this one in that its track was very narrow and was from south to north; on that occasion also it practically died out, only to reappear farther north, and there was at least one other outbreak of the same kind in another part of Great Britain.

EXPLANATIONS of the precise conditions under which a tornado arises are somewhat speculative, owing to want of sufficiently detailed observations of atmospheric structure in the immediate neighbourhood. It is evident that they develop most often, as did the London storm, at the discontinuity between different wind currents, but it is unlikely that the differences in density between the different currents provide any appreciable part of the kinetic energy of the whirl, which must presumably come from the latent heat set free in the condensation of water vapour into rain. According to this view, tornadoes may be more frequent in America because of the nearer presence of large areas of warm sea-water capable of supplying the necessary water vapour, and not, as has sometimes been assumed, because of the greater contrasts of temperature there.

THE U.S. coastguard patrol vessel *Marion* returned to New London, Conn., on Sept. 18, after a ten weeks' cruise in the waters between Greenland and Labrador; and some preliminary information as to the main results has been received. More than 2500 soundings were made with the echo gear. The larger part of the area was found to have a depth of more than 1000 fathoms, and 2000 fathoms or more was reached at

the southern end. The Greenland shelf is not so wide as was supposed, and has a very abrupt outer edge. The Labrador shelf, on the other hand, is wider than it is generally charted, and has a remarkable trough in it, running parallel to the coast, at a distance of 40 miles, for the greater part of its length. More than 2000 records of temperature and salinity were obtained at various depths at 191 positions, intended for the dynamical calculation of the speed of the ice-bearing currents on the basis of the work of V. Bjerknes. This will take a considerable time, but so far as they have been examined they have led the officers of the expedition to some unexpected conclusions. No trace of a warm north-going under-current was found in Davis Strait, and it is suggested that the openness of the North Water is due to the shape of the basin. A layer of water 100 metres thick covered the larger part of the deep area with "a temperature 5° above normal." The deep-bottom water had a temperature of 2·6° C., and a salinity of 34·90, and, in the opinion of the leader, Lieut.-Commander E. H. Smith, is not formed locally, but has crept slowly northwards from the Antarctic regions. Warm Atlantic water pushed in past Cape Farewell, and apparently kept well over to the Greenland side; on the Labrador side water of low salinity extended far seawards. About 1000 bergs were seen off Disko Island, and 200 near Cape Harrison. No pack-ice was found south of Cumberland Sound.

At the International Conference for Phytopathology and Economic Entomology, held in Holland in 1923, a prize fund was inaugurated at the instance of Prof. Eriksson, who contributed a substantial sum to it. Other contributions were made and sums collected, so that the standing committee of the Conference is now able to announce the offer of two prizes of the value of 1000 Swedish crowns (about £55) each. The prizes are to be awarded for the best two memoirs concerning: (1) investigations on rust (Uredineæ) diseases of cereals (wheat, oats, barley, and rye); and (2) investigations on the rôle played by insects or other invertebrates in the transmission or initiation of virus disease in plants. Competitors may be of any nationality, and memoirs (which may be in English, French, or German) must reach the Secretary of the Committee on or before May 30, 1930. The awards will be announced, after adjudication by two boards of specialists of international reputation, during the International Botanical Conference in Cambridge in 1930. Full particulars of the scheme may be had on application to the Secretary, Mr. T. A. Schoevers, Wageningen, Holland.

The first Liversidge Lecture before the Chemical Society, entitled "Physical Chemistry in the Service of Biology," will be delivered by Prof. F. G. Donnan in the meeting hall of the Institution of Mechanical Engineers on Thursday, Nov. 29, at 5.30 P.M. The lecture is open to the public, without ticket.

Prof. A. R. Ling, of the University of Birmingham, will deliver the eleventh Streatfeild Memorial Lecture before the Institute of Chemistry in the Lecture Theatre, King's College, Strand, W.C.2, on Friday, Nov. 16, at 8 P.M., taking as his subject, "Contributions to the History of Starch and its Transformation Products." Admission is by ticket, obtainable free of charge, from the registrar of the Institute of Chemistry, 30 Russell Square, London, W.C.1.

It has been decided by the council of the British Institute of Radiology incorporated with the Röntgen Society, to hold a special meeting at the opening of the new session on lines similar to last year, when the inaugural meeting of this body was celebrated. On the present occasion, in addition to the address by Dr. G. W. C. Kaye, the president for 1928–29, papers have been promised by Prof. W. L. Bragg, Sir Thomas Horder, Mr. W. Sampson Handley, Mr. A. T. Walton, Dr. G. Shearer, and other distinguished workers in the radiological world. Most of the meetings will be held at the Central Hall, Westminster, and at the same time there will be shown examples of the most modern X-ray and allied apparatus, which will include exhibits by all British firms engaged in this industry. The proceedings are not open to the general public, but any person practically interested in radiological work is invited to attend. The Director of the Institute, Dr. J. Muir, 32 Welbeck St., London, W.1, will give any information desired.

Intending purchasers of publications of the U.S. Bureau of Standards, such as the *Journal of Research*, obtainable through the Superintendent of Documents, Washington, will be glad to have the information, forwarded to us by a correspondent, that the Superintendent of Documents will not accept cheques, but only international money orders.

The reviewer of "British Rainfall" in NATURE of Nov. 3, p. 678, suggested that Mr. L. C. W. Bonacina's article on the snowfall of the half-century from 1876 to 1925 was inspired by the heavy snowfall in the south of England last Christmas. Mr. Bonacina writes to correct this impression. His article was actually in typescript last November, and the reference to the Christmas snowstorm was added afterwards.

Applications are invited for the following appointments, on or before the dates mentioned:—A chemical assistant in the bio-chemical laboratory of the General Hospital, Birmingham—The House Governor, General Hospital, Birmingham (Nov. 13). Two assistant inspectors of weights and measures under the Somerset County Council—The Clerk of the Somerset County Council, Boulevard, Weston-super-Mare (Nov. 15). A temporary technical assistant on farm economics under the Board of Agriculture for Scotland—The Secretary, Board of Agriculture for Scotland, Queen Street, Edinburgh (Nov. 15). A senior assistant in the chemical department of the West of Scotland Agricultural College—The Secretary, West of Scotland Agricultural College, 6 Blythswood Square, Glasgow (Nov. 15). A lecturer in mechanical engineering at the Aston Technical College—The Chief Education Officer, Birmingham (Nov. 16). An assistant at the Low Temperature Research Station, Cambridge, with

knowledge of physics and biology, for work in connexion with the preservation of fruit and vegetables—The Superintendent, Low Temperature Research Station, Cambridge (Nov. 17). A lecturer in electrical and mechanical engineering at the College, Swindon—The Principal, The College, Swindon (Nov. 17). A research assistant under the Safety in Mines Research Board for work in connexion with wire ropes used in coal mines—The Under-Secretary for Mines, Establishment Branch, Mines Department, Dean Stanley Street, S.W.1 (Nov. 19). An assistant lecturer in dairy husbandry in the department of agriculture of the University of Leeds—The Registrar, The University, Leeds (Nov. 19). An agricultural entomologist at the Kirton Agricultural Institute—The Principal, Kirton Agricultural Institute, Kirton, nr. Boston, Lincs. (Nov. 20). An assistant to the public analyst of the City of Manchester—The Medical Officer of Health, 1 Mount Street, Manchester (Dec. 1). A physiologist, a cytologist, and an entomologist at the Rothamsted Experimental Station, for research on virus diseases of plants—The Secretary, Rothamsted Experimental Station, Harpenden (Jan. 31). An agronomist under the Director of Investigations of the Australian Tobacco Investigation—F. L. McDougall, Room 321, Australia House, Strand, W.C.2. An investigator on aluminium founding, under the British Non-Ferrous Metals Research Association—The Director, British Non-Ferrous Metals Research Association, 71 Temple Row, Birmingham.

ERRATUM.—Mr. K. Sreenivasan, referring to his letter entitled "Long Wave Radio Reception and Atmospheric Ozone" in NATURE of Oct. 27, p. 646, informs us that while correcting the proof he overlooked a mistake on p. 646, near the bottom of col. 2. The figure for correlation given there is $1{\cdot}77 \pm 0{\cdot}23$; it should be $1{\cdot}77/2 \pm 0{\cdot}023$, that is, $0{\cdot}88 \pm 0{\cdot}023$.

Our Astronomical Column.

TAYLOR'S COMET.—Herr Reinmuth, of the Königstuhl Observatory, announces that he made a careful search by photography for Taylor's comet on two nights without success, which gives ground for apprehension that this comet is following the example of the lost comet of Biela; it will be remembered that Biela's comet divided into two portions in 1846; the two portions were again seen six years later, but then vanished completely Taylor's comet likewise divided into two portions in 1916. It was too badly placed in 1922 to make observation possible. It looks as though division into two nearly equal portions is too great a strain on a comet's constitution for it to survive long as a visible object. However, it is too early yet to give up hope, as the comet is approaching the earth, and also coming into a better position in the morning sky.

THE LEONID METEORS.—Prof. Harlow Shapley, in *Harvard Announcement Card*, No. 74, reminds observers that the maximum of this shower is due in 1931 and 1932; he asks for half-hour counts of meteors to be made each night, from Nov. 10 to 17, at as many stations as possible; if this is done each year until the maximum is past, it will give useful information on the distribution of density on each side of the maximum. He also asks for calculations to be made as to the perturbations of the swarm since 1899; it will be remembered that in 1899, Drs. Downing and Johnston Stoney calculated that the action of Jupiter would cause the dense part of the swarm to miss the earth; this was in fact verified, but their prediction was published too late to warn the public, so that great disappointment and considerable distrust of astronomical predictions resulted.

There is a special difficulty in such predictions; the periods of the earth and meteors not being exactly commensurable, we meet each time a portion of the swarm that has not met the earth before, so that we have to guess its position, guided by our knowledge of the positions of other portions of the swarm at a considerable distance away from it.

DISTURBANCES ON JUPITER.—Rev. T. E. R. Phillips spoke on this subject at the October meeting of the British Astronomical Association. Mr. B. M. Peek observed a curious marking south of the south tropical belt early in August. This expelled a number of small dark spots that travelled at a great speed in the direction of increasing longitude. They gave a rotation period of 9 h. 59 m., which is the greatest ever recorded. They were carefully watched as they approached the Great Red Spot. The majority of them were deflected into a curved path which went round the Spot on the north side. As they passed the narrow passage between the Spot and the equatorial belt, they were drawn out into elongated ovals, suggesting a strong current through the narrows. They were followed for a short distance after this and then melted away. A few of the spots hazarded the direct path across the Red Spot, but they suffered for their temerity, as they were lost to sight and never reappeared. Mr. Peek's original marking also produced a region of irregular disturbance, which travelled, though much more slowly, in the opposite direction, that of diminishing longitude.

News of the disturbance was sent by cable to Dr. Wright, and it is hoped that he may have obtained some photographs of the phenomena in light of different wave-lengths; such photographs give information on the relative heights of markings. R. A. Proctor used to explain markings with a long rotation period as having come from a great depth, where the rotational speed was less, so that they lagged behind on reaching the surface.

THE GREAT FIREBALL OF SEPT. 30.—Mr. W. F. Denning writes: "This object passed over the north of England, its luminous flight beginning over Hawick, then passing over Northumberland in a direction to east by south; it continued its course far out over the North Sea to the region of the Dogger Bank. About seventy-five accounts of the fireball's appearance were received, and from the best of these the object appears to have had a height of from about 60 to 21 miles along a path of about 160 miles, which it traversed at a velocity of about 18 miles per second. The radiant point was at 220° + 16°, near the star Zeta in Boötes, which was about 15° above the horizon a few degrees north of west at the time of the meteor's appearance. The light it gave startled some of the many observers in Yorkshire, Durham, and other northern counties. No detonation was heard, but it appears highly probable that the object fell into the sea. Many persons allude to the fireball as appearing to be quite low in the air, several estimates of the height being 50 yards, 100 yards, and 100 feet. Two of the observers state that they distinctly heard a 'fizzing' noise as the object passed. Errors of this kind are often made, however, by persons who lack experience in observing such phenomena."

Research Items.

A CHINESE FRESCO OF T'ANG STYLE.—A second fresco from the Moon Hill Buddhist Monastery near Ch'ing Hua Chên in Honan Province has been acquired by the Museum of the University of Pennsylvania, and is described by Miss Helen E. Fernald in the *Museum Journal*, vol. 19, No. 2. It comes from the wall which faced the first fresco in the monastery, and is nearly perfect, showing greater intensity of colour and greater massiveness than the first in the central Buddha figure. It is eighteen feet in height and twenty-nine feet long. In design the style is that of the T'ang dynasty. The centre is occupied by a huge figure of Sâkyamuni Buddha seated on the lotus throne. On each side is a huge Bodhisattva sitting European fashion turned 'three-quarters' towards the Buddha. In the foreground between the Buddha and the Bodhisattva on each side are two graceful Bodhisattvas. Another Bodhisattva holding a bowl and pomegranate, and a child worshipper, complete a group which is surrounded by a number of military-looking figures in armour and jewelry, probably devas. In colour the whole is magnificent. The painting appears to belong to a convention of grouping which became traditionally established in sculpture and painting early in the T'ang dynasty, representing the Buddha with two attendant Bodhisattvas, and a host of other adoring beings. Although very few early Chinese frescoes exist to-day, it is recorded that enormous numbers of them were painted during the T'ang period and earlier. Probably they were destroyed in the rising against foreign religions in the ninth and tenth centuries.

