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Industry and Scientific Research.

THE close relation between the dyestuffs industry and general organic research emphasised in the course of recent Parliamentary debates on the Dyestuffs (Import Regulation) Act was not controverted by those who considered that the Act should be allowed to lapse. On the other hand, doubts as to whether Imperial Chemical Industries, Ltd., by which the major proportion of dyestuffs research in Great Britain has been conducted, was doing so much for research as might be expected, and a suggestion that such research was being or might be curtailed, were alleged by certain members as reasons for not voting for a measure which they would otherwise have supported. The report of the Dyestuffs Development Committee, indeed, shows that there has been a slight decrease in the number of research workers employed in the dyestuffs industry between 1920 and 1928. This difference, however, as Major A. G. Church has pointed out, is largely due to the attraction of such research workers into other industries. Apart from this, the figures given in the report are too early to record the full effect of the extension of research activity in this field which has resulted from and only become possible through the pooling of resources following the formation of Imperial Chemical Industries, Ltd.

The relation between industry and research is extremely complicated, and there are certain aspects which were by no means covered in the recent debates and discussions. It must be conceded that industrial research inevitably has an economic trend, which may at times impose limitations. There is a certain amount of justification for making research obligatory when State support is given in any form. On the other hand, the prosperity of the dyestuffs industry and the organic chemical industry depends essentially upon continuous and wisely directed research. Any relaxation of effort in that direction would speedily result in decay. It is open to debate whether any stipulation regarding research could be made without involving machinery for control which would be a serious hindrance to scientific management.

The problems raised are not peculiar to Great Britain. Prof. R. Willstätter has recently directed attention to the changed relations between the universities and chemical industry in Germany (*Chem. Zeit.*, **54**, 793; 1930; **55**, 1; 1931), and views with serious concern the increasing difficulty with which the newly qualified chemists are absorbed into industry and their insecurity of tenure. Such conditions he regards as dangerous to the scientific

position of Germany, which cannot be maintained if students of ability are no longer freely attracted by scientific studies and careers.

The opinion has been expressed that the world is suffering from over-production of chemists and of research, in common with over-production of all kinds. This view is probably encouraged by the common impression that there are now no striking advances to be made in the field of organic chemistry, pure or applied. Its main principles have in general been discovered, and the research chemist, whether in industry or in scientific laboratories, is now occupied with the intensive study of relatively small parts of the field.

While the apparent orderliness of the immense edifice developed from Kekulé's theory undoubtedly strengthens the impression that chemistry is a static science, such a view is fundamentally false. If propounded twenty or thirty years ago, since when the main structure of theoretical organic chemistry has remained essentially unchanged, this view would have been confounded by subsequent discoveries and advances in almost every branch of organic chemistry. Well within these three decades we have seen the development of the rayon industry, the synthetic resins industry, the cellulose lacquer industry, oil-cracking, and low temperature carbonisation. Immense developments have been recorded in the production of insecticides and synthetic drugs and in the vulcanisation of rubber. The technical production of indigo essentially dates from the Deutschen Gold- und Silberscheideanstalt or Roessler sodamide fusion patent of 1901, the Sandmeyer process from thiocarbanilide being still more recent. Moreover, within this period there is scarcely one of the older fields which can be described as exhausted or failing to produce fresh wealth. The oldest section of the dyestuffs field, the triphenylmethane or aniline colours, formerly regarded as comparatively fugitive, was found in 1915 to be capable of yielding with phosphotungstic acid a series of lake or pigment colours of surpassing light fastness, whilst the azo section is still providing new dyestuffs to overcome the dyeing difficulties presented by the new rayon fibres.

Although many of the branches of organic chemical industry have sprung from the discoveries, often fortuitous, made in scientific laboratories—as, for example, Perkin's mauve, Griess's azo dyes, Baeyer's phthaleins and synthetic indigo, Knorr's antipyrine, Ehrlich's salvarsan, the nitrocellulose silk of Count Chardonnet, the viscose of Cross—the significance of such discoveries was frequently unrealised at the time either by scientific workers or industry. This alone should make us cautious in advocating any restriction of research. There are too many problems in our national and industrial life urgently demanding scientific solutions for such a policy to be either timely or wise. It is almost impossible to predict just where the next important advance will be made, or, in reviewing the results of a year's investigations, to single out the one discovery by which posterity will mark the year.

The influence of industry on scientific research is, however, fully as important as that of scientific research on industry. Even in the field of technique it is impossible to assess the contributions of either on a cash basis. The greater resources of the industrial research laboratory and its improved and frequently more advanced technique are continually reacting on scientific laboratories. The range of reaction conditions open to the organic chemist has enormously expanded in the last decade, and processes can now be effected in extremely high vacuum or under pressures of several thousand atmospheres and at temperatures ranging from the neighbourhood of absolute zero to those of the electric furnace; whilst the activators or catalysts available range from the new organic catalysts, bordering on biochemistry, over almost the whole field of inorganic chemistry.

Nor is it only refinements of technique that are continually changing the conditions of scientific and industrial research. Almost every year sees fresh compounds, formerly curiosities and accessible only by tedious and costly laboratory processes, produced on the commercial scale at a price which allows their use in industry or in scientific laboratories as the raw material of further researches. The papers published in the journal of any chemical society reveal the way in which the scope of scientific research has been enlarged and influenced by industrial advances. The utilisation of waste materials, the delicate balance between by-product and main-product, the fall or rise in price of basic materials like sulphuric acid, methyl alcohol, glycerol, which alone may result in new routes for existing products—the war-time shortage of sulphuric acid, for example, led to the development of alternative processes for phenols and amines which have not been entirely replaced by the earlier methods—these are factors which continually emphasise the dynamic character of industrial research and frequently have far-reaching effects on scientific research.

If, however, the increasing complexity of the field of organic chemistry makes restriction of re-

search inconceivable, the demands made on leadership are increasingly severe. It was never easier than to-day for research ability to be wasted in an attack on unprofitable problems. Scientific progress has almost invariably come from the ideas and work of a talented few, and depends as much upon the quality and personality of the investigator as upon his technique. The most serious problem is the production of research leaders of the requisite imagination, foresight, and enthusiasm to direct wisely the team work which modern industrial research demands. Any circumstance, whether of rates of pay, status, or insecurity of tenure, which hinders the recruitment for industrial research of potential leaders of the requisite calibre is a national and not merely an industrial danger. There is little doubt that if the concentration of professional opportunities within at most one or two firms, as in Germany, does affect adversely the position and prospects of chemists, industry will quickly suffer from the reaction.

The distinction between scientific and industrial research to-day is not easy to define. Their relationship is dynamic and so intimate that circumstances which injure or cramp one react likewise on the other: neither can advance while the other is starved, and on this fact Prof. Willstätter based his plea for more generous assistance for the German universities from chemical industry. Such assistance is now being given more freely in Great Britain, and the closer relationship between the universities and industry are undoubtedly to their common advantage.