AN AZILIAN STATION IN ARIÈGE.—An account of the recent excavation of a cave at Montardit (Ariège), known as the 'Trou Violet,' by Ida Vaillant-Couturier Treat and Paul Vaillant-Couturier, is given in *L'Anthropologie*, vol. 38, Nos. 3-4. The cave was first identified as an archæological station some twenty or more years ago, when a superficial examination brought to light neolithic remains. Shortly after, further evidences of occupation were found, as well as a fragment of the pelvis of a child, though in the interval a considerable quantity of cave earth was removed by the peasantry for use as fertiliser. Systematic excavation was begun in 1926, and has been continued regularly since then. It has been carried through a series of five stratifications down to bedrock. Of these, the fourth is Magdalenian, while the second, immediately below the disturbed area, is Azilian. The conformation of the cave is peculiar. A platform or sill is succeeded by an almost vertical drop, making the remoter part of the cave an almost well-like shaft. By Azilian times, this had been practically completely filled in and provided a floor of considerable area, extending beneath the whole vault. Two interments were found which unquestionably belonged to Azilian times and had not been introduced by later inhumation. In one the remains were practically complete, but the other had been disturbed either by animals or man, and only a skull cap, clavicle, and a few other bones remained. It is concluded that the cave was used occasionally rather than as a place of regular occupation in late Magdalenian times, and similarly in early Azilian times, but that gradually it came to be regularly occupied, even after it had been used for sepulchral purposes. The human remains are comparable with those of Mas d'Azil, Ofnet, and Mugem. The discovery of pebbles showing traces of colour related the site to the lower of Piette's sites at Mas d'Azil, which is only a few kilometres away.

VITAMIN CONTENT OF RICE.—Investigations have been made to determine a satisfactory standard for beriberi-preventing rices (E. B. Veddar and R. T. Feliciano, *Phillipine Jour. Science*, **35**). No rice of the series examined produced polyneuritis when fed to pigeons, provided that 50 per cent or more of the external layers of the grain were present. The proportion of these requisite layers was determined with reasonable accuracy by simple inspection after staining with Grams' iodine solution. For practical purposes, human beriberi can also be prevented by selecting rice in this manner, though it cannot be recommended as a legal standard. It is suggested that races be classified as highly-, medium-, or undermilled according as they retain 0 to 20, 21 to 49, and 50 to 100 per cent of the external layers. From the chemical side, 1·28 per cent fat is the best single index for a beriberi-preventing rice, 0·62 per cent phosphorus pentoxide is fair, 1·05 per cent ash is poor, while amido-nitrogen is useless for the purpose. A definite chemical index is proposed for use as a standard for beriberi-preventing rice. No rice possessing these requirements produced polyneuritis in pigeons, and as pigeons are much more susceptible to the deficiency of anti-neuritic vitamin than is man, this standard will not only protect man, but will also provide a margin of safety. This factor of safety is necessary, as the vitamin content may be reduced by defective storage or preparation for food. Experiments with insect-infected rices indicate the probability that the loss of vitamin during long storage of undermilled rice is caused by the depredation of insects that eat the external layers of the grain.

SOUND-PRODUCTION IN BOOK-LICE.—In the *Entomologist's Monthly Magazine*, August 1928, Mr. J. V. Pearman has an interesting communication on this subject. For many years various writers have claimed that certain Psocoptera or book-lice are capable of producing an audible ticking noise (the 'death watch'). Others have denied the capability of sound production by such minute fragile insects. Mr. Pearman, however, has been able to demonstrate that the species *Clothilla pulsatoria* is able to make audible sounds by tapping a slightly thickened knob, near the apex of the ventral side of the abdomen, against the substratum upon which the insect is resting. The sound is most distinct when the creature is placed upon paper, more variable when it is on cardboard or wood, and non-audible on glass. The sound-production appears to be confined to the female, and is considered to be a mating call. In certain other Psocids the inner surface of each hind coxa bears a scale-covered swelling which, in some species, has a kind of tympanum or presumed resonator situated just behind it. It is suggested that these organs are also for sound-production, and that the sound is made by the scaled swellings of the two legs being rubbed together. These organs are more largely developed in the males, and the hypothesis of their sound-producing function is, at present, conjectural.

BLOOD VASCULAR SYSTEM OF THE SPINY DOGFISH.—The spiny dogfish, *Squalus acanthias*, is common off the coasts of the British Isles, and is not infrequently used instead of the common dogfish for class purposes. Until now, no adequate description of the blood system has been available, and the account given by Dr. O'Donoghue and Miss Abbott (*Trans. R. Soc. Edin.*, vol. 55, pt. 3, No. 33; 1928) will be specially welcomed by university teachers. The authors find the vascular

system of this dogfish one of the most primitive and least specialised of any Elasmobranch so far described. The presence of six complete branchial arches between the dorsal and ventral aortæ in the embryo, as in the embryo of all the higher vertebrate groups, and their more or less complete retention in the adult, suggest that the higher vertebrata had a remote ancestor the branchial circulation of which is most nearly approached in living forms by the pentanchid selachians. The authors have interpreted the blood system in the light of recent embryological work, and have suggested a terminology for some of the vessels which is more suitable and useful in comparing the conditions in Elasmobranchs with those in other and higher vertebrate groups. The paper is a valuable and much-needed contribution to the comparative anatomy of the vertebrate blood system.

PHILIPPINE TREMATODES.—In a paper on the Trematodes of Philippine fish, frogs, birds, and bats, M. A. Tubangui (*Philipp. Jour. Sci.*, **36**, No. 3; 1928) describes a dozen new species and a new genus. The most interesting is a new species of *Opecœlus* in which an anus is present. The two branches of the intestine unite not far from the posterior end of the worm, and form a short narrow canal which opens to the exterior through an anus which is not quite terminal but is situated on the ventral surface. This worm occurs in the intestine of two species of *Glossogobius*. In two Japanese species of *Opecœlus* from the intestine of fishes an anus is present (Ozaki, 1926).

AMPHIBIANS OF WESTERN NORTH AMERICA.—A recent *Occasional Paper of the California Academy of Sciences* is a detailed account of the amphibians of the western States, illustrated by original photographs from living specimens. Although the amphibian fauna of the area is stated to be not very numerous, the present account (by Joseph R. Slevin) admits 46 species and sub-species, of which 22 are salamanders and 24 are frogs, toads, etc. The specific characters of these are described in detail, and short notices given of distribution and habits. Although many of the islands on the western coast of North America contain one or two species, and Vancouver shelters as many as six, it is a striking fact that no amphibians have been found on the islands in the Gulf of California.

EXPERIMENTALLY-INDUCED METAMORPHOSIS IN *ECHINUS*.—Prof. Julian S. Huxley records observations (*Amer. Naturalist*, **62**, 363-376; 1928) on experimentally-induced metamorphosis in *Echinus*. Treatment of advanced larvæ of *Echinus miliaris* with very dilute solutions of mercuric chloride (about $M/(2 \times 10^6)$, rapidly brings about precocious metamorphosis. This appears to be caused through the differential susceptibility of larval tissues and echinus rudiment; the former are more affected by the poison, begin to dedifferentiate, and can then be readily resorbed by the echinus rudiment. When the echinus rudiment is small, metamorphosis is less rapid and may be incomplete, both larval and echinus tissues being dedifferentiated. It is suggested that a similar mechanism is operative in the normal metamorphosis of echinids; the larval tissues dedifferentiating when the weight of the echinus rudiment causes the organism to sink away from the favourable conditions for food and oxygen at the surface of the sea.

NEW BRITISH FRESHWATER PEARL MUSSEL.—An extraordinary find has just been made of a new species of freshwater pearl mussel in the British Islands. Mr. R. A. Phillips describes this find, which comes from the River Nore, at Durrow, Queen's County, I.F.S., under the name of *Margaritifera durrovensis* (*Proc. Malac. Soc. Lond.*, vol. 18). It differs from the well-known form, *M. margaritifera* (Linn.), in habitat, for it dwells in deep shady pools in hard water, instead of quick running streams of soft water, so that the umbones are not eroded, and the posterior end of the shell which projects up into the water as the animal crawls along the bottom becomes coated with 'race.' It differs also in its external form and umbonal rugæ as well as in the teeth and muscle scars, in which points it seems to approximate the *M. auricularia* (Speng.) dredged from the neolithic deposits in the bed of the Thames near London. A note on the anatomical features of the animal by Mr. H. H. Bloomer is appended to Mr. Phillips' paper, which is illustrated by three plates from photographs by Mr. A. E. Salisbury.

YIELD OF CONIFERS IN GREAT BRITAIN.—In the Forestry Commission's *Bulletin No. 3* (1920), the "Rate of Growth of Conifers in the British Isles" was dealt with, the information being based on ascertained data and the measurement of sample plots. This Bulletin is now out-of-print and has been revised and re-issued as *Bulletin No. 10*, entitled "Growth and Yield of Conifers in Great Britain." As its title implies, the material here recorded is of a technical character, of interest chiefly to the professional forester, the grower of woods, and the persons who afterwards purchase and make use of the produce. The data of growth are obtained by the periodical and careful measurement of small areas of marked trees termed 'sample plots.' The first selection of such areas requires knowledge and discrimination; since to obtain results of importance areas of different classes of soil at different elevations, exposures, and so forth, require to be selected for each species dealt with. That the considerable amount of investigation work so far carried out has been possible is almost entirely due to the sympathy and cordial assistance extended to the officers of the Commission and others by private land owners, for the majority of the sample plots at present in existence in Great Britain are situated in privately owned woods. A certain amount of new data is included in the revised bulletin, and it may be confidently recommended to the study of all interested in this important matter.

SEED MIXTURES FOR HAY AND GRAZING LAND.—Stapledon and Davies (Welsh Plant Breeding Station, Series H, No. 8, Seasons 1921–1928) deal with various problems of seed mixtures for hay and grazing land, especially in connexion with environment and competition. The effects of soil condition and management have been studied in considerable detail, and yield results of much interest and importance. Comparisons are made of the response from various types of seed mixtures under varying cultural conditions, the practical aspect being kept in view throughout. Special attention has been devoted to colonisation by unsown species. It appears that the trend of such colonisation is determined by the earliness of re-entry of bent grass and Yorkshire fog, and the degree of control which is exercised over these species if they appear immediately and abundantly. Within four years, twenty-four species had made a spontaneous appearance in one of the experimental fields, in addition to others introduced as impurities in the seed sown. Further investigations deal with the influence of inter-specific competition in seed mixtures. This competition is largely determined by the reaction of the individual species to the cultural conditions and management, excessive competition having an adverse effect upon yield. Some species are naturally aggressive in type, but the degree of aggression may be modified by appropriate treatment of the sward. On

the whole, the grasses are aggressive compared to the clovers, chiefly because the grasses are the earlier to start into growth in the spring. Practical application of these experimental results is made in the compounding of "Sensible seed mixtures." The various factors which make for a successful mixture are considered, and details are given of type mixtures suitable for various purposes, subject to modification according to local requirements and conditions.

SYDNEY AND THE BLUE MOUNTAINS.—Three lectures by Dr. W. H. Woolnough, Advising Geologist to the Government of Australia, on the physical features of Sydney and the Blue Mountains, show the excellent physiographic studies in that area which have been stimulated by its many interesting problems. The lectures show the drift of opinion toward the view that faults have been more effective than folds in the formation of the eastern front of the plateau of New South Wales. Both processes have contributed, and at one time a monoclinal fold was regarded as the main movement and the faulting as subordinate. The claim that the Arctic coal seams indicate former tropical conditions where they occur receives no support from Dr. Woolnough; for he declares emphatically that the rich coal seams of the Sydney area are not due to tropical forests, but were laid down under a climate that may have been frigid in severity. The author is perhaps unfortunately conservative in his retention of the term Permo-Carboniferous for the whole of the Coal Measures and associated beds in New South Wales.

FORMER GLACIATION OF KASHMIR.—A recent *Memoir of the Geological Survey of India* is devoted to a study of the glaciation of the East Lidar Valley in Kashmir by Lieut.-Colonel J. L. Grinlinton (vol. 49, part 2, 1928). The greater part of the memoir is devoted to a careful description of phenomena and is illustrated by a fine set of photographs, sketches, and maps. The probable sequence of events is then deduced. Before the main Lidar valley was cut there existed a high, dissected plateau from which the higher peaks of the present day were carved. This area was first glaciated in what is called the *High Level* epoch of glaciation. A period of deep valley cutting followed, after which came the *Low Level* epoch of glaciation. After the first and maximum extension of the ice downstream, there was a recession during which the ice retreated to the vicinity of the snouts of present-day glaciers. A second epoch of advance and retreat was followed in turn by a third and fourth, leading to the stage of recession represented by the restricted glaciers of the present day. It is noteworthy that an investigation of the former glaciation of the upper Indus by Dainelli also led to the recognition of four successive advances of the ice, but so far no correlation of the respective phases of extension and recession has been attempted.