It is easy, however, to overstress from either side the economic aspects of the relation between industry and scientific research. If there are ways in which scientific research cannot compete with industry, there are still inestimable services which scientific research can render to the nation as well as to industry. Scientific research, in its freedom from the economic motive, can do much to counteract that tendency in industry for the good to be the enemy of the best, and to secure our advance to the best of all possible solutions. Scientific research, in the widening fields opened to it by industrial developments, can use its resources to explore the byways, the economically unattractive fields from which will come in the future, as they have so often in the past, the fundamental and epoch-making discoveries. On such workers, too, in their quest of truth for truth's sake, must ever fall the responsibility of kindling and rekindling that enthusiasm and devotion to which alone Nature yields her most precious secrets.

Faraday's Worth in Wisdom.

A Tribute to Michael Faraday. By Rollo Appleyard. Pp. xiii + 204 + 21 plates. (London: Constable and Co., Ltd., 1931.) 7*s.* 6*d.* net.

"A magnet hung in a hardware shop,
. . . . .
(said it) If I can wheedle
A knife or a needle,
Why not a Silver Churn?"

HOW this was to be done was shown at the Royal Institution, ages before Gilbert stated the fable of the magnet and the silver churn and knowing no physics gave it the wrong 'moral'.

The industrial value of Faraday's discoveries has long been patent, throughout the civilised world: little heed has yet been given to the example he set and to the spiritual doctrine he professed. Perhaps, in near days to come, hastening as we now are the exhaustion of natural resources, through disproportionate use of machinery and greed of gold, his spiritual legacy may be of more value to us in overcoming and directing the crude, untamed human nature within us, which our modern advance in knowledge serves but to cover with a thin veneer. In celebrating in September, this year, the centenary of his greatest discovery, we shall do well to consider his moral worth and teaching at least as fully as his contributions to knowledge. Something we must do to save the world from government by *Alfalfa Bills* and Oklahoma waste of oil (*Times*, Feb. 17, 18).

The appearance of Mr. Appleyard's book is opportune. He has not only sought out particulars of Faraday's forebears in their north country homes and of Faraday's father at his Newington, South London, forge but has also delved into Royal Institution archives and elsewhere: thus garnering not a few items of interest which are welcome additions to the story of the immortal scientific magician. He also has an interesting chapter touching on Clerk Maxwell's work in connexion with Faraday, as the mathematical exponent of its meaning. The book is one to ponder well. Various arresting moments in the philosopher's life are dealt with in a way that will appeal to all who can appreciate the charm of Mr. Appleyard's style and his sympathetic attitude towards his subject. We can picture him, upon an Athenæum sofa, browsing in search of inspiration. We can ourselves browse with delight upon the lawn which he has consequently laid out for us: as sward it would scarcely appeal to the Sutton firm; the herbage is more that of a Swiss upland pasture, in which gentian blue is mixed with anemone

yellow, set off with multi-coloured pansies and occasional red silene.

With such an example before them, the Arnold Bennetts need gibe no more at the scientific worker's literary ineptitude but take lessons from the book, how they may put real substance into their lines: it is seducing, though no seductions are pictured in the Saga; the young may read it with advantage, not merely with safety.

Yet when it is read—when the whole of the literature relating to the man, including his own works, is studied—we remain unable to account for the miracle he himself was. Seemingly, a magnetic personality was beaten into him by his father's hammerings. Maybe, he had his being in the unit charge of electricity which he was the first to divine: nearer we can scarcely get. In the East, he would long since have passed into tradition as a god. In his own country his name has yet to figure in the history books. Definitely a prototype, to be idealised as the truly scientific, all but faultless experimentalist and natural philosopher, the early stages of his mental development remain unfathomable. He was not a bookbinder's apprentice for nothing. He early became a reader of informative books; his style was formed, the habit of thinking for himself and his experimental outlook established, prior to his coming under Davy's inspiration—for Davy also was an inspired worker. Under and from him, he must have learnt much: it is strange that we know nothing of their intercourse. A man who could do what Davy did at so early a period, while on travel, with the simplest appliances, probably in his bedroom—who could work out the chemistry of iodine and establish diamond as carbon while visiting a foreign Court—must have had a magnetic personality and influence. The lines of force already ruled in Faraday's character must have been wondrously cut through and drawn out by such example. Still, in those years, he was but finding himself and overcoming his innate humility; he developed late, we know. This perhaps is why he passed no remark upon his master's work. On the other hand, we should be mindful of the advantage he enjoyed—one that none of us can enjoy to-day—in having an all but virgin field. Not because this gave boundless opportunity for discovery but because he was able to work without prejudice. Can a mind possibly grow up to-day so clean as Faraday's was? I doubt it. The student to-day rides in upon the last wave of fashion: so narrow is our human intelligence that he cannot thereafter rid himself of first impressions. We have only to think of the way in which the fear of the devil has been put into man's mind by priesthoods. The teachers of natural science are but a priesthood to-day, too often teaching faiths in misinterpretation of facts. Faraday was all but free from such priestly influence. We have yet to appreciate the perils of positive education dominated by examinations.

Faraday himself preached the most perfect sermon that has ever been preached, before Prince Albert, the Prince Consort, in 1854. Let us hope that this will be put into the hands of, at least, every visitor to the exhibition that will be held in September next at the Albert Hall. He laid down clear rules for mental education. The doctrine set out by Herbert Spencer, Huxley and others is already far better stated in this lecture—better because Faraday was both experimentalist and seer whilst they were doctrinaire teachers, Spencer especially.

In only one particular was Faraday subject to the restrictive influence of education and convention—that of religion. He was a strict Glasite (a Sandemanian). He kept his Sunday mind rigidly apart from his week-day mind, a fact sufficiently remarkable to deserve close psychological study. Since his day, not a few scientific workers of distinction have maintained a like attitude. Within us is an inherited power which not only limits our freedom of thought but also tends to direct us. Three words, said Faraday, express the great deficiency in the exercise of the mental powers: *deficiency of judgment*. The inability remains with us to-day. It seems improbable that more than the few will ever learn to form *proportionate judgments*. Some of us have hoped that the faculty would be the outcome of early training in understanding and the use of knowledge: that it has not been so hitherto, let us hope, is because we have not yet learnt sufficiently to appreciate the force of Faraday's teaching and example as to apply it properly.

That Faraday was free from bias and prejudice in his experimental work is clear from his attitude towards spiritualism. He made table-turning the subject of close rational study and inquiry—with negative results. The conclusion of his letter on the subject is striking:

"I think the system of education that could leave the mental condition of the public body in the state in which this subject has found it, must have been greatly deficient in some very important principle."

We do not seem to have advanced very far in

the interval of nearly eighty years, notwithstanding all our education.

Faraday is remarkable in comparison with Ruskin, a man of eminently artistic temperament, yet highly scientific in his manner of work, a more than competent geologist. Owing to his mother's commanding influence, Ruskin was a militant churchman. It is clear that, as he grew older, he modified his views in no slight degree : in late life, he even confessed that, were he to begin again, he might have shed his orthodoxy—it was only too late to begin. Faraday and Ruskin moved in worlds apart—yet they had much in common. To them we may add a third great influence in Victorian days—Carlyle. It may well be that such men are no longer possible—that the influence of 'combines' and of so-called 'rationalisation' in industry is to crush out the element of individuality: to eliminate the element upon which the moral stability of the world specially depends. Science to-day is not cultivated to moral purpose so much as to gain some private end : an we be not careful, future generations may have to record that, like the dog in the poem, it 'went mad and bit the man'.

To be orthodox, let me say : the book has a perfect index and wonderful pictures—the Royal Institution looks a mile long, as it ought to be !

HENRY E. ARMSTRONG.

Systematic Zoology.

Handbuch der Zoologie : eine Naturgeschichte der Stämme des Tierreiches. Gegründet von Prof. Dr. Willy Kükenthal. Herausgegeben von Dr. Thilo Krumbach. Band 2 : *Vermes Amera, Vermes Polymera, Echiurida, Sipunculida, Priapulida.* (1) Lieferung 6 (Teil 4 und Teil 5). Pp. 147-242 + 64. 17 gold marks. (2) Lieferung 7, Teil 2. Pp. 129-256. 14 gold marks. (3) Lieferung 8, Teil 4. Pp. 243-402. 18 gold marks. (4) Lieferung 9, Teil 1. Pp. 113-192. 10 gold marks. (5) Lieferung 10, Teil 4. Pp. 403-482. 10 gold marks. (6) Band 4 : *Progoneata, Chilopoda, Insecta.* Lieferung 8. Pp. 801-892. 12 gold marks. (7) Band 7 : *Sauropsida, Allgemeines ; Reptilia ; Aves.* Hälfte 2, Lieferung 5. Pp. 433-544. 12 gold marks. (Berlin und Leipzig : Walter de Gruyter und Co., 1929.)

SINCE our last notice of this valuable work, seven new parts have been issued. The editor and the publishers are to be commended for their sustained zeal and for the manner in which text and illustrations are being produced. The parts before us are planned on the same lines as their predecessors, already noticed in these columns.

(1) In this part three small but interesting groups of animals are considered. Dr. Remane, who has in recent years contributed a good deal to our knowledge of the Gastrotricha, is responsible for the account of this group and of the Kinorhyncha, and Prof. Cori for that of the Kamptozoa (that is, the Polyzoa Entoprocta). All three chapters are noteworthy for the excellence of both text and figures, and they fully supply the needs of the advanced student. Prof. Cori has worked over the anatomy and histology of *Pedicellina* and has prepared more than forty original drawings, chiefly of this genus. *Arthropodaria benedeni* occurs, as is stated, at Ostend ; Prof. Cori has omitted the record of this species from Hull, and of *Barentsia gracilis* from the Isle of Man.

(2) Prof. Fuhrmann, the author of the chapters on Trematoda, has written this account of the class Cestoidea, which includes the subclasses Cestodaria (with two orders Amphilinidea and Gyrocotylidea) and Cestoda. In discussing the morphology of Gyrocotyle and its relative *Gyrocotyloides* (a new genus) the author advances good reasons for regarding the funnel as anterior. Following the account of the two small but important orders is a useful summary, in about twenty pages, of the principal features of structure and of life-history of the Cestoda, the orders of which are then described in turn, beginning with the Tetraphyllidea (40 pages), the Diphyllidea (6 pages), and the Tetrarhynchidea (unfinished). The wealth of well-drawn new figures is a feature of this part.

(3) Prof. Max Rauther has produced in 150 pages a useful account of the Nematoda—their structure, development, physiology, ecology, and systematics. He must have been faced often with the difficult problem of what should be included and what omitted, and on the whole he has chosen judiciously. Many readers would have welcomed a somewhat fuller treatment of free-living Nematodes, for the emphasis in this work is on the parasitic forms. Instead of the brief reference to diminution of chromatin we should have preferred a short illustrated account of the chromosomes of *Ascaris* and their history during the early cleavages of the egg, to bring out, as this case does so well, the principle of the germ-track.

(4) The major portion of this part is devoted to a description by Prof. Bresslau of the reproductive apparatus and development of *Turbellaria.* It

includes an admirable account, with numerous schematic and other illustrations, of the different types of reproductive apparatus, and a description of the development of entolecithal and of ectolecithal eggs. The remainder of the part deals with the physiology of movement and of the eyes. This memoir on the Turbellaria promises to be the best available general account of the class.

(5) Prof. Rauther is also the author of the chapters on the Nematomorpha (46 pages) and the Acanthocephala (34 pages). For both groups the accounts of the different systems of organs, the life-history, and systematics are well done and are illustrated by 96 figures, many of them original or from recent memoirs.

The second volume of the "Handbuch", in which these five parts are included, reaches a high standard and we look forward to the appearance of the remaining parts of this volume, especially those on the Polychæta, Hirudinea, and Gephyrea.

(6) Dr. Handlirsch continues his account of the Insecta. The present chapters deal successively with seven orders, including the Mantodea, Blattariæ, Isoptera (with some good illustrations of the nests of termites), Mallophaga, and Siphunculata. The external morphology is adequately considered, but the internal organs of some of the orders deserved fuller treatment, and the systematics of both Mallophaga and Siphunculata could with advantage have been rather more extended. We should have desired to see included some references to the histology of the organs and tissues and to the occurrence of symbionts; there is no reference to these, and the mere remark that there are gut parasites in termites gives no suggestion of the very interesting relationships which exist between the termites and their intestinal protozoa.

(7) Dr. Stresemann maintains his high standard in the further description of the biology and structure of birds. The major portion of this part is concerned with the food of birds and the associated structural modifications of beak, tongue, and foot; the relations of birds to flowers; the storage of food, for example, by the Californian woodpecker; the processes of digestion, the biochemistry of eggs and of metabolism in the embryo, and the periodic changes in the reserve of fat. The later part of the chapter deals with the anatomy and physiology of movement of the vertebral column, of the legs, and of the sleeping posture (unfinished). The author has drawn his material from a great variety of sources and has treated the subjects considered in a thorough and interesting manner.

Bartholomew Sikes's System of Alcoholometry.

Alcoholometry: an Account of the British Method of Alcoholic Strength Determination; with an Historical Introduction written by the Author in collaboration with George H. Gabb. By Francis G. H. Tate. Pp. xviii + 93 + 12 plates. (London: H.M. Stationery Office, 1930.) 5*s*. net.

BARTHOLOMEW SIKES devised a system of alcoholometry which was legalised in Great Britain in 1816 for ascertaining the strength of spirits for revenue purposes and has remained in official use ever since. He designed a metal hydrometer and compiled tables for use in conjunction with it, which, together, provide a simple means of determining the strength of mixtures of alcohol and water. All that has to be done is to float the hydrometer in the sample of which the strength is required, observe the hydrometer reading, take the temperature of the sample and then consult the tables, where, under the temperature and against the hydrometer reading, is found the strength of the spirit. Such a simple and rapid method was not devised in a moment. Indeed, the Excise Department was established in 1643, nearly two hundred years before the adoption of Sikes's system, and from its inception one of its duties was the collection of taxes levied on spirits.