SURVEY FROM AIRCRAFT.—In a pamphlet (*Professional Paper* No. 20, price 2*s.* 6*d.*) published by the Survey of India, Lieut.-Col. C. A. Beazeley describes the methods of reconnaisance survey from aircraft. The system was used by the author in Mesopotamia during the War, and at a later date in that country in filling gaps in mapping where ground survey and air photography were not feasible. No fixed points are needed on the unmapped area, and about a hundred square miles can be sketched in an hour or an hour and a half. The method does not of course produce accurate surveys, but it is valuable when more accurate methods of work are not possible. The chief difficulties in this form of sketching which differentiate it from ground work of a similar nature are, first, the necessity for keeping a constant air speed, or if changes have to be made, recording and allowing for the changes; secondly, the maintenance of a uniform height above the ground; and thirdly, the need of keeping the course. The pamphlet is most practical, and indicates material and apparatus, besides discussing the difficulties of the work. Illustrations, including a specimen air route traverse, are added.

TRANSPARENCY OF FABRICS.—The August issue of the *Journal of Research*, the new periodical in which the Scientific and Technologic Papers of the Bureau of Standards now appear, contains a paper by Messrs. Coblentz, Stair, and Schoffstall on the transmission of visible and of ultra-violet light through fabrics of silk, cotton, linen, wool, and two forms of 'rayon.' A mercury-in-quartz arc supplied the light, which was filtered through a yellow-green glass to give visible light and through a purple glass to give ultra-violet light. Both bleached and black-dyed samples of the same material were examined, the difference giving the transmission of the material itself, apart from that transmitted through the spaces between the threads. There is practically no difference between the transmission of ultra-violet light through white fabrics of the same weight of cotton, linen, and rayon; silk is a little less transparent, and wool about half as transparent as cotton. The transparency of each material is greatly reduced by dyeing it orange, yellow, green, or tan, but for pink the reduction is less. The feathers of fowls transmit ultra-violet light much better than fabrics of the same colour.

THE COSMIC RAYS.—The two points of outstanding interest discussed by Prof. R. A. Millikan and Dr. G. H. Cameron in their paper in the October issue of the *Physical Review* are the place of origin of the cosmic rays, and the kinetics of their production. As has already been mentioned in NATURE (Oct. 6, p. 555), it is believed that the rays are produced in interstellar space; the evidence now adduced in support of this is twofold: first, that there is no marked cosmic radiation from the sun, which is the nearest star, and in many respects a typical one; and secondly, the fact that the energy of the cosmic rays is about one-tenth that of starlight, requires that if the rays were produced in stars they would have to come from their outermost layers, and that the processes responsible for their emission would have to stop rather abruptly at a certain depth, which is extremely unlikely. The kinetic aspect of atom-building is also explained in a very plausible way. It is not necessary to assume, for example, that sixteen protons and eight electrons all meet at one instant and condense into an oxygen nucleus. The protons and electrons can gradually build up into a cluster in which they retain initially their atomic individuality, and then, at a later stage, the cluster can collapse completely to give the new heavy nucleus, with emission of the quantum of radiant energy—the cosmic ray—appropriate to the resulting change in mass. High temperatures must be inimical to the growth of atomic clusters, and it may be that the low temperatures and densities of interstellar space also favour the nuclear condensation, in some way at present unknown. The remainder of the paper is concerned with other aspects of the phenomenon, in particular its thermodynamical significance, the synthesis of the experimental absorption curves, and the question of the bearing of Dr. Aston's accurate determinations of atomic weights upon the possibility of occurrence of radioactive disintegrations. It is noticeable that Prof. Millikan and Dr. Cameron do not consider here why the most favoured condensations of protons and electrons should be those which go to build up the few nuclei which are actually found to constitute the greater part of ponderable matter.

Conference of Australian Physicists.

A CONFERENCE of physicists and astronomers, arranged by members of the Institute of Physics resident in Australia, was held at Canberra on Aug. 15–18, and was attended by nearly forty research workers. This conference arose from a desire to hold more frequent meetings of physicists than are provided by the biennial meetings of the Australian Association for the Advancement of Science. It was felt that the conference had met a real need, and it was decided to hold a similar meeting in Sydney or Melbourne during August 1929. Advantage was also taken of the occasion to hold the fourth general meeting of Australian members of the Institute of Physics, under the chairmanship of Prof. A. D. Ross, of the University of West Australia. Meetings were also held during the conference of the Radio Research Board and the Geophysical Prospecting Committee. The conference was organised by Profs. Laby, Ross, Vonwiller, and Dr. Duffield, while Drs. G. H. Briggs and E. O. Hercus acted as secretaries; arrangements for the next meeting are in the same hands.

A visit was made to the Commonwealth Solar Observatory at Mount Stromlo, ten miles from the Federal capital, where members were welcomed by Dr. and Mrs. Duffield and shown the observatory buildings and equipment, including the Oddy and Farnham telescopes, the latter fitted with photo-electric cells for stellar intensity measurements, and the structural arrangements for the 30-inch reflector, which include the Reynolds dome, a vertical tube 6 ft. in diameter, and a thermally insulated horizontal tunnel in the basement.

The meetings of the Conference were devoted to reports of research work and to the discussion of topics of general interest to members. In opening a discussion on the new quantum theory, Mrs. G. H. Briggs gave an account of Bohr's recent work on the inherent conflict of the ideas of causality and space-time in quantum processes. Mr. H. S. W. Massey referred to the success of the wave mechanics in accounting for the space distribution of scattered electrons and other phenomena. Profs. Madsen and Laby contributed to a discussion on radio research in Australia; emphasis was laid on the need for pure research, and the suggestion was made that some fraction of the broadcasting revenue of a quarter of a million sterling should be set aside for this purpose. Mr. R. O. Cherry described measurements of the relative field strength distribution from the broadcasting station 3LO, Melbourne, found with a portable set over a range of about 50 miles from the aerial. Dr. Bieler, Deputy Director of the Imperial Geophysical Experimental Survey party, gave a description of methods of prospecting which are being tested in the field in selected localities in Australia. Major E. H. Booth, of the University of Sydney, discussed the seismic method of prospecting and described experiments on earth waves detected with a modification of the Tucker microphone. At the conclusion of this discussion a resolution was passed by the Conference urging the executive committee of the Survey to include a study of the seismic method in the scope of the work.

Mr. S. Radcliff showed some exhibits, demonstrating by a new method the appreciable vapour pressure of such substances as sulphur, sealing-wax, and other waxes often used in physical apparatus. Prof. Ross described further work on the magnetic properties of manganese steels, showing that their properties could be attributed to the isomorphism of manganese and gamma iron. The manganese restrains the magnetic transformation on cooling the metal from high to ordinary temperatures, but at liquid air temperature the metastability is wholly or partly destroyed. The alloy may consist chiefly of either austenite, hardenite, troostite, sorbite, or pearlite, according to the heat treatment.

Mr. W. B. Rimmer, assistant director of the observatory, described a spectroscopic examination of type *B* stars, showing that in each spectral subdivision 'line character' is related to absolute magnitude, sharp lines being associated with bright stars. Mr. Allen discussed the measurement of some multiplet lines by the method of photographic spectrophotometry developed at the Utrecht Institute. Mr. J. Nangle, Government Astronomer for New South Wales, described the steady progress towards the completion of the section of the Astrographic Catalogue allotted to the Sydney Observatory. It is hoped that the work will be finished in about ten years. Prof. Bailey (University of Sydney) described experiments on the attachment of electrons to molecules, and Mr. J. Bannon experiments on the motion of electrons in pentane and ethylene. Mr. J. S. Rogers, in the ensuing discussion, stressed the importance in such work of eliminating impurities. Mr. J. Shearer described work carried out with Mr. Bingham and Prof. Laby establishing the reflection of radiation of about 50 A. at grazing angles up to 25° from glass surfaces, and up to 45° for steel and quartz surfaces (NATURE, July 21, p. 96). Prof. Laby communicated a paper by Mr. Webster on X-ray intensity measurement by a photographic method, and one by himself and Mr. Kannuluik on an accurate determination, corrected for the low heat loss, of the thermal and electrical conductivities of a large single crystal of copper at room temperature, and at the temperature of liquid air. Prof. Vonwiller described an interference method of measuring with high accuracy the refractive index of materials such as mica which can be obtained in the form of uniform sheets. Mr. Ray Davis contributed two papers on hydrogen ion concentration, and papers were received from Messrs. Cairns and Johnston of the Watheroo Magnetic Observatory.

Some Band and Emission Spectra.[1]

R. C. JOHNSON.—The band spectra of the alkaline earth halides. (1) CaF, SrF. A continuation and extension of theoretical work done recently on these band spectra by Meckel. A complete quantum analysis of the gross structure of the whole of the bands has been made, and for this purpose a re-measurement of some 250 of the heads under high dispersion was undertaken.

The molecules CaF and SrF give rise to at least three band systems which are analogous in almost every respect. These are assigned to the electron transitions $3\,^2S \rightarrow 1\,^2S$, $2\,^2S \rightarrow 1\,^2S$, $2\,^2P \rightarrow 1\,^2S$. The vibrational constants of the molecules in these various states have been evaluated. Many unusual features found in these band spectra, such as the fewness of the sequences and their exceptional length, are attributed to the smallness of the variation of these vibrational constants with electronic state. Among the unusual features also observed and discussed are

[1] Abstracts of papers read before the Royal Society on Nov. 1.

(*a*) the occurrence of strong Q branches in $^2S \longrightarrow {}^2S$ transitions, and (*b*) a definite discrepancy in $f(n'')$ as evaluated from the $^2S \longrightarrow {}^2S$ and $^2P \longrightarrow {}^2S$ systems.

(2) BaF, MgF. A quantum analysis is made of the gross structure of the band spectra of the molecules. In the case of the barium fluoride bands, new measurements of the heads have been made, from plates taken in the first order of a 21-ft. grating. The familiar BaF bands in the green region are believed to constitute two systems attributed to the electron transitions $2\,^2S \longrightarrow 1\,^2S$, and $3\,^2D \longrightarrow 1\,^2S$. A number of bands measured by George, and attributed by him to BaO, have been analysed and found to have their final state in common with the above BaF systems, thus proving their fluoride origin. This system is believed to be due to $2\,^2D \longrightarrow 1\,^2S$. These suggested transitions of the type $^2D \longrightarrow {}^2S$, which are believed to be new to band spectra, are discussed. The absence of the transition $2\,^2P \longrightarrow 1\,^2S$ from the recorded date of the BaF molecule is noteworthy.

The recorded emission bands of MgF constitute a $2\,^2P \longrightarrow 1\,^2S$ system, in which $\Delta 2\,^2P = 18{\cdot}6\,\nu$. The vibrational constants of these various states of both the BaF and MgF molecules are given.

J. M. Walter and S. Barratt.—The band spectra associated with zinc, cadmium, and mercury. The majority of these supposed band absorption spectra, and one band system previously attributed to mercury, would appear to be oxide and chloride spectra. In the present experiments the only bands found which can be attributed to zinc and cadmium themselves, are two weak and diffuse bands, one for each metal. The absorption spectrum of mercury, however, is much richer, and there is no doubt that mercury vapour contains diatomic molecules. The bromides of the three metals, together with the iodide of cadmium, all yield absorption band systems analogous to the chloride bands.

W. Jevons.—Observations in connexion with the band systems of the fluorides of beryllium and magnesium. The vibrational analyses of the band-head data for the BeF and MgF doublet systems lead to the following interpretations of the heads in each band, those in brackets not having yet been detected. In BeF: R_2, R_1, Q_2, (Q_1) with a doublet separation of the order $R_2 - R_1 = 3$ cm.$^{-1}$, rather than R_2, $Q_2\,(R_1)$, Q_1 with a separation $Q_2 - Q_1 = 35$ cm.$^{-1}$ as hitherto assumed. In MgF: P_1, Q_1, (P_2), Q_2 with an electronic doublet separation $Q_2 - Q_1 = 5{\cdot}5$ cm.$^{-1}$, not 22 cm.$^{-1}$ as hitherto given. With these interpretations there is now a continuous increase of the separation of the system-origins of the doublet systems of the alkaline earth fluorides from beryllium to barium fluorides.

With beryllium oxide in the carbon arc in air, conditions may be so arranged as to obtain in the outer flame either (*a*) the fluoride system strong with the oxide system relatively weak, or (*b*) the oxide system strong with scarcely a trace of the fluoride system. In condition (*b*) the ultra-violet region $\lambda 3500 - \lambda 2900$ (where the fluoride system would occur if developed) is occupied by a new set of bands, which, like the BeF and BeO bands, are degraded towards the red.

A similar result is obtained, though less satisfactorily, with other beryllium salts. The new bands are less regularly distributed than any bands of diatomic molecules, and are due either to BeF_2 or to an oxide of beryllium. No bands due to the chloride and no further bands of the fluoride have been found.

The data of the BeO band-system are extended by the recognition of a violet sequence $n'' - n' = -2$, not hitherto observed on account of the $\lambda 4216$ sequence of CN and strong metallic lines.