The early part of Mr. Tate's book gives an account of the development of alcoholometry in Great Britain prior to the adoption of Sikes's system. In brief, the important points are: the origin of the term 'proof spirit' in connexion with the early 'gunpowder test'; the re-invention of the hydrometer by Boyle in 1675, which led to the development of the hydrometer for spirit assaying; the legalisation of the use of Clarke's hydrometer in 1787; and the classical work of Gilpin and Blagden (*Phil. Trans. Roy. Soc.*, 1790, 1792, and 1794) on the density of mixtures of alcohol and water. Here the author is traversing ground which has been covered by other writers, but so recently as 1898 Scarisbrick, an official of the Inland Revenue, wrote in his "Spirit Assaying": "Sikes does not seem to have left a scrap of information as to the principles underlying his system". Mr. Tate, however, has had access to twenty-eight manuscript note-books left by Sikes, and so is able to contribute new material to the study of Sikes's system.

Hitherto the only information available has been that contained in the Act of 1816 and the tables legalised by the Act. These, however, contain no explanation of the basis of construction either of the

hydrometer or the tables, and a number of questions relating to these matters have been the subject of controversy and conjecture.

It has been suggested that Sikes ignored the fundamental work of Gilpin, adopted a hydrometer previously designed by Boriés, prepared a skeleton table by reading this hydrometer at various temperatures in spirits made up to known strengths, and completed the tables by interpolation. Mr. Tate is able to show that Sikes gave considerable thought to the design of his hydrometer and made the fullest use of the accurate data of Gilpin in compiling his tables. He is also able to show how the rather unusual temperature 51° F. came to be employed in the definition of proof-spirit.

The strength of a spirit expressed as the percentage of alcohol by volume in the spirit can only be valid for one particular temperature. Proof-strength is merely a roundabout method of expressing percentage composition by volume—at 50° F. 100 gallons of a spirit n per cent over-proof contain the same volume of alcohol as $(100+n)$ gallons of proof-spirit, also at 50° F.—and so proof-strengths must also be defined at one particular temperature. The temperature adopted by Sikes for his proof-strengths was unknown, and attempts to determine it from such evidence as is available in the Act and tables have led to values ranging from 51° F. to 62° F. Mr. Tate is able to produce evidence from Sikes's note-books showing that the temperature which he actually used was 50° F.

It is a well-known anomaly of Sikes's system that the duty assessed on a given weight of spirit varies with the temperature at which the assessment is made, the duty charged being greater when the spirit is assayed at a high temperature that when it is assayed at a lower temperature. Sikes's note-books include tables of corrections which would eliminate this anomaly, but they have never been adopted for official use.

The new information regarding Sikes's system which Mr. Tate has made available will be of interest to many readers. His book also gives an account of the preparation of revised Sikes's tables by Sir Edward Thorpe, which received Parliamentary sanction in 1915; the recent extension of the range of the hydrometer and tables legalised in 1930; and the three last chapters deal with the standardisation of hydrometers, methods of allowing for 'obscuration', and the use of the refractometer respectively. A useful bibliography is given at the end of the book.

One important question is not discussed in the book. Metal hydrometers have very obvious disadvantages as compared with glass hydrometers, and even so long ago as 1792 Blagden advised the authorities that metal hydrometers were unsatisfactory. Glass hydrometers have largely replaced metal ones for assessing the duty on spirits in India, and in industry generally, glass hydrometers are used almost to the exclusion of metal ones. The relative merits of glass and metal hydrometers, however, are not discussed in the book.

Plant-Dispersal.

The Dispersal of Plants throughout the World. By Henry N. Ridley. Pp. xx + 744 + 22 plates. (Ashford, Kent: L. Reeve and Co., Ltd., 1930.) 63*s*. net.

AN authoritative and comprehensive work on plant-dispersal—mainly, that is, the means by which fruits and seeds of flowering plants and spores of ferns, mosses, and other cryptogams are dispersed from the parent plant—has long been a desideratum. Such a work is now to hand, and we congratulate Mr. Ridley on the completion of his book, which embodies the results of his own observations over many years and of a digest of the very considerable and widely scattered literature of the subject.

Mr. Ridley is a keen naturalist and his first-hand knowledge of the vegetation of Malaya, his home for twenty years, and his visits to other parts of the world, have allowed him a wide view of his subject. In his introduction, he refers to the absence of an adequate work on plant-dispersal, the more remarkable in view of its important bearing on the distribution of plants throughout the world, and as a factor in the evolution of species and genera of even more importance than modifications for insect- or wind-pollination—a subject on which there are fairly complete treatises. Changes in climate and environment have supplied special opportunities for the effective operation of means of dispersal, and competition between individuals of a species or between different species has also been an important factor. Modifications for dispersal are of a secondary nature; in cases where there exists a tolerably complete series of genera or species the author can discover "no sudden change in Nature giving rise to modifications of fruit or seed for the purpose of dissemination. The evolution of a winged or adhesive fruit or seed seems to have been gradual, and to have been effected by a reduction or accrescence of certain parts, which had a primary use not connected with dispersal."

The hairs on the ovary, a protection from rain,

may develop in the fruit into wool for wind-dispersal or into spines or hooks for attachment to passing animals; and sepals may persist and enlarge to form wings or floating plates for the ripe fruit. A minute and apparently trivial alteration is frequently critical for the distribution of the species. The occasionally firmer texture of the funicle in seeds of *Laburnum* keeps them attached to the pod until that is blown away by the wind, thus ensuring a wider dispersal than the mere scattering of the seeds round the parent plant.

The headings of the chapters are supplied by the various agents operating in dispersal—wind, water, animal, or a mechanism inherent in the plant itself. Wind plays one of the most important parts; it scatters not only seeds or fruits provided with some special mechanism such as wings or plumes, but also very largely those of which the small size and lightness are the only aids to dispersal. It is most effective in open country, across arms of the sea or tracts of desert. In arctic regions, fruits and seeds may be blown across the ice or carried by drift-ice to distant shores; "many of the arctic plants found on the summits of the mountains of temperate Europe, Asia, and America probably owed their position to wind blowing over the ice in the Glacial period". Few seeds compare in lightness with the quartz-grains which have been found 700 miles from land; but, as Wallace pointed out, their compression and irregularity of outline, offering a larger surface to the air, is a compensating factor; the absence, however, of certain widely distributed small-seeded plants from remote islands suggests that favourable conditions for their flight must be scarce.

In the tropics, most of the epiphytes on the trunks and boughs of forest-trees are wind-borne; though in the formation of the flora of the pollard-willows of Great Britain birds play a conspicuous part in the carriage of berries and drupes. The dust-seed of orchids is produced in enormous quantity, and the occurrence of species on remote islands indicates its efficacy for dispersal. Plants with plumed fruits and seeds are scarce or wanting in dense forests and on oceanic islands. These are practically unable to cross large tracts of water, but fall into it after a few miles of flight. Such plants are continental, mostly herbaceous, and so, quickly fruiting, can rapidly cross mountains and open country; if their fruits or seeds fall, the following blasts pick them up and carry them on. Adaptations for wind dispersal are manifold and are provided by various parts of flower and fruit; an account of these occupies nearly one hundred pages of the book.

The action of water in dispersal is perhaps even more important than that of wind, but the associated modifications are not so elaborate or striking. Sufficient buoyancy and a sufficiently long period of impermeability by water are almost the only requirements. Both large and small seeds are frequently dispersed by rain-wash or sudden rushes of water. Heavier seeds may sink and germinate at the bottom, rising to the surface as seedlings to be drifted away and stranded on a suitable bank. Ice, stream, river, and flood are all effective agents in carrying fruits and seeds or large portions of a plant. Mr. Ridley gives a comprehensive list of river-dispersed species, with notes based on observations by himself and others. Dispersal by sea is treated in an even more comprehensive manner.

Exigencies of space forbid more than a passing reference to the chapters on dispersal by animals—mammals, birds, reptiles, fish, insects, and others—and the devices of the plant for effecting adhesion to the carrier; or by human agency, or some mechanism in the mature fruit from which the seeds are shot explosively. A chapter on island floras indicates briefly how the various agents have operated in stocking a number of oceanic islands.

To use a hackneyed phrase, the book is a mine of information, and is, moreover, eminently readable. There is a remarkable absence of technical terms, though it is in no sense a 'popular' production. The illustrations, by Miss M. B. Moss and the author, are helpful to the understanding of the many devices for transport of fruit or seed. A. B. R.

Our Bookshelf.

(1) *The Fields and Methods of Knowledge: a Textbook in Orientation and Logic.* By Prof. Raymond F. Piper and Dr. Paul W. Ward. Pp. xxv + 398 + xl. (New York and London: Alfred A. Knopf, Inc., 1929.) 16*s*.

(2) *Rational Induction: an Analysis of the Method of Science and Philosophy.* By Dr. Homer H. Dubs. Pp. xv + 510. (Chicago: University of Chicago Press; London: Cambridge University Press, 1930.) 21*s*. net.

(1) THE two books under review have several things in common, although their scope is different. The dominating purpose of Profs. Piper and Ward is educational; while Dr. Dubs investigates the traditional methods of proof. The endeavour of Profs. Piper and Ward to lead their readers to a better acquaintance with the physical universe, society and man, is not an innovation in teaching. But in view of the extraordinary growth of human knowledge, it seems useful if not necessary that 'freshmen' be given a comprehensive panorama of the fields and methods of knowledge, with the view of helping their orientation and to enable

them to think for themselves. In this, Profs. Piper and Ward have succeeded; and their practical classification of the sciences could be read with profit even by specialists on one subject or the other.

It is difficult to dispute on any point of the book if one takes into account its purpose. But one cannot fail from noting the pragmatic character of its exposition. For example, the importance of the calculus is denoted with reference to its applications to reality. Again, in the exposition of logic, much prominence is given to induction, verification, and discovery, while formal logic is summarily treated. The bibliographies at the end of each chapter, the appendix on questions and exercises, and a very good index are features which enhance the practical value of this work.

(2) Dr. Dubs has written a comprehensive book on inductive logic, and one which has the distinction of being accurate and clear. But it is difficult to note anything in it of the importance announced by the author in his preface. His main thesis is that "induction always concerns itself with the establishment of the correctness of a hypothesis or assumption. The attempt to establish this hypothesis may be by one of three ways: empirical induction, immediate description, or rational induction, which is the most general of them all. Its very simplicity, however, has often led to its being misunderstood by those who have used it, especially by logicians, who have too often tried to assimilate it to the better-recognised deductive procedure" (pp. 126-127). So the author endeavours to re-state the case for rational induction; but in doing so, he hits upon scarcely anything new in the field of inductive logic. T. G.

Joseph Fraunhofers Leben, Leistungen und Wirksamkeit. Nach Quellen geschildert von Prof. Moritz v. Rohr. (*Grosse Männer: Studien zur Biologie des Genies*, herausgegeben von Wilhelm Ostwald, Band 10.) Pp. xx+233. (Leipzig: Akademische Verlagsgesellschaft m.b.H., 1929.) 15 gold marks.

IN this sympathetic and concise biography, Prof. von Rohr has rendered yet another service to science. The achievements of Joseph Fraunhofer, who was the founder of the modern technical optical industry in Germany, were too little known even in his own country.

The book paints a grey picture of the optical industry at the opening of the nineteenth century, with its preoccupation in the mass production of cheap spectacle lenses and its lack of attention to more complex instruments. It is suggested that English opticians owed much of their pre-eminence at that time to the demands of seamen for telescopes and the like.

Whence springs genius? How could this lad with his desultory and indifferent schooling train himself to become a leader not only in technical practice, but also in those fundamental steps which mark the emergence from crudeness and haze to precision and clarity in the understanding of the underlying principles of technical optics? All the world knows of the Fraunhofer lines and their applications to exact refractometry, but how many realise the painstaking efforts at refractometry with the aid of a monochromator; the ambitious attempt to produce non-spherical surfaces of optical accuracy?

Fraunhofer belongs not to Germany alone but to the world. To read this little book is to gain a clearer perspective in one's view of present-day problems, and encouragement in the patient efforts which they require. L. C. M.

Handbuch der anorganischen Chemie. Herausgegeben von Prof. Dr. R. Abegg, Dr. Fr. Auerbach und Prof. Dr. I. Koppel. In 4 Bänden. Band 4, Abteilung 3: *Die Elemente der achten Gruppe des periodischen Systems.* Teil 2: *Eisen und seine Verbindungen.* B Lieferung 1. Pp. Bxvi +B463. (Leipzig: S. Hirzel, 1930.) 45 gold marks.

THE high standard of all the volumes of Abegg's "Handbuch" is too well known to require comment, and it is only necessary to announce that a further volume has appeared in which the description of the elements is carried into the eighth group. The rapid progress towards completion under the editorship of Dr. Koppel is to be especially praised, and the way in which he has maintained the character of the work deserves the highest commendation. Unlike some other comprehensive works on inorganic chemistry, 'Abegg' has always been characterised by a maturity of exposition and a critical treatment of the material which shows clearly that the contributors have not been content merely in amassing abstracts. The present volume, which deals with compounds of iron, covers the field in a way which leaves nothing to be desired. It will be invaluable to all chemists. As in previous volumes, emphasis is laid on the physico-chemical aspects of the substances, but not to the neglect of descriptive chemistry. The complex iron cyanides and colloid systems are to be dealt with in another volume.

An Introduction to Regional Surveying. By C. C. Fagg and G. E. Hutchings. Pp. xi+150. (Cambridge: At the University Press, 1930.) 7*s.* 6*d.* net.