W. E. Curtis and A. Harvey.—The structure of the band spectrum of helium (5). The details and analysis of five new He_2 bands are given. One of these is a weak vibrational band associated with the known band near $\lambda 5730$ ($3D \longrightarrow 2P$ of $_oHe_2$). Another is the $_pHe_2$ counterpart of the $_oHe_2$ band designated $3X \longrightarrow 2P$, and described in the preceding paper of this series. The remaining three have $2P$ as the final electronic level and a new type of level (Z) as initial. It is rotationally single, like S and X, but the rotation terms cannot be represented by the usual type of formula, nor are the relative intensities of the branches at all similar to those in other bands.

In consequence of the abnormal character of the initial level the appearance of the $Z \longrightarrow P$ bands is very peculiar; the wave-numbers of the R branch, for example, decrease continuously with increase of rotational quantum number, thus giving it the appearance of a P branch. Two perturbations are recorded in these bands, one a large displacement, and the other a splitting into two components of about equal intensity. The Zeeman effect has already been found to be very unusual in magnitude and character for the band $4Z \longrightarrow 2P$.

The X and Z levels are clearly additional to the ordinary atomic system of levels, and the evidence leads to a tentative identification of them with certain new types predicted by Hund for diatomic molecules, but not hitherto definitely established by observation. Although the chief properties of the new bands may readily be accounted for on this view, several unexplained peculiarities remain, such as the absence of Q branches in $X \longrightarrow P$ transitions, and the relative intensities of the branches in $Z \longrightarrow P$ transitions.

J. C. McLennan, R. Ruedy, and A. C. Burton.—An investigation of the absorption spectra of water and ice with reference to the spectra of the major planets. In this investigation the absorption spectra of columns of water of 4 metres and of 21·5 metres length were photographed. Absorption spectra were also obtained with lengths of ice up to 14 metres. Three absorption bands were obtained with water in the infra-red region that would be identified with bands in the spectra of the major planets, and could be taken to indicate the existence of water about these planets not in the form of vapour or ice, but in the liquid state. The absorption in the green shown by planetary spectra cannot be attributed to water, and search for it is being made with certain other liquefied gases.

J. C. McLennan and A. M. I. A. W. Durnford.—The Zeeman effect for the spectrum of tantalum. In all, some fifty-five Zeeman patterns were secured for wave-lengths of tantalum between $\lambda 5548$ and $\lambda 6700$ A. These include practically all the strong arc wave-lengths. A concave grating of 3 metres radius was employed that gave a dispersion for the second order spectrum of 2·6 A. per mm. over the region examined. The light source consisted of a modified form of vacuum arc in a chamber that formed an integral part of the electromagnet. This latter was of the Du Bois type, and a field strength of 21,500 gauss was used.

J. C. McLennan, H. C. H. Ireton, and E. W. Samson.—On the luminescence in solid nitrogen under cathode ray bombardment. With spectrographs of high-light power, the spectrum of luminescent solid nitrogen was photographed from $\lambda 2000$ up to $\lambda 8600$ A. In addition to the bands at $\lambda\lambda 5945$, 5609, and 5230 A. formerly observed, a strong band was found at $\lambda 8535$ A., one at $\lambda 6725$ A., one at $\lambda 6400$ A., and a faint narrow one at $\lambda 6187$ A. in the long wave-length region. Two series of bands were observed with short wave-length region with nearly constant wave-

number differences that were approximately equal to 215 and 175. The bands at λλ5945, 5609, and 5230 A. were all phosphorescent ones, and the light emitted that corresponded to them was not noticeably polarised.

Decay curves were obtained for the luminosity corresponding to these three bands. In the decay of the λ5945 A. light, two distinct stages were noted, and in the decay of that corresponding to λ5230 A. three stages were observed. In both cases the phosphorescence was of the 'vanishing type.'

The results of the investigation suggest that hydrogen occluded in minute traces in the solid nitrogen may account for the phosphorescence observed with the latter when subjected to electronic irradiation.

Crystal Structure and Properties.[1]

A. MÜLLER.—A further X-ray investigation of long-chain compounds. The fortunate discovery of a single crystal of a normal hydrocarbon, n-$C_{29}H_{60}$, has made it possible to determine with considerable accuracy certain details of the structure of a long-chain molecule. The ratio of the length of the fundamental sub-period of the chain has been measured to 1 part in 1000. Various other constants have been less accurately determined.

Each carbon atom in the chain is known to be associated with two hydrogen atoms, with the exception of each of the end atoms, to which three are attached, forming methyl groups. If each carbon atom with its two hydrogens be considered as a separate group capable of representation by a single scattering centre, the chain is found to have a regular zigzag form with a centre at every corner. The two end carbons may with very good approximation be taken to be represented by the two ends of the zigzag. The centres therefore lie on two parallel lines, 15 on one, 14 on the other. The ratio of the distance between two consecutive centres on the same line to the length of the chain, the sub-period of the chain, is $0{\cdot}03286 \pm 0{\cdot}00002$. As the length of the chain is 77·2 A., this distance is $2{\cdot}53_7$ A., which is, within the limits of experimental error, the distance between two corresponding atoms in diamond. The closest distance between two lines of centres belonging to different molecules is 3·7 A. Thus there is room for the replacement of hydrogens by oxygens, and in fact it is found that the dimensions (though not the intensities of the reflections) of the ketone $C_{30}H_{60}O$ and the hydrocarbon $C_{30}H_{62}$ are identical.

The area of cross section of the molecule is found to be $18{\cdot}5 \times 10^{-16}$ sq. cm., a result in good agreement with the values already determined in the case of other single crystals of long-chain compounds.

I. E. KNAGGS.—The form of the central carbon atom in pentaerythritol tetra-acetate as shown by X-ray crystal analysis. The X-ray examination of these crystals was undertaken with the view of studying the behaviour of the central carbon atom in a compound in which the four carbon valencies are satisfied by like groups. Pentaerythritol tetra-acetate crystallises in the tetragonal bipyramidal class; the crystals are built on the Bravais lattice, $I\ell$ and the space group C_{4h}^4; there are two molecules in the unit cell, which has the dimensions $11{\cdot}98^2 \times 5{\cdot}47$ A.

The molecule possesses a four-fold alternating axis of symmetry, which must pass through the central carbon atom. The central carbon atom itself may be tetrahedral, though some slight departure from true tetrahedral symmetry is possible. A probable structure for the crystals is suggested.

J. E. LENNARD-JONES AND B. M. DENT.—The change in the lattice spacing at a crystal boundary. The contraction of the lattice at the (100) boundary of crystals of the NaCl type is confined almost entirely to the top layer and is of the order of 5 per cent. An upper limit is found for the decrease in the interatomic spacing in the surface layer; this also is of the order of 5 per cent. The surface tension of a number of crystals of the NaCl type is calculated.

N. A. ALSTON AND J. WEST.—The structure of topaz. From a quantitative analysis by X-rays of the structure of topaz, $[Al(F,OH)]_2\ SiO_4$, it appears that although this crystal is sometimes considered to belong to the orthorhombic pyramidal (polar) class, the structure actually found is holohedral in character.

The chief feature of the structure is the arrangement of the oxygen and fluorine atoms. Regarding these atoms as equal in size, they form a close-packed assemblage which belongs strictly to neither of the two well-known hexagonal and cubic types of close-packing. These two types and the assemblage found in topaz may be conveniently regarded as the simplest examples of the ways in which a series of identical planes, consisting of similar atoms in contact, may be closely stacked together, one on top of the other, so as to form a series of layers in periodic succession.

Some of the more complex structures still awaiting analysis, which, whilst exhibiting certain features characteristic of close packing, belong neither to the hexagonal nor to the cubic type, may actually prove to be based on one of these less simple arrangements. Although in a structure of this kind it is difficult to distinguish between oxygen and fluorine atoms, it is believed that the four atoms which surround tetrahedrally each silicon atom are oxygen, whilst of the six atoms arranged symmetrically about each aluminium atom, four are oxygen and two are fluorine.

J. C. MCLENNAN, R. RUEDY, AND E. COHEN.—The magnetic susceptibility of single crystals of zinc and cadmium. The magnetic constants of single crystals of zinc and cadmium have been determined. For the magnetic susceptibility $\chi_{\parallel}$ (parallel) and $\chi_{\perp}$ (normal) to the hexagonal axis, the results are

$$\text{Cd} \ldots\ \chi_{\parallel} = 190 \times 10^{-6}, \quad \chi_{\perp} = 145 \times 10^{-6}.$$
$$\text{Zn} \ldots\ \chi_{\parallel} = 261 \times 10^{-6}, \quad \chi_{\perp} = 160 \times 10^{-6}.$$

With mercury the results obtained lend support to the view that this metal crystallises in a rhombohedral form.

R. W. JAMES AND G. W. BRINDLEY.—A quantitative study of the reflection of X-rays by sylvine. The variation of the intensity of reflection of X-rays from sylvine with temperature is quantitatively in agreement with the Debye-Waller law from the temperature of liquid air up to about 400° abs. At higher temperatures the decrease of intensity with increasing temperature is much more rapid than the law indicates. The value of the temperature factor based on observations at room temperature and at the temperature of liquid air agrees very well with that calculated by Waller from the elastic constants of the crystal, and also with the value calculated from the Debye-Waller law using the characteristic temperature.

The absolute values of the intensity of reflection are in good agreement with those calculated from the Schrödinger density distribution for K^+ and Cl^- obtained by Hartree's method, if each element of the distribution is assumed to scatter classically, and if, in correcting for temperature, the existence of zero-point energy is assumed.

[1] Abstracts of papers read before the Royal Society on Nov. 1.

Vitamin *A* as an Anti-Infective Agent.

WHEN the fat-soluble vitamins were first differentiated, it was soon recognised that animals maintained on synthetic purified rations deficient in fat-soluble *A* not only ceased to grow after a variable time, but also were very prone to develop various infections. One of the most obvious and common of these was an infection of the conjunctiva, which is known as xerophthalmia; hence the usual signs of vitamin *A* deficiency looked for were cessation of growth and this eye disease. When vitamin *D* was differentiated from vitamin *A*, the question arose as to whether the signs of fat-soluble vitamin deficiency were due to lack of vitamin *A* or vitamin *D*. It was found that both are necessary for proper growth; but except for some recent observations by Goldblatt and Benischek, the relationship between these vitamins and infective processes has not been fully worked out. The results of these authors suggested that vitamin *A* was the more closely related to the prevention of infection.

H. N. Green and E. Mellanby have therefore made a study of the effects upon rats of maintenance upon a diet deficient solely in vitamin *A* (*Brit. Med. Jour.*, p. 691, vol. 2, 1928). The animals were fed a synthetic ration well balanced as regards protein, fat, carbohydrate and salts, and containing vitamin *B* (marmite), vitamin *C* (lemon juice), and vitamin *D* (irradiated ergosterol in the form of 'Radiostol' solution, ½ to 1 drop daily each animal). Some rats were kept on a diet deficient in both vitamins *A* and *D*, whilst another group were given vitamin *A* in the form of dried cabbage (0·5 gm. daily), butter (0·1 gm. daily), or cod-liver oil (5-10 mgm. daily). The results obtained were quite clear-cut. On the diets lacking vitamin *A* the animals lived for 58-169 days; during most of the time they ate their food well and showed moderate growth; during the last week or so of life, however, the appetite failed, weight was lost, and finally death ensued. In almost all these animals (93 in all) some, and generally many, organs were found infected with micro-organisms. The presence of vitamin *D* in the ration made no difference to the results: it appeared, indeed, to hasten the onset of the infection, probably owing to its stimulating effect on growth whereby the stores of vitamin *A* were caused to disappear more rapidly.

In all the animals lack of fat and general visceral atrophy were striking features: in addition, 91 of the 93 showed evidence of infection in some part of the body. Only 38 per cent developed the characteristic lesion of xerophthalmia in this series, other types of infection having been found more commonly: thus 72 to 90 per cent, according to the period of survival, showed abscesses at the base of the tongue, in the accessory salivary glands, and 44 per cent or more gave evidence of infection of the urinary tract. Other sites of infection were the intestines (21 per cent), the lungs (9 per cent), and the nasal sinuses or middle ear (20 per cent); once an abscess in the wall of the left ventricle of the heart was seen.

These observations should be contrasted with the results obtained in 50 animals fed on the same diet plus one of the sources of vitamin *A* mentioned above for periods as long as, or longer than, those the deficient rats survived. In none was any signs of bacterial infection observed: three cysts of the liver, of parasitic origin, were noted; otherwise the tissues were perfectly healthy.

It appears, then, that vitamin *A* plays a significant part in maintaining the resistance of the body to infection, and it is probably more directly related to resistance to infection than any other known food factor. If these results can be applied to man, it appears possible that various infections may be ultimately traced to deficiency of vitamin *A* in the diet. It is known the xerophthalmia occurs in man in conditions of deficient intake of fat-soluble vitamins, but the condition is rare, and only occasionally is the deficiency so gross as to lead to its appearance. More important is the possible relationship between inflammatory processes of the nasal sinuses, middle ear disease, and pneumonia, and vitamin *A* deficiency. At present it is impossible to be certain about such a relationship, but it is generally agreed that the usual sources of vitamin *A*, milk, butter, eggs, and green vegetables often find little place in a modern dietary. Making due allowance for differences in requirement between rat and man, but remembering that xerophthalmia can occur in both under similar types of nutritional deficiency, we might expect that a more adequate consumption of vitamin *A* by human beings might decrease the incidence of at any rate some of the commoner suppurative processes. The possibility of a dietary deficiency should also be borne in mind in their treatment.