REGIONAL survey, as an exercise in concrete geographical study, was introduced into university education in Great Britain by the late Prof. A. J. Herbertson under the inspiration of Prof. P. Geddes. The methods since then have been utilised in most of the schools of geography in Great Britain, and a great deal of work has been accomplished, though relatively little has been published, largely for lack of means. The authors of this small volume are enthusiasts and have themselves done good work in regional survey. They set out here to explain some of the methods of field work and mapping. Their aim is practical guidance, and even if they explain a good deal that will be obvious to any student of geography, they have written a useful handbook for which there is a real need. There are several sketch maps and diagrams.

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.*]

Atmospheric Pressure and the State of the Earth's Magnetism.

WHILE examining data for atmospheric pressure and terrestrial magnetism at various observatories of the Meteorological Office to discover possible relationships, and after meeting with no clear-cut success so long as attention was confined to daily mean values of pressure, I have now obtained results pointing to a hitherto unsuspected relation between the type of the diurnal variation of pressure and the general state of magnetic conditions, as regards disturbance and quiet, over the earth. As the best available index of the degree of magnetic disturbance

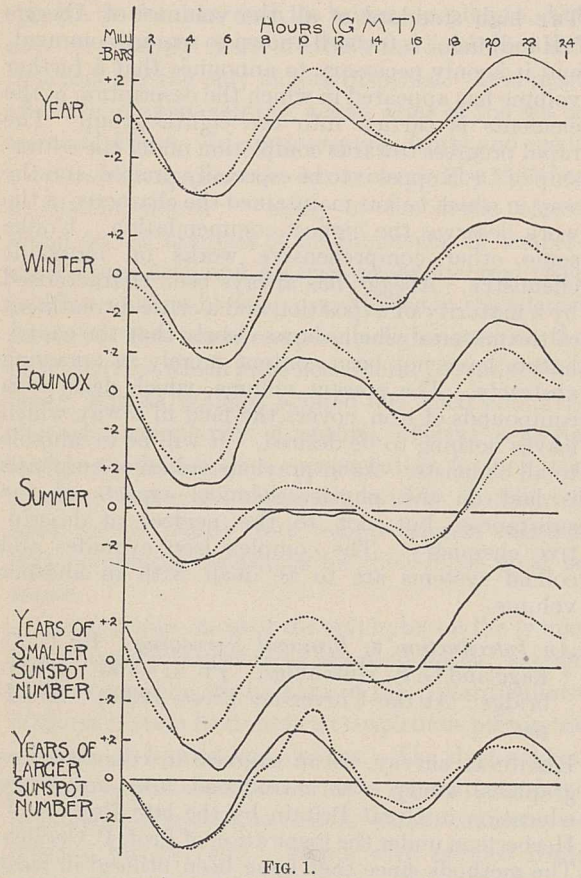


FIG. 1.

on each Greenwich day, the international magnetic character figure was used; the pressure data were those for Aberdeen Observatory as printed in the Observatories' Year Books of the Meteorological Office, Air Ministry. Mean diurnal inequalities of pressure corrected for non-periodic change were computed for the two sets of days, magnetically quiet and magnetically disturbed, on the basis of the five days of each type per month selected at De Bilt over the seven years 1922–28.

By grouping the inequalities according to the season of the year (defining winter as the four months November–February, summer the months May–August, and the remaining four months forming equinox), diurnal variations of pressure representative of the three seasons were constructed. A further rearrangement of the data gave inequalities illustrating the pressure variations on the two types of days in years of low and high solar activity. The mean sunspot number for the group of years 1922–24 is 12·2; for 1925–28 the mean is 63·5.

The results are shown in the six pairs of curves on Fig. 1. The dotted curve in each pair represents the diurnal variation of pressure on magnetically quiet days and the full curve on magnetically disturbed days. The difference in form clearly shows the change in the pressure variation from one type of magnetic days to the other.

From these it is clear that in all but the last pair the predominant features of the change are the reduced development of the forenoon maximum and enhancement of the evening maximum on disturbed as compared with quiet days. That the effect is consistently present in each of the pairs of curves for the separate seasons as well as for the year as a whole is strong evidence of its reality. The last two pairs of curves illustrating the change of form of the variation in years of relatively low and of relatively high solar activity clearly indicate that, while the change is very marked in feebly active years, it may be masked or even partly reversed in years of frequent and large sunspots.

When the mean inequalities are analysed harmonically, it becomes obvious that change of form of the variation is confined almost entirely to the 24-hour wave; the amplitude and phase are both affected. In each pair of magnetically quiet and disturbed day pressure variations, except that for the group of years 1925–28, the amplitude of the first harmonic on disturbed days exceeds that for quiet days. The ratio of the amplitudes increases from 1·4 for the winter months to 1·7 for equinox and 2·2 in summer; in the group of years of low sunspot development it is 3·3. In all the groupings of the data there is a retardation of the 24-hour wave in passing from quiet to disturbed days; the retardation is a little more than two hours in all groups except that representing high solar activity, when it is about half an hour.

Against these changes in the whole day wave the constancy of the 12-hour component is striking. The ratio of the amplitudes for the two types of days remains steadily about unity in all groups and the changes in phase angle are not significant.

J. M. STAGG.

Lerwick Observatory, Shetland.

The Karoonda (S.A.) Meteorite of Nov. 25, 1930.

AT 10.53 P.M. on the evening of Nov. 25 an extremely brilliant fire-ball was seen by many observers in South Australia. It was observed at Port Lincoln on the west coast, Wirrappa (94 miles north-west of Port Augusta), Mount Gambier in the south-east of South Australia, Murrayville in Victoria, and Broken Hill in New South Wales, the radius of observation being thus well over 250 miles.

When first seen, the meteorite compared in brightness with a star of first or second magnitude, but rapidly (in a few seconds) increased to a brilliancy which gave an illumination comparable to that of daylight, even in Adelaide. An amusing feature of many reports is the illusion of close proximity due to this brightness. It was described by many observers as an immense ball of bluish-white colour, equal in diameter to the full moon, and having a luminous tail several degrees in length. As it approached the earth showers of sparks issued from the main body.

Observers within a few miles of it heard a noise which is variously compared to the loud rumble of an earthquake, to the roar of a passing train, or to "the banging-together of sheets of galvanised iron". Messrs. Honeyman and Millard, of Karoonda, who were nearer the locality of the fall than any other observers (2¼ miles distant), give the following account: ". . . the disappearance of the meteorite was followed by a loud detonation as though a very heavy charge of explosive had been let off underground. This caused a distinct vibration of buildings near by. This sound was followed, at an interval of about three seconds, by a loud crackling and rending sound from the sky in the direction in which the meteorite was last seen, then by a low rumbling of thunder which gradually died away in the distance."

The meteorite appears to have descended at a steep angle of about 70° with the horizontal. When first seen it had an altitude of 150 miles or more, and the duration of its fall was approximately six seconds. It travelled in an east-south-east direction.

A search party from the University of Adelaide and Adelaide Observatory proceeded to Karoonda on Dec. 6. Two days were spent in making inquiries from local eye-witnesses of the fall. These enabled the locality to be determined within a radius of one or two miles, and on the third day the meteorite was found lying in a sandy fallowed wheat-field, 2¼ miles east of the township of Karoonda. It had made a crater-like hole in the sand eighteen inches in diameter and about the same depth, with a surrounding ridge of sand three feet six inches across.

The meteoritic stone had shattered on striking the earth, and numerous fragments were scattered over a radius of four or five feet. The bulk of its mass, however, was within the crater, the largest fragments being on the east side and pointing nearly vertically down. In addition to pieces varying from an ounce or two to seven pounds in weight, there were very numerous smaller fragments and much finely pulverised material mixed with sand. The whole was collected, and the meteoritic material separated from the sand in a magnetic separator. The total weight of the meteorite was thus ascertained to have been 92 lb. On some of the larger fragments a surface layer about one millimetre thick had obviously undergone recent fusion, and both this and other parts of the surface showed the customary 'thumb-marks' and lines of flow.

The meteorite is of a type unfamiliar to any persons who have yet seen it, and possibly unrepresented in Australian collections. It is certainly an 'aerolite' or stony meteorite, and probably of the class termed "Chondrites" by Prior (Guide to the Collection of Meteorites—British Museum Handbook) and the subclass or group "Enstatite—Chondrites".

The material is uniformly of a dark grey, approaching a black colour, with numerous spherical inclusions (chondrules) and specks of metallic lustre, possibly troilite. It is quite friable, has a specific gravity of 2·44 and a distinct 'earthy' odour. A chemical analysis is in progress.

KERR GRANT.
Adelaide. G. F. DODWELL
(Government Astronomer).

Rational Logarithms.

I HAVE recently been considering how best the theory of logarithms could be presented to a beginner without such a paralysing opening as used to be the practice (see Todhunter). I do not know what is done now. But the result of this consideration has been the development of a complete exposition of the whole fundamental principle of the logarithm without any of the mathematical treatment which, so far as I know, is universally employed. The idea, of course, is that this should be an introduction to the usual mathematical treatment, not a substitute for it.

Any discussion with beginners is nothing if not concrete, so that actual figures must be obtained. I have found that this fundamental, basic, or 'low down' treatment of the subject leads directly to a very convenient approximate expression for the logarithm to base e of a number. As is the case with the usual expansions, the expression becomes peculiarly simplified when it is used to find $\log(n+1)/n$ or $\log(n+1) - \log n$, and in order to keep this note within reasonable limits, I give the expression for this only. This is $\log_e(n+1) - \log_e n = \dfrac{12n(n+1)+1}{6n(n+1)(2n+1)}$.

This gives the logarithm with great facility and with very considerable accuracy:

With $n = 10$ the error is $0{\cdot}0^{7}65506$.
$n = 100$,, $0{\cdot}0^{12}81284$.
$n = 1000$,, $0{\cdot}0^{17}8311$.

In obtaining the fractional expression, two very small errors are intentionally made for the sake of simplicity. The first is almost exactly eliminated by subtracting $\dfrac{1}{12(n+1)^2(2n+1)^3}$, but this merely reduces the error by over-correction to one-eighth of what it was with $n = 9$, increasing to one-quarter with $n = 1000$.

The residual error is due to the second cause and as yet I have not been able to get an expression to meet it. That for the first correction, however, is obtained by interesting and instructive means, not quite so easy as those employed in obtaining the original fraction.

I have never seen this way of dealing with logarithms described. I should have expected to find it in Hutton's introduction to his famous tables of 1794, where he discusses every method known at that date. At the same time, it is difficult to imagine that so elementary a process, suitable almost for a kindergarten, is not known, or if it is, why it is not used.

C. V. BOYS.

Denaturation of Wool by Urea.

IN a letter to NATURE of Nov. 1, p. 685, I stated that saturated aqueous solutions of urea unmasked a sulphide in sheep's wool and also extracted a sulphide from the wool. These two statements were based on the observation that addition of a tenth volume of 20 per cent sodium nitroprusside solution, to suspensions of wool in such urea solutions, ten minutes after addition of a similar proportion of 10 per cent potassium cyanide solution (to reduce any –SS– to thiol groups), always led to the development, both in the wool and in the liquid, of a strong pink or magenta colour precisely like that of Arnold's nitroprusside reaction for organic thiol compounds, although in control tests wool not treated with urea developed only a feeble pink, and urea solutions which had not been in contact with wool developed none at all.

I write now to say that the conclusion that the urea solution had extracted a sulphide from the wool was erroneous, for subsequent work has shown that the apparently typical thiol reaction obtained in the extracts was due entirely to a hitherto unknown, and at first very elusive, reaction between urea and some derivative of sodium nitroprusside, previously formed in its solution as a result of an obscure change which may for temporary convenience be referred to as 'ripening'. If the nitroprusside solution is ripe enough, this reaction with urea will become obvious

within a few minutes, though it may take a long time to attain its maximum. With unripe nitroprusside solution, it may require any time up to two hours to begin, or it may fail altogether. It occurs only if the test mixture is alkaline but not too strongly so, and only if ammonia is absent. It is quicker and more intense the stronger the urea solution, but is recognisable in 2 per cent solution. It can be distinguished from a true thiol reaction by the fact that on addition of ammonia the colour soon fades to yellow. In the light of these observations, it is now evident that in my former experiments the nitroprusside solutions used when testing the extracts of wool must have been fully ripe, and that used in testing the control urea solutions must have been much less so. The wool itself would react equally strongly with either solution.

I have made only incidental observations on the process of ripening. An approximately neutral 20 per cent nitroprusside solution is sometimes adequately ripe after it has stood twenty-four hours, but the time required varies greatly in different glass vessels, and the solution usually improves up to at least a fortnight. No deposit is formed, and the only obvious change is a slight yellowing. Ripening is much quicker in the presence of 1 per cent of sodium bicarbonate, but if such a solution is saturated with urea it soon undergoes a change, as a result of which it will turn blue or green when acidified with hydrochloric acid containing ferric chloride, although the ripe solution does not give this reaction by itself.

While still exploring the conditions necessary for this 'pseudo-thiol' reaction, and contemplating the possibility that it might be responsible also for the apparent thiol reaction given by the urea-treated wool, I received from Dr. Rimington, of the Woollen Industries Research Association at Leeds, a letter saying that wool which he had treated for twenty-four hours with saturated urea solution and then washed in water refused to give a thiol reaction. His procedure had been to suspend the washed urea-treated wool in saturated ammonium sulphate solution, then reduce it by adding sodium cyanide up to 0·55 per cent, and after ten minutes add fresh nitroprusside solution and ammonia. In my own procedure the wool had always been reduced by 1 per cent potassium cyanide solution while still in the urea solution, and had hence been exposed during ten minutes to a markedly alkaline urea solution. Also, the Arnold test had always been applied in the presence of urea and without addition of any ammonium compound, conditions under which a pseudo-thiol reaction might conceivably occur.