Condition of Plaice in the North Sea.

IN *Min. Agric. and Fish., Fishery Investigations*, Ser. 2, vol. 10, No. 3, 1927, Miss D. E. Thursby-Pelham reports on the condition of the plaice stock in the North Sea in 1925 as compared with 1923, and on the changes that took place in 1924 and 1925. The investigations by the Ministry have been continued year by year and tend to indicate that the plaice stock, which showed a marked increase both in size-distribution and abundance immediately after the War, and such a rapid decline under intense fishing in succeeding years, is still in a condition of flux.

The landings of plaice during 1923, 1924, and 1925 were below those of any previous year since the inception of reliable statistics in 1906. In 1925 the position with regard to the actual quantity landed, and abundance as evidenced by the catch per 100 hours' fishing, was better than in the two previous years. Less fishing, moreover, was carried on during that year, and therefore the effect of the increased abundance on the landings was not so marked as would have been the case if fishing had been carried on with its former intensity. This improvement, however, was entirely due to increased quantities of 'small' plaice, since both 'large' and 'medium' continued to decline both in actual quantities landed and in abundance.

The decline in size as evidenced by the statistical categories has been continuous since 1922 from year to year, but was not so marked during the year March 1925–February 1926 as in previous years. The evidence may indicate that the size-distribution of the plaice stock is becoming stabilised.

The question arises as to the extent to which the small size of the plaice caught may be attributed to over-feeding, and to what degree it is due to natural fluctuations. It would appear, from the very limited available evidence, that the great abundance of 'small' in 1925 was due to natural fluctuations. The same is true to some extent with regard to the scarcity of 'medium,' but it would seem that, in addition, the heavy fishing since the War has played a considerable part in the decline in abundance of this category. Miss Pelham expresses the opinion that the extent of the effect of fishing should be more easily adjudged in and after 1926, when it will be seen whether the very abundant 'small' of the last few years have remained uncaught in sufficient quantities to augment the 'medium' and the 'large.'

University and Educational Intelligence.

CAMBRIDGE.—The annual report of the Board of Research Studies shows a further slight increase in the number of students working for research degrees, the increase coming mainly from the graduates of the University of Cambridge itself. Trinity and Emmanuel Colleges lead the field in the number of such students, with Newnham, St. John's, Gonville and Caius, and Christ's Colleges coming next on the list. On the whole, there is a tendency for the numbers to increase in all the colleges. The subjects of study most prominently represented are physics, mathematics, physical chemistry, botany, English, history, agriculture, and biochemistry. More than one-third of the students are now Cambridge graduates, the greater number from outside coming from the universities of the United States, Australia, Canada, Wales, and London.

Dr. W. E. Dixon, Downing College, has been appointed assessor to the Regius professor of physic. J. W. Brunyate, Trinity College, has been nominated to the Choate memorial fellowship at Harvard University, and T. Smith, Trinity College, to the Jane Eliza Procter visiting fellowship at Princeton University. W. H. McCrea, Trinity College, has been elected to an Isaac Newton studentship in astronomy and optics.

EDINBURGH.—The University Court, at its meeting on Oct. 29, received with gratification intimation of a gift of £5000 from Sir Leybourne Davidson, of Huntly Lodge, for the foundation and endowment of a fellowship for the encouragement and promotion of research in bacteriology and immunology.

The Court expressed its thanks for a gift by Sir John Gilmour, Rector of the University, to the Department of Research in Animal Breeding, of plaster casts of two Clydesdale horses which were used as foundation stock in the Montrave stud. These models are of great interest in showing the type from which the modern Clydesdale has sprung.

The Court confirmed the following appointments: Mr. Harold S. Ruse, to be lecturer in mathematics; Mr. James Paton, to be lecturer in natural philosophy; Mr. W. G. Millar, to be lecturer in pathology; and Mr. Alfred T. Haynes, to be lecturer in actuarial mathematics.

GLASGOW.—A gift of £10,000 from Mr. William Teacher has enabled the University to establish an endowed lectureship in bacteriology in connexion with the Royal Infirmary. The lecturer will at the same time hold the post of bacteriologist to the Hospital.

Another gift, of approximately £15,000, has been made to the University by Sir Frederick Gardiner and his brother William for the purpose of establishing a research lectureship in the pathology of children's diseases at the Royal Hospital for Sick Children. The lecturer will also be appointed pathologist to the Hospital. The Gardiner brothers have already founded and endowed three chairs in the University, the professorships of organic chemistry, of physiological chemistry, and of bacteriology.

LONDON.—The following doctorates have been conferred:—D.Sc. in Botany: Mr. W. J. Dowson (Imperial College—Royal College of Science), for a thesis entitled "(1) On the Stem Rot or Wilt Disease of Carnations; (2) On an extraordinary *Botrytis* causing a Disease of Narcissus Leaves; (3) A Blossom Wilt and Stem Rot of Cultivated Antirrhinums and Schizanthus due to *Sclerotinia slerotiorum* (lib.) Massee; (4) On a Core Rot and Premature Fall of Apples associated with *Sclerotinia Fructigena*; (5) A Die-back of Rambler Roses due to *Gnomonia Rubi* Rehm"; D.Sc. in Chemistry: Mr. Ahmad Zaki (University College), for a thesis entitled "Benzoic Esters and Electronic Affinities of Radicles"; D.Sc. in Geology: Mr. K. W. Earle (University College), for a thesis entitled "The Geology of the British Virgin Islands, and other West Indian Studies"; D.Sc. in Chemistry: Mr. L. L. Bircumsha, for a thesis entitled "The Surface Tension of Liquid Metals," and other papers; Mr. B. M. Cavanagh, for a thesis entitled "On the Interpretation of the Thermodynamic Properties of Solutions" and "On New Principles and Methods of Potentiometric Titration"; and Dr. F. H. Constable, for a thesis entitled "A New Interference Method of Measuring the Surface Area of Film Catalysts," and other papers.

The Laura de Saliceto Studentship, of the value of £150, has been awarded for 1929 to Dr. A. F. Watson, for the purpose of continuing investigations on a detailed study of dietary and other factors contributing to the genesis and development of experimentally induced tumours in animals.

MR. F. G. G. A. MARRAINE has been appointed to the post of lecturer and demonstrator at Faraday House Electrical Engineering College.

SIR DUGALD CLERK has accepted the chairmanship of a committee appointed by the President of the Board of Education to advise as to the scope and methods of the Board's inquiry into technical education for the engineering industry. Mr. H. B. Wallis will act as secretary to the committee, and all communications should be addressed to him at the Office of the Board of Education, King Charles Street, Whitehall, London, S.W.1.

THE new buildings for the Departments of Physics and Chemistry of University College, Cardiff, have been completed and the transference of classes and equipment to the new quarters is practically accomplished. A new building to accommodate the Advisory and Research Department in Agriculture has also been completed and will be in occupation during the present term. Dr. Norman Thomas has been appointed professor of engineering in succession to Prof. A. J. Sutton Pippard (resigned). In the Welsh National School of Medicine, Prof. J. H. Dible has been appointed professor of pathology and bacteriology in succession to Prof. E. H. Kettle (resigned).

THE British Federation of University Women, Crosby Hall, Chelsea, S.W.3, makes the following announcement with reference to offers of travelling fellowships for women for the academic year 1929–30, the latest date for the receipt of applications from British women graduates resident in Great Britain being given in brackets: An international fellowship of the value of 1500 dollars, for research in any country other than the holder's own, offered by the American Association of University Women (Nov. 26). An international junior fellowship of the value of £250, for research in a country other than the holder's own, in language, history, archæology, philosophy, and theology, offered by the International Federation of University Women (Jan. 31, 1929). A vacation scholarship of the value of 2000 French francs, for research or other advanced study in France, offered by the French Association of University Women (Jan. 31, 1929). Application forms and regulations may be obtained from the Secretary, British Federation of University Women, as above.

Calendar of Customs and Festivals.

November 11.

ST. MARTIN. "The Glory of Gaul." Bishop of Tours.—A native of Sabaria in Upper Pannonia, born in 317, the son of a military tribune and himself a soldier. He is best known for his charity to a beggar, to whom he gave half his cloak, clothed in which Christ appeared to him in a vision the following night. On entering the Church he became a hermit, when he restored one of his disciples to life, and also a slave who had been hanged. On one occasion the ghost of a reputed martyr, whose chapel and altar were held in great repute by the people, appeared to the saint and revealed that he had been no holy man, but a robber, executed for his crimes.

As Bishop of Tours, St. Martin was active in extirpating the pagan temples and sacred groves in which his diocese abounded. Once, at the request of pagans, he allowed himself to be bound to a sacred pine while it was being felled, but on his making the sign of the cross it fell so as not to crush him. The pagan beliefs of his diocese must also be held responsible for St. Martin's activity in casting out devils, though, curiously enough, he confessed that this achievement became increasingly difficult as he grew old.

MARTINMAS; MARTINALIA.—On the Continent the goose killed in England at Michaelmas was sacrificed at Martinmas, the explanatory legend being that St. Martin, being unwilling to accept the bishopric of Tours, hid himself from the diocesan electors, but was discovered by a goose. In the ancient clog calendars the day was marked with a goose.

As the pastoral peoples brought in the flocks and herds from the grazing grounds to their winter quarters, the opportunity was taken to weed out superfluous head, sacrificing some of the increase to the gods, and salting down provision for the winter. This practice survived in the custom of a feast celebrated at Martinmas over the greater part of Christendom. In vine countries the new wine was then tasted. In Scotland and the north of England a fat ox was called *Mart*, a name said to be derived from Martinmas, as the time when beeves, swine, etc., were killed for winter store. The English were notorious as meat eaters among European nations in the Middle Ages, and the extent to which the people were dependent on salted meat in the winter months must be held the ground for the belief that they were peculiarly subject to scurvy. Several passages are quoted by Brand in reference to Martlemas beef, that is, beef dried in the chimney like bacon.

In Scotland as late as the middle of the eighteenth century Martinmas continued to be the recognised date for beginning to make provision for the winter. In Forfarshire, it was recorded that twenty-four beeves were killed in a week. In Wigton, the poorer people eat no beef and little mutton—a sheep or two killed at Martinmas and salted down for winter.

In Northumberland, families who clubbed together to buy a beast for the feast were known as a 'mart.' The entrails of the animal were stuffed with a kind of pudding meat, and known as black puddings. These were sent as presents. A similar entertainment in Germany was known as the 'feast of sausages.' Dishes of entrails accompanied by liberal potations were traditional in Franconia.

In parts of Ireland in the villages every family used to kill an animal of some kind, those rich enough a cow or sheep, even the poorest a hen or cock, and sprinkle the threshold and the four corners of the house with the blood. This excluded all evil spirits from the house until the following Martinmas. Persons sprinkled with the blood were also freed from evil influences.

The close association of ecclesiastical and popular custom is seen in the practice recorded in the North Riding of Yorkshire, in which a party of singers, mostly women, made a peregrination around the neighbouring villages, carrying a small waxen image of Christ adorned with evergreens, while they sang a nativity hymn. This continued until 'good living' began on Christmas Eve, when every housewife produced a cheese preserved for the festival, on which, before any part was tasted, the mark of the cross was made with a sharp knife.

In the Roman Calendar, Martinmas superseded the Vinalia, the feast of the new wine. As a further indication of the close connexion between Martinmas and the wine feast may be mentioned the practice of boys placing out jars of water in the belief that it would be turned into wine in the course of the night. Usually the parents looked to it that they were not disappointed.

November 13.

ST. BRICE'S DAY.—Down to a late period an observance known as 'bull-running' was observed on this day at Stamford. The butchers of the town provided a bull at their own charges, which was placed overnight in a stable belonging to the Alderman. On the following morning the town bellman published a proclamation that all shut up their shop doors and gates, that none do any violence to strangers, a guard being appointed to escort them through the town, and that none have any iron on their bull clubs. The bull was then turned loose into a street stopped at each end, and pursued by all the inhabitants and their dogs. Finally, the bull was driven to the bridge, where he was forced into the river. At nightfall he was slaughtered and the flesh sold at a low price to the poor. At one time a female clad in blue and decked with ribbons was a part of the celebration. Its traditional origin in a fight between two bulls checked by William Earl of Warren, connects it with a meadow, the 'bull meadow,' in which the town of Stamford holds certain traditional rights.

It may be noted that in the Manor of Whitlesea, in Cambridgeshire, there is a custom for the inhabitants to choose on the Sunday next after Martinmas two persons called stovers, who oversee public business and provide a common bull, in consideration whereof they enjoyed a certain pasture called 'bull-grass.'

November 17.

ST. HUGH, BISHOP OF LINCOLN, A.D. 1200.—Gunpowder Plot, though the best known, is not the earliest political event by which the November fires have been adopted. In the twelfth year of Queen Elizabeth's reign, her accession to the throne was celebrated in an outburst of Protestant enthusiasm on Nov. 17, with a procession, bonfires, and illuminations in the city of London. The celebration was continued regularly until late in the eighteenth century. The principal figure in the procession was an effigy of the Pope, who was accompanied by his counsellor, a person dressed as the devil, who embraced him and whispered to him as the procession moved on. In the reign of Queen Anne the figure of the Pretender was added. Pope, devil, and Pretender were all burnt in effigy at the Inner Temple gates after the statue of Queen Elizabeth on Temple Bar, wreathed in laurel for the occasion, had been visited.

Societies and Academies.

LONDON.

Royal Society, Nov. 1.—G. D. Bengough, J. M. Stuart, and A. R. Lee: The theory of metallic corrosion in the light of quantitative measurements (2). Forms of corrosion-time curves for zinc in potassium chloride solutions in the presence of oxygen have been defined at 25° C. and 760 mm. over the range $N/20{,}000$ to N. Each curve has a short initial branch, concave upwards. With solutions as weak as $N/10{,}000$, displaced hydrogen may either appear as gas or be oxidised. In $N/10$ solutions, nearly 15 per cent of the total corrosion is associated with gas evolution. The curves for corrosion due to oxygen absorption are exponential in weak solutions (up to about $N/5000$), and straight lines steeply inclined to the horizontal in stronger solutions (up to N at least). The controlling factors are concentrations of chlorine ions for exponential curves and rate of oxygen supply for straight lines. The final amount of corrosion is independent of oxygen supply and is determined by concentration of chlorine ions, and rate of their withdrawal from solution.

C. V. Raman and K. S. Krishnan: The production of new radiations by light scattering. Part 1. When any transparent medium is irradiated by monochromatic light, the radiations scattered by the molecules contain spectral lines of modified frequencies, the difference between incident and scattered frequencies corresponding to a characteristic infra-red frequency of the molecule. Most of the modified lines are of smaller frequency than the exciting line. There are some relatively feeble lines the frequencies of which exceed the frequency of the exciting line by an infra-red frequency of the molecule. In these lines we have for the first time direct experimental proof of *induced emission* (or negative absorption) of radiation by molecules. The scattered lines are sometimes accompanied by a nebulosity or continuous spectrum, extending unsymmetrically on the two sides. The modified radiations scattered at 90° exhibit striking polarisation, the degree of polarisation being different for lines corresponding to different frequency shifts.

P. E. Shaw: Tribo-electricity and friction. (4) Tribo-electric charges arise by the clash of solid surfaces as when fine particles are blown at high speed through a tube or into a large vessel. With metal particles and surfaces, when the particles and surfaces are *unlike* (for example, zinc filings and copper surface), the amount of charge is closely proportioned to the well-known electrochemical values. When the particles and surface are *alike* (for example, zinc filings and zinc surface), no charges would be expected, but they invariably arise. The general law is that charges arise by the clash of solids, like or unlike, metallic or non-metallic.

E. B. Moullin: An ampere meter for measuring currents of very high frequency. A new form of ammeter has been designed primarily for measuring alternating currents of extremely high frequency, such as 3×10^7 cycles per second. The calibration of any instrument must be affected by frequency, and this instrument has been arranged to have a geometrical form for which the correcting factor can be calculated. The system consists of two parallel circular cylinders mounted inside, and parallel to the axis of, a circular screen tube. The two circular cylinders are in electrical connexion at one end, and one of them is mounted on an elastic support which permits that cylinder to move parallel to itself. The current to be measured flows along one cylinder and returns by the other, and the consequent repulsive force between them causes the elastic support to yield proportionately to the root mean square value of the current. The movement is observed by means of a suitably arranged optical microscope.

S. Goldstein: The influence of the earth's magnetic field on electric transmission in the upper atmosphere. A detailed study has been made of the magneto-ionic theory of the propagation of radio waves in the upper atmosphere. Mathematical formulæ are given for the polarisation and wave-velocity of a plane wave-train in an ionised medium with imposed magnetic field oblique to the direction of propagation and the results applied to calculate the polarisation of downcoming radio waves. The agreement with experiment is satisfactory.

S. R. Milner: The 'action' of an electromagnetic field. The electromagnetic equations in their usual form express the rates of variation of the field vectors along the time axis of an arbitrary observer. The consideration of the rates of variation along other lines in space-time, in particular along the lines which mark out the simplest structure of the field, leads to the equally legitimate conception of the field as being in motion. In this way expressions for the Hamiltonian and Eulerian *actions* of the field are obtained which form strict equivalents to those for the actions of a dynamical system.

H. A. Wilson: Chemical equilibrium in the vapour of a mixture of paraffins and unsaturated hydrocarbons. The thermodynamical method previously used (*Proc. Roy. Soc.* A, vol. 116, p. 501; 1927) to calculate the equilibrium composition of a mixture of paraffins is applied to a mixture of paraffins and unsaturated hydrocarbons. An expression for the fraction of the total pressure due to unsaturated hydrocarbons, in equilibrium, is obtained. This fraction diminishes as the pressure is increased, increases as the temperature increases, and cannot be greater than one-half when the vapour is in contact with liquid.

E. H. Gowan: The effect of ozone on the temperature of the upper atmosphere. An equilibrium equation using water vapour and ozone is set up and the steps of a solution by successive approximations are given. The theoretical consideration of the radiative equilibrium leads to a warm region agreeing very well as regards both temperature and height with the results of indirect observations.

H. Gregory and C. T. Archer: The thermal conductivities of carbon monoxide and nitrous oxide. An experimental determination was carried out. A comparison is given of some of the physical properties of these gases with those of gases of equal molecular weight. While the viscosities of carbon monoxide and nitrogen, and of nitrous oxide and carbon dioxide, are equal, as suggested by the kinetic theory of gases, a marked difference exists in the values of the thermal conductivities of the gases considered.

N. K. Adam and G. Jessop: The structure of thin films, Part 12. The action of cholesterol in reducing the area of certain expanded films to that of condensed films, discovered by Leathes in 1923, is further investigated. It is probably due to mechanical obstruction of the tilting oscillations of the molecules in the expanded state, by the bulky and massive cholesterol molecules, not to any special attraction between the cholesterol and the smaller molecules. The condensing action can be imitated by other very large molecules, the effects of which are not, however, precisely similar. An attempt is made to correlate the minor differences in condensing effect of various molecules with their solidity at various points, as indicated by their constitutional formulæ.

W. A. Bone, L. Horton, and L. J. Tei: Researches on the chemistry of coal (5). Further investigations have

been carried out upon the benzene pressure-extraction of various types of coals with the view of arriving at some understanding of the origin and development during the 'maturing' process of the constituents which are principally responsible for the coking propensities of bituminous coals. The coals examined in detail included (1) the Morwell brown-coal occurring in Victoria in Australia, (2) a series of lignitic and other coals from the Western Canadian Coalfield (Saskatchewan and Alberta), and (3) three bituminous coals (two of British and the third of South African origin). Incidentally, it is shown that the substances removed by the process are not produced by thermal decomposition (in the sense of any real breakdown of the coal substance) but are pre-existent in it, either as such, or in some loose molecular association with the coal complex, more probably the latter. The residues from benzene pressure-extraction are always quite devoid of coking propensities. The general effect of 'maturing' has been progressively to diminish the oxygen contents of the substances comprised in each and all the various fractions of the benzene-pressure extracts as well as of the benzene extracted residue.

H. L. Callendar: Steam tables and equations extended by direct experiment to 4000 lb./sq. in. and 400° C. A steady flow method was devised, with a jacketed condenser (*Phil. Trans.*, 1912) capable of reading to 1 in 5000 of the total heat of either water or steam at pressures up to 4000 lb./sq. in., and independent of the thermal capacity of the apparatus at high temperatures. The work was interrupted by the War, but has recently been completed with the assistance of the British Electrical and Allied Industries Research Association. The results for the total heat of water verify the thermodynamic formula at saturation (*Phil. Trans.*, 1902) with great precision up to the critical point. Those for steam show complete agreement with the expression $c/(1-Z^2)$ for the co-aggregation volume, but cannot be reconciled with the van der Waals' theory of the critical state. By combining the observations on the volumes and the total heats, it is easy to deduce the corresponding expressions for the entropy and the saturation pressure. The saturation lines for water and steam could be traced by experiment beyond the critical point up to 380° C. The observations agree all the way from 0° to 380° C. with the theoretical formula, and afford independent verification of the whole system of equations. No change is required in the original value of c representing the first term in the series, and the results appear to be strongly in favour of the co-aggregation theory.

W. R. C. Coode-Adams: The refractive index of quartz. In a previous paper (*Proc. Roy. Soc.* A, vol. 117; 1927) an equation was produced connecting the refractive index of quartz and the wave-length for the ordinary ray. This was of the Ketteler-Helmholtz type and derived its constants partly from previous work on the optical rotatory power. The other constants were solved taking known values for the refractive index. In the present paper the same is attempted for the extraordinary ray.

ROME.

Royal National Academy of the Lincei, June 1.—**G. Giorgi**: Factors and indices in linear groups and in normal groups of operations.—**Q. Majorana**: Further consideration of the photo-electric phenomenon of the audion. Substances other than the cupric oxide or cuprite covering the wire leading to the grid are capable of producing effects analogous to the photo-electric phenomenon realised when a strong beam of light, periodically interrupted, falls on a sensitive audion connected with an amplifying system. Such are freshly prepared thallium sulphide (probably an oxysulphide), molybdenite, argentite, silver sulphide prepared artificially, and light-sensitive selenium. The phenomenon appears to be a perturbation, electrical in character, caused by the arrival of the light, but not corresponding with external liberation of electrons. It depends on the nature of the substances used, which all exhibit semi-conductivity, or, as with silver sulphide, distinct electrolytic conductivity.—**P. Vinassa**: Symmetrical electronyls and monatomic molecules.—**N. Parravano** and **V. Montoro**: 'Blanc' alumina. Alumina prepared by decomposition of aluminium chloride at a low temperature is crystalline, trigonal, of low density, and possessed of high adsorptive powers. At about 650° it undergoes an exothermic transformation owing to contraction in the volume of the unit cell. The name 'Blanc' alumina, after Prof. G. A. Blanc, is suggested for this material.—**L. Petri**: Gurwitsch's mitogenetic radiations.—**A. Perroncito**: Extirpation of the liver (two new methods).—**A. Palatini**: The varieties V_n which contain a constant vectorial field.—**R. Caccioppoli**: The infinitesimal character of quadrable surfaces.—**U. Crudeli**: Saint-Venant's conditions relative to the deformations of natural media.—**U. Barbieri**: Astronomical-geodetic station on Monte Colma di Mombarone, August 1927.—**G. Gentile**: The intensified terms of calcium.—**F. Rasetti**: Calculation of the terms M by means of the statistical potential of the atom.—**E. Segrè** and **E. Amaldi**: The anomalous dispersion of mercury and of lithium. Results are given of measurements of the intensities of certain absorption lines of lithium and mercury. The ratio between the numbers of dispersion electrons for the lithium lines 6708 A. and 3232 A. is found to have the value 135 (± 20 per cent). No absolute measurements were possible with the mercury lines.—**F. de Carli** and **P. Agostini**: The double carbonate of copper and sodium. Hydrated copper sodium carbonate, Na_2CO_3, $CuCO_3$, $3H_2O$, may be converted into the corresponding anhydrous compound by heating it in a current of carbon dioxide. The anhydrous salt, which is pale blue, is unstable in the air and readily absorbs moisture to give the hydrate. The heating curve shows that the absorption of heat corresponding with the loss of carbon dioxide occurs between 220° and 230°. The thermal changes accompanying the decomposition of the double carbonate and of copper carbonate are given by the equations Na_2CO_3, $CuCO_3$ (sol.) = Na_2CO_3 (sol.) + $CuCO_3$ (sol.) + 10·330 Cal. and $CuCO_3$ (sol.) = CuO (sol.) + CO_2 (gas) + 0·995 Cal.; for the heat of formation of cupric carbonate from its elements, $Cu + C + 1\frac{1}{2}O_2 = CuCO_3$ (sol.) + 138·345 Cal.—**S. Berlingozzi**: Chemical constitution and rotatory power (3). The rotatory powers of several acyl-asparagines are compared with the values of the dissociation constants of the acids corresponding with the acyl substituents. The diminution of the value of $(M)_D$ with increase in k is brought out with special clearness in groups of compounds containing acyl groups of analogous structure. This relationship is complete with the ortho and meta compounds, and in the more numerous para compounds examined the only exception is anisoylasparagine, which has a lower molecular rotation than would be expected from the dissociation constant of anisic acid.—**P. Misciattelli**: Analysis of a radioactive pyromorphite from Gennammari (Sardinia). The slight radioactivity of this mineral is regarded as due to the presence of small proportions of radium introduced by water, which extracts it from a deep-lying uranium mineral.—**L. Bucciante**: Duration of the kinetic and interkinetic periods in the embryos of chickens incubated at various temperatures. The increased growth in the embryos of chickens produced by increase in the temperature of

incubation is the result of sensibly equal influences exerted on the kinesis and interkinesis.—**O. M. Olivo** and **E. de Lorenzi**: The duration of interkinesis in cells cultivated *in vitro*.—**B. Monterosso**: Cirrepedological studies (2): Anabiosis in *Chthamalus*.—**A. Stefanelli**: The existence of diffuse nervous networks with expansional significance in reptiles.—**M. Comel**: The reciprocal equilibrating power of two regulating phosphate solutions. The results of experiments on Jarisch solutions with different hydrogen ion concentrations, and on their behaviour towards muscle, confirm the possession by tissues of marked ability to regulate chemical reaction. By the action of equilibrating systems formed of slightly dissociated complex acid-salts, the tissues seem capable of maintaining their reaction close to the neutral point, at any rate in the presence of acid solutions.—**G. Lentati**: Experiments on the histogenesis of the islets of Langerhans.

Diary of Societies.

FRIDAY, NOVEMBER 9.

FARADAY SOCIETY (at Royal Institution), at 3.30.—Sir Oliver Lodge: Some Debatable Problems in Physics (Spiers Memorial Lecture).

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—J. W. Madeley: Town Water Supply in India.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Dr. W. M. Smart: On the Frequency Distribution of Restricted Proper Motions.—M. A. Ellison: Micrometrical Measures of the Potsdam Double Stars, made with the 10-in. Refractor of the Armagh Observatory.—K. Nakamura: Observation of Meteors from Skjellerup's Comet, 1927 *k*.—Prof. S. Chapman: The Electrical Conductivity of Stellar Matter.—Dr. W. J. S. Lockyer: A Wide Absorption Band in some *B*-type Stars.—W. M. H. Greaves and H. W. Newton: Magnetic Storms and Solar Activity, 1874-1927.—Prof. E. A. Milne: (*a*) The Theoretical Contours of Absorption Lines in Stellar Atmospheres; (*b*) Ionisation in Stellar Atmospheres: Generalised Saha Formulæ: Maximum Intensities and the Determination of the Coefficient of Opacity.—Prof. S. Chapman: On the Radial Limitation of the Sun's Magnetic Field.

PHYSICAL SOCIETY (at Imperial College of Science), at 5.—J. B. Seth, Chetan Anand, and Gian Chand: The Effect of Moist Air on the Resistance of Pencil Lines.—Dr. L. F. Richardson, V. Stanyon, and other Students of Westminster Training College: An Absolute Current-balance having a Simple Approximate Theory.—Prof. E. V. Appleton: Notes on Wireless Methods of Investigating the Electrical Structure of the Upper Atmosphere. I.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.

MALACOLOGICAL SOCIETY OF LONDON (in Zoological Department, University College), at 6.—H. Lemche: On some Uncertain Species of *Nudibranchiata* from the North Atlantic Ocean.—Lt.-Col. A. J. Peile: (*a*) Radula of *Monomphalus*; (*b*) A new *Indoennea* from the Malay States.—L. R. Cox: The Varietal Names in K. Schreiber's Vers. Conch. Linnés Syst. 1793.—J. R. le B. Tomlin: Description of Two New Species of *Tortulosa*.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—T. M. C. Lance and others: Discussion on Loud Speakers.

INSTITUTION OF MECHANICAL ENGINEERS (Informal Meeting), at 7.—E. T. Elbourne: Marketing Engineering Products Overseas.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—Annual General Meeting.

KEIGHLEY ASSOCIATION OF ENGINEERS (at Temperance Institute, Keighley), at 7.30.—C. H. Carter: Precise Length and Angular Measurement.

INSTITUTE OF METALS (Sheffield Local Section) (in Applied Science Department, Sheffield University), at 7.30.—Prof. F. C. Thompson: Flow in Metal Shaping Processes.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.30.—B. Campbell: Nitrocellulose Finishes.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section), at 8.30.—A. H. Levy: Injury of Lens causing Alteration of Refraction.—A. F. MacCallan: Ocular Manifestations of Local Sepsis.

SATURDAY, NOVEMBER 10.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Rev. T. E. R. Phillips: Recent Observations and Discoveries respecting the Planets (II.).

PHYSIOLOGICAL SOCIETY (in Department of Physiology, London Hospital Medical College), at 4.—D. Hunter: Some Observations on the Regulation of Calcium Metabolism.—J. H. Shaxby: The Resonance Theory of Audition: a Historical Note.—J. R. Marrack: Note on the Osmotic Pressure of Mixtures of Pseudo- and Euglobulin.—Prof. H. E. Roaf: Discrimination of Colour.—Demonstrations:—W. A. M. Smart: Some Labour-saving Devices for the Research Worker:—(*a*) Slide Rule: Surface Area of Body ($S = 71{\cdot}84\ W^{0{\cdot}425}\ H^{0{\cdot}725}$); (*b*) Nomograms—Correlation by Ranks:—

$$(r+1)/2 = \text{Cos}\ 2\pi\ \Sigma d/(N^2-1),$$
$$r = \text{Sin}\ \pi\ [1 - 6\ \Sigma d/(N^2-1)]/2,$$
$$r/2 = \text{Sin}\ \pi\ [1 - 6\ \Sigma d^2/N\ (N^2-1)]/6;$$

(*c*) Probability Paper—an Improved Type.—F. Campbell Smith and C. Gordon-Wilson: The Cadmium Photo-electric Cell as a Means for Measuring the Absorption of Ultra-violet Radiation in Dilute Physiological Fluids.—J. T. Cunningham: Effect of Raised Temperature on Seminal Epithelium.—Prof. H. E. Roaf: (*a*) An Apparatus for Quantitative Measurement of Differences in Colour Discrimination; (*b*) Identity of the Yellow Sensation produced by Mono- and Hetero-chromatic Light; (*c*) A New Perimetric Device.—H. T. Goodwin: A New Design for Students' Drums.

HULL ASSOCIATION OF ENGINEERS (at Technical College, Hull), at 7.15.—Prof. G. E. Scholes: Heat Engine Cycles.

INSTITUTION OF MECHANICAL ENGINEERS (Glasgow Branch) (at Glasgow).—Dr. A. McCance and J. Jefferson: Steel Castings.

MONDAY, NOVEMBER 12.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—Capt. J. G. Withycombe: Lettering on Maps.

ROYAL SOCIETY OF MEDICINE (War Section), at 5.—Major W. D. Keyworth: Severe Malaria among British Troops in the East African Campaign.

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE (at Institution of Mechanical Engineers), at 5.30.—M. Fieux: Twin Gyro Stabiliser.

INSTITUTION OF AUTOMOBILE ENGINEERS (Midlands Centre) (at Queen's Hotel, Birmingham), at 7.—L. H. Hounsfield: The Integrity of the Technical Man.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—J. Coxon and others: Discussion on Engineering Requirements of a Modern Office Building.

INSTITUTION OF ELECTRICAL ENGINEERS (North-Eastern Centre) (jointly with North-Eastern Students' Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.—Prof. S. P. Smith: Automobile Ignition Systems.

INSTITUTION OF ELECTRICAL ENGINEERS (South Midland Centre) (at Birmingham University), at 7.—Dr. J. D. Morgan: Action of a Spark-gap.

ELECTRICAL ASSOCIATION FOR WOMEN (at E.L.M.A. Lighting Service Bureau, 15 Savoy Street), at 7.—H. W. Gambrell: A Complete Electric Radio-Gramophone Equipment.

INSTITUTION OF HEATING AND VENTILATING ENGINEERS (Associate Members and Graduates' Branch) (at Borough Polytechnic), at 7.30.—H. F. W. Joyce: Space occupied by Heating and Ventilating Apparatus.

INSTITUTE OF METALS (Scottish Local Section) (at 39 Elmbank Crescent, Glasgow), at 7.30.—A. C. Sturney: Nickel in the Non-Ferrous Foundry.

ROYAL SOCIETY OF ARTS, at 8.—Dr. F. Kidd: Biology and Refrigeration (Cantor Lectures) (I.).

SURVEYORS' INSTITUTION, at 8.—C. B. Fisher: Presidential Address.

CAMBRIDGE PHILOSOPHICAL SOCIETY (in University Chemical Laboratory, Cambridge), at 8.45.—Dr. E. K. Rideal: Chemiluminescence.

INSTITUTION OF ELECTRICAL ENGINEERS (Western Centre) (at South Wales Institute of Engineers, Cardiff).—H. B. Poynder: Some Practical Considerations in the Design of Automatic Equipments for Heavy Traction Sub-stations.

TUESDAY, NOVEMBER 13.

ROYAL SOCIETY OF MEDICINE (Therapeutics and Tropical Diseases Sections), at 5.—Dr. J. B. Christopherson, Prof. A. J. Gunn, Sir Leonard Rogers, and others: Joint Discussion on The Special Uses of Antimony.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. H. L. Callendar: Co-aggregation *versus* Continuity in the Change of State from Liquid to Vapour (Tyndall Lectures) (III.).

INSTITUTION OF PETROLEUM TECHNOLOGISTS (at Royal Society of Arts), at 5.30.—G. Heseldin: Drilling and Production Methods in the Greater Seminole Field, Oklahoma, U.S.A.

INSTITUTE OF MARINE ENIGNEERS, at 6.30.—Major R. H. Mayo: Air Transport.

INSTITUTION OF ELECTRICAL ENGINEERS (East Midland Sub-Centre) (at Loughborough College), at 6.45.—S. H. Holden: Electricity Meters.

SOCIETY OF CHEMICAL INDUSTRY (Birmingham and Midland Section) (at Chamber of Commerce, Birmingham), at 7.—J. H. Lane: Recent Developments in Beet Sugar Manufacture.

INSTITUTION OF ELECTRICAL ENGINEERS (North Midland Centre) (at Hotel Metropole, Leeds), at 7.—W. B. Woodhouse: Overhead Electric Lines (illustrated by Cinematograph Film).

INSTITUTION OF ELECTRICAL ENGINEERS (North-Western Centre) (at Engineers' Club, Manchester), at 7.—F. Lydall: The Electrification of the Pietermaritzburg-Glencoe Section of the South African Railways.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Kinematograph Group), at 7.—Examples of Modern British Film Production.

INSTITUTION OF AUTOMOBILE ENGINEERS (Coventry Centre) (at Broadgate Café, Coventry), at 7.30.—Dr. E. C. Wadlow: The Comparative Merits of Road and Dynamometer Testing for Motor Vehicles.

INSTITUTION OF ELECTRICAL ENGINEERS (Scottish Centre) (at Royal Technical College, Glasgow), at 7.30.—D. S. Munro: Some Tendencies in Installation Work (Chairman's Address).—P. D. Morgan: Electrical Research Association Report on A Critical Study of the Current Rating of Low-Pressure Ordinary-Duty Fusible Cut-outs.

QUEKETT MICROSCOPICAL CLUB, at 7.30.

HULL CHEMICAL AND ENGINEERING SOCIETY (Grey Street, Hull), at 7.45.—H. Thompson: The Chemistry of Food.

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN, at 8.—C. J. S. Thompson: The Apothecary and some Curious Materia Medica of the Seventeenth Century.

INSTITUTION OF MECHANICAL ENGINEERS (South Wales Branch) (at Swansea).—W. O. Dayson: Chairman's Address.

WEDNESDAY, NOVEMBER 14.

ROYAL SOCIETY OF MEDICINE (Surgery: Sub-Section of Proctology), at 5.30.—Dr. C. Dukes and others: Discussion on Urinary Infections after Excision of the Rectum; their Cause and Prevention.

INSTITUTION OF CHEMICAL ENGINEERS (at Institution of Civil Engineers), at 6.30.—Dr. P. Klein: Making Rubber Goods of Latex by Electro-Deposition (Lecture).

BELFAST ASSOCIATION OF ENGINEERS (at Municipal College of Technology, Belfast), at 7.30.—A. W. Brown: Low-pressure Hot Water Heating.

INSTITUTION OF MECHANICAL ENGINEERS (Sheffield Branch), at 7.30.—H. E. Yerbury: Corrosion of Metals and its Prevention.

ROYAL SOCIETY OF ARTS, at 8.—O. Ramsden: English Silver and its Future.

SOCIETY OF CHEMICAL INDUSTRY (South Wales Section) (at Technical College, Cardiff).—Dr. F. Arnall: The Training of a Works Chemist.

THURSDAY, NOVEMBER 15.

ROYAL SOCIETY, at 4.30.—Prof. S. W. J. Smith, A. A. Dee, and J. Young: The Mode of Formation of Neumann Bands. Part I. The Mechanism of Twining in the Body-Centred Cubic Lattice. Part II. The Evidence that the Bands are Twins. Part III. The Movement from which the

Twining Results.—Dr. C. F. Elam: An Investigation of some Banded Structures in Metal, with an Appendix by Prof. G. I. Taylor.—F. H. Rolt and H. Barrell: The Difference between the Mechanical and Optical Lengths of a Steel End-Gauge.—D. A. Jackson: Hyperfine Structure in the Arc Spectrum of Cæsium and Nuclear Rotation.—*Papers to be read in title only*:—G. S. Adair: A Theory of Partial Osmotic Pressures and Membrane Equilibria with special reference to the Application of Dalton's Law to Hæmoglobin Solutions in the Presence of Salts.—A. T. Waterman: The Effect of Electric Fields on the Emission of Electrons from Conductors.—A. T. Price: A Mathematical Discussion on the Structure of Wood in Relation to its Elastic Properties.—Prof. A. Fowler and E. W. H. Selwyn: Further Investigations of the Spectrum of Singly Ionised Carbon (C II) —Prof. O. W. Richardson and F. C. Chalklin: The Soft X-Ray Levels of Iron, Cobalt, Nickel, and Copper.—W. Mandell: (*a*) The Change in Elastic Properties on Replacing the Potassium Atom of Rochelle Salt by the Ammonium Group; (*b*) The Determination of the Piezo-Electric Moduli of Ammonium Seignette Salt.—Prof. A. M. Tyndall, L. H. Starr, and C. F. Powell: The Mobility of Ions in Air. Part IV. Investigations by two New Methods.—Prof. A. M. Tyndall, G. C. Grindley, and P. A. Sheppard: The Mobility of Ions in Air. Part V. The Transformation of the Positive Ions of Short Ages.—L. J. Freeman: The Spectrum of Doubly Ionised Nitrogen (N III).—W. R. Dean: Fluid Motion in a Curved Channel.—H. E. Watson and A. S. Menon: The Electrical Conductivity of Thin Oil Films. Part I.—W. Kapucinski and J. G. Eymers: Intensity Measurements in the Secondary Spectrum of Hydrogen.—E. Rudberg: Some Remarks concerning the Production and Absorption of Soft X-Rays and Secondary Electrons.—E. J. Williams, J. M. Nuttall, and H. S. Barlow: The Special Distribution of Photo-Electrons produced by X-Rays.—L. W. Nordheim: The Effect of the Image Force on the Emission and Reflection of Electrons by Metals.—B. Swirles: The Internal Conversion of Gamma Rays. Part II.—W. G. Kannuluik and Prof. T. H. Laby: The Thermal and Electrical Conductivity of Copper Crystals at various Temperatures.—Dr. H. Jeffreys: On Aerofoils of Small Thickness.—R. S. Bartlett: The Increase in Thermionic Currents from Tungsten in Strong Electric Fields.—H. D. H. Drane: Elastic Constants of Fused Quartz. Change of Young's Modulus with Temperature.—L. H. Thomas: On the Rate at which Particles take up Random Velocities from Encounters according to the Inverse Square Law.—F. A. Jenkins and H. de Laszlo: Structure of the Violet Bands of Silicon Nitride.—R. A. Fisher: The General Sampling Distribution of the Multiple Correlation Coefficient.—Prof. G. I. Taylor and C. F. Sharman: A Mechanical Method for Solving Problems of Flow in Compressible Fluids.—Prof. A. S. Eddington: A Symmetrical Treatment of the Wave Equation.—A. C. Menzies: Ground Terms on the Spectrum of Nickel II. and Proposed Standard Wave-length in the Schumann Region.—J. M. Whittaker: On the Principle of Least Action in Wave-Mechanics.—Dr. J. A. V. Butler: The Equilibrium of Heterogeneous Systems including Electrolytes. Part III.—Prof. T. H. Havelock: The Wave Pattern of a Doublet in a Stream.—G. R. Goldsbrough: The Tides in Oceans on a Rotating Globe. Part II.—T. Bradshaw and Prof. G. H. Livens: The Formula for the Optical Rotatory Dispersion of Quartz.—Dr. H. T. Flint: The New Metric of Einstein and the Wave Equation.

LINNEAN SOCIETY, at 5.—Dr. H. H. Thomas: Further Observations on the Cuticle Structure of Mesozoic Cycadean Fronds.—A. H. Clark: On some Recent Crinoids in the Collection of the British Museum.—Dr. C. A. Nilsson-Cantell: New and Interesting Species of *Scalpellum* from a Telegraph Cable near the Coast of North Chile.—Prof. W. M. Tattersall: *Asellus cavaticus* Schiodte, a Blind Isopod new to the British Fauna, from a Well in Hampshire.

ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Capt. G. Pitt-Rivers: The Clash of Culture (III.). The Empire and the Native Problem.

BIOCHEMICAL SOCIETY—UNIVERSITY OF BIRMINGHAM (at University of Birmingham), at 5.30.—P. J. Powell: Beet Sugar Manufacture—Providing the Raw Material.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—J. D. Young: Losses of Efficiency in Steamship Operation.

INSTITUTE OF METALS (Birmingham Local Section) (at Engineers' Club, Birmingham), at 7.—Open Discussion on Standardisation.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—Demonstration of Colour Photography.

INSTITUTE OF CHEMISTRY (Edinburgh and East of Scotland Section) (jointly with Society of Chemical Industry—Edinburgh and East of Scotland Section) (at North British Station Hotel, Edinburgh), at 7.30.—Dr. W. J. Jenkins: Nitro-Cellulose Lacquers and Enamels.

INSTITUTION OF ELECTRICAL ENGINEERS (Irish Centre—Dublin) (at Trinity College, Dublin), at 7.45.

CHEMICAL SOCIETY, at 8.—F. L. Gilbert and Prof. T. M. Lowry: Studies of Valency. Part XII. Isomeric Derivatives of Diethyl Telluride.—Prof. T. M. Lowry and F. L. Gilbert: Studies of Valency. Part XIII. Further Experiments on the Molecular Structure and Configuration of the Quadrivalent Derivatives of Tellurium.

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (Laboratory Meeting) (at London School of Hygiene and Tropical Medicine), at 8.15.—Demonstrations by Major H. C. Brown, Dr. W. T. C. Broom, Dr. P. A. Buxton, Dr. L. J. Davis, B. Jobling, Dr. S. Sharpe, Miss E. K. Sikes, Dr. A. C. Stevenson, Dr. C. M. Wenyon, Dr. E. Hindle, V. B. Wigglesworth, Prof. Warrington Yorke.—Dr. L. E. Napier: Cinematograph Film, Scenes in the Kala-Azar Endemic Areas in Bengal.

INSTITUTION OF MECHANICAL ENGINEERS (Leeds Branch).—H. E. Yerbury: Corrosion of Metals and its Prevention.

INSTITUTION OF MINING AND METALLURGY (at Geological Society).

FRIDAY, NOVEMBER 16.

ROYAL ASTRONOMICAL SOCIETY (Geophysical Discussion), at 4.30.—Prof. S. Chapman, W. M. H. Greaves, and others: Magnetic Phenomena in Relation to the Upper Atmosphere and to Solar Activity.

BIOCHEMICAL SOCIETY (at St. Thomas's Hospital Medical School), at 5.—V. B. Reader: A Third Factor Present in Marmite, necessary for the Nutrition of the Rat.—H. J. Holman and Prof. S. B. Schryver: The Separation of the Basic Products of the Hydrolysis of Proteins.—J. R. Marrack: Ketosis in Sea-sickness.—Dr. L. J. Harris and T. Moore: Hypervitaminosis.—M. G. Eggleton and P. Eggleton: A Method of Estimating Phosphagen and other Phosphorus Compounds in Voluntary Muscle.—W. J. N. Burch: A Synthesis of Hydroxyglutamic Acid.—W. J. N. Burch and Prof. R. H. A. Plimmer: Esters of Phosphoric Acid.—J. Lowndes and Prof. R. H. A. Plimmer: Bromination of Histidine.—Prof. R. H. A. Plimmer, W. H. Raymond, and J. Lowndes: Comparative Vitamin-B Values of Foodstuffs.—H. Allen, F. Dickens, E. C. Dodds, and F. C. Howitt: A Study of the Œstrus-producing Hormone with Special Reference to its Preparation and Standardisation in Water-soluble Form.

INSTITUTION OF MECHANICAL ENGINEERS, at 6.—Dr. H. W. Swift: Power Transmission by Belts: an Investigation of Fundamentals.

INSTITUTION OF LOCOMOTIVE ENGINEERS (North-Eastern Centre) (at Hotel Metropole, Leeds), at 7.—E. Windle: The Locomotive Smoke-box.

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN (Pictorial Group, Informal Meeting), at 7.—T. H. B. Scott: British Cottage Homes.

GLASGOW DYERS' SOCIETY (at 7 Gordon Street, Glasgow), at 7.15.—Dr. S. G. Barker: Some Scientific Aspects of Wool as they affect the Wearer.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—A. H. Croucher: Some Applications of Time and Remote Control Switches.

TEXTILE INSTITUTE (Lancashire Section) (jointly with Blackburn Textile Society) (at Technical College, Blackburn), at 7.30.—A. Munro: Art, Textile Decoration, and Commerce.

SOCIETY OF DYERS AND COLOURISTS (Manchester Section) (at Manchester).—Dr. R. H. Pickard: The Aims of Recent Research at the Shirley Institute.

INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND (at Grosvenor Restaurant, Gordon Street, Glasgow).—The "James Watt" Lecture.

SATURDAY, NOVEMBER 17.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. W. G. Whittaker: North Country Folk Music (I.).

BRITISH ASSOCIATION OF CHEMISTS (Annual General Meeting) (at Birmingham), at 7.

INSTITUTE OF BRITISH FOUNDRYMEN (Lancashire Branch, Junior Section) (at College of Technology, Manchester), at 7.—P. A. Russell: Shrinkage Holes in Small Grey Iron Castings.

BRITISH MYCOLOGICAL SOCIETY (at University College).

PUBLIC LECTURES.

FRIDAY, NOVEMBER 9.

UNIVERSITY COLLEGE, at 5.30.—W. L. Cook: The British Coal Industry.

SATURDAY, NOVEMBER 10.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Swiss Scenes and Flowers.

MONDAY, NOVEMBER 12.

UNIVERSITY COLLEGE, at 5.30.—Dr. P. Stamberger: The Colloid Chemistry of the Rubber Industry. (Succeeding Lectures on Nov. 14, 16, 19, and 21.) (Gow Lectures.)

INSTITUTION OF CIVIL ENGINEERS, at 8.—H. E. Stilgoe: Some Aspects of the London Water Supply (Chadwick Public Lectures).

TUESDAY, NOVEMBER 13.

KING'S COLLEGE, at 5.30.—Miss Evelyn Underhill (Mrs. Stuart Moore): The Philosophy of Contemplation.

UNIVERSITY COLLEGE, at 6.30.—P. Dunsheath: High Tension Transmission of Power. (Succeeding Lectures on Nov. 20, 27, Dec. 4 and 11.)

WEDNESDAY, NOVEMBER 14.

ROYAL INSTITUTE OF PUBLIC HEALTH, at 4.—Dr. R. H. B. Adamson: The Health of Women and Girls in Relation to Industry.

KING'S COLLEGE, at 5.30.—Prof. R. J. S. McDowall: The Indebtedness of Industry to Pure Science: Physiology and National Efficiency.

FRIDAY, NOVEMBER 16.

KING'S COLLEGE, at 8.—Prof. A. R. Ling: Contributions to the History of Starch and its Transformation Products (Streatfeild Memorial Lecture).

SATURDAY, NOVEMBER 17.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—H. N. Milligan: "Missing Links" and Evolution.

CONGRESSES.

NOVEMBER 14, 15, 16, AND 17.

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY.

Exhibition and Meetings.

Wednesday, Nov. 14.

At 8.15 (in Barnes Hall, Royal Society of Medicine).—Prof. W. L. Bragg: X-Ray Optics (Mackenzie-Davidson Memorial Lecture).

Thursday, Nov. 15 (at Central Hall, Westminster).

At 10.30 A.M.—Exhibition of X-Ray Apparatus.

At 2.30.—Dr. G. W. C. Kaye: Radiology, Mediæval and Modern (Presidential Address).

At 5.—Dr. W. S. Handley: Radiology from a Surgeon's Standpoint (Silvanus Thompson Memorial Lecture).

Friday, Nov. 16 (at Central Hall, Westminster).

At 10 A.M.—Exhibition.

At 10-11.30 A.M.—Sir Thomas Horder, Bart., A. J. Walton, Dr. A. E. Barclay, and others.—Discussion on The Value of the Opaque Meal in Diagnosis.

At 10.15 A.M.—W. V. Mayneord: The Distribution of X-Rays within an Irradiated Medium.

At 10.45 A.M.—Dr. G. Shearer: Some Applications of X-Ray Spectroscopy to Industrial Problems.

At 2.30-4.—Continuation of Discussion on Opaque Meals.

At 2.30.—W. E. Schall: Some Engineering Lessons from Stockholm.

Saturday, Nov. 17.

Visit to National Physical Laboratory.

NOVEMBER 19-24.

INTERNATIONAL CONFERENCE ON BITUMINOUS COAL (at Pittsburgh, Pa. U.S.A.).—Among the subjects to be discussed are:—Fixed Nitrogen, The Liquefaction of Coal, Low Temperature Distillation, High Temperature Distillation, Power from Coal, Coal Tars, and Oils, Complete Gasification of Coal, Origin of Coal, Coal Washing, Pulverised Coal, Catalysts, and the general aspects of the Bituminous Coal Industry.