I have accordingly made a further set of experiments, in which comparisons were made between the intensities of the Arnold reaction given by wool which had been treated with saturated urea solutions alkalised to different extents by addition of suitable salts, and in which any pseudo-thiol reaction was precluded by applying the Arnold test only after the wool had been washed during twenty-four hours with large volumes of water, and then reduced in 1 per cent potassium cyanide solution for ten minutes, after which a little ammonium sulphate was added to the cyanide suspension, followed by freshly made nitroprusside solution. The results show that any apparent thiol reaction given by the wool thus tested is a genuine one, and also that more sulphide is unmasked in ten minutes by urea solution containing 1 per cent potassium cyanide solution, or half per cent sodium carbonate, than in twenty-four hours by 1 per cent potassium cyanide solution or in ten minutes by half per cent sodium carbonate, or in twenty-four hours by approximately neutral urea solution. The experiments do not show, however, whether neutral urea solutions unmask very little sulphide or none at all, for I have been unable to find wool which does not give at least a slight Arnold reaction after reduction in 1 per cent potassium cyanide solution and it is impossible to attach significance to slight contrasts in the intensities of the colours, since these often fade rapidly when the wool is removed from the test-liquids. Comparing wools which have been exposed during ten minutes to a temperature of 100°, one in water, the other in saturated urea solution, there is, however, a great contrast; only the latter becomes intensely pink. As the liquids become feebly alkaline during the heating, this experiment does not show the effect of neutral urea solution. My former bald statement that saturated urea solutions unmask a sulphide in wool should accordingly be qualified by addition of the words "at least when they have more than a certain alkalinity".

In the case of egg albumin treated with urea, where Hatton and I took as a measure of the amount denatured the percentage of protein rendered insoluble in 27 per cent ammonium sulphate solution, we found that when the *c*H of the saturated urea solution was approximately that at which egg-albumin is isoelectric, the rate of denaturation was a minimum and very slow; and that the more remote the *c*H was from this, the quicker was the rate, especially on the alkaline side: none of the alkalinities or acidities concerned was so great as to bring about more than negligible denaturation in the absence of urea. I have not ascertained whether any similar relation would hold good for wool when the unmasking of sulphide is taken as a measure of denaturation, but the results referred to earlier strongly suggest that it would at least be true for such variations in *c*H as lie on the alkaline side of the hydrion concentrations common in distilled water.

W. RAMSDEN.

Department of Biochemistry,
University of Liverpool,
Feb. 13.

Agricultural Field Experiments.

MR. HOWARD'S letter in NATURE of Jan. 31 (p. 166) gives interesting confirmation of the reviewer's opinion in NATURE of Nov. 29, p. 843, that depth of sowing influences the yield of wheat, yet I venture to suggest that such an extreme case as he quotes scarcely bears upon the point at issue. When seeds do not germinate, it is equivalent to a light seeding rate, which, as I pointed out, makes wonderfully little effect on the yield. Whether such differences as one may expect to occur between the depths of coulters in the same drill make any appreciable effect on the yields of the different rows is still, I think, an open question, and I suggest that the differences which the reviewer has observed between the yields of his rows may have been due to their being unevenly spaced. The yield which is comparatively unaffected by seeding rate, is that per areal and not that per linear unit. The reviewer quotes "an apparently uniform field" at Aarslev as upsetting my view that for practical purposes randomness can be obtained from the half-drill strip "provided care is taken to drill across ploughman's 'lands'", if they exist; yet Dr. Sanders in his account of that experiment makes no mention of an "apparently uniform field" (*Journal Agricultural Science*, **20**, p. 65), but writes, "This oscillation apparently arose as a legacy of the old practice of ploughing in high ridges", and so on.

Even if the unsuitability of the field had been overlooked, the Aarslev plots were probably a good deal wider than drill width, and half-drill strips would have been extremely unlikely to coincide both in breadth and phase with the periodicity in question, while any

partial coincidence would have betrayed the existence of the snare.

Finally, there is a fallacy in Mr. Howard's last sentence—"It is obvious in such questions that nothing can be gained by the application of formulæ and figures to the results obtained by poor agriculture". There is no question, of course, of connecting the half-drill strip method of experimenting with poor agriculture; its great merit lies in the fact that in its present form it is ordinary farming practice: if, however, that practice were poor agriculture, it would be a mistake to carry out trials by methods conforming to better standards: field trials must be capable of being considered a random sample of the practice, not of the theory, of agriculture.

This may seem a hard saying, but an example will make my meaning clear. After a long series of experiments the Irish Department of Agriculture decided to introduce Dr. Hunter's Spratt-Archer barley as being the best suited for the country. This was almost everywhere a great and outstanding success; yet in one district, which shall be nameless, the farmers refused to grow it, alleging that their own native race of barley was superior to it. After some time the Department, to demonstrate Spratt-Archer's superiority, produced a single line culture of the native barley and tested it against the Spratt-Archer in the district in question. To their surprise, they found the farmers were perfectly right: the native barley gave the higher yield. At the same time the reason became plain: the barley in question starts more quickly and is able to smother the weeds, which flourish in that not too well farmed land; Spratt-Archer, growing less strongly at first, is, however, the victim and not the conqueror of the weeds, and the original experiments, carried out on well-farmed land, were definitely misleading when their conclusions were applied elsewhere.

Taught by experience, the Department is now engaged in breeding a barley to meet these conditions; and this barley, when obtained, will rightly be tested by "results obtained by poor agriculture".

STUDENT.

REFERRING to the effect of increased depth of sowing, "Student" writes "When seeds do not germinate, it is equivalent to a light seeding rate". . . . This is true, but changes in depth of sowing give rise to changes not only in the percentage germination but also in the time of germination. It is my experience that yield may be affected by both these factors.

My description of the field at Aarslev as "apparently uniform" would seem to be justified by Dr. Sanders' statement that "This oscillation *apparently* arose as a legacy of the old practice of ploughing in high ridges" (italics mine)—appeal was made to the history of the field for an explanation of the curious periodicity.

I am in complete agreement with the concluding part of "Student's" communication, summed up in his own phrase, "field trials must be capable of being considered a random sample of the practice, not of the theory, of agriculture". This is too often overlooked by those who use special machinery and methods for field experimental work.

THE WRITER OF THE ARTICLE.

Vacuum Spark Spectra to 40 A.: the Spectra of Be III, Be IV, B IV, B V, and C V.

THE series of hydrogen- and helium-like spectra, which was previously traced [1] to Be IV, has now been completed with B IV, B V, and C V, and the limit of optical spectra brought down to 40·28 A.

The vacuum spark was produced by a capacity of 0·3 μF charged to 60,000 volts. Half an hour with about 30 sparks a minute was sufficient for an exposure. The plates were taken with the same metal grating as was used before,[1] but now set up in a new spectrograph at a glancing angle of 5·4°. Comparing the results with those from a glass grating [2] at 6°, there seems to be no reason to prefer this material to speculum metal in the shortest wave-length region.

Fig. 1, *a*, shows the spectrum obtained with metallic beryllium as the negative electrode against a tube of Acheson graphite filled with boron nitride. A spark between pure graphite electrodes gave the spectrum of Fig. 1, *b*, consisting of one single carbon line at 40 A. in the first three orders.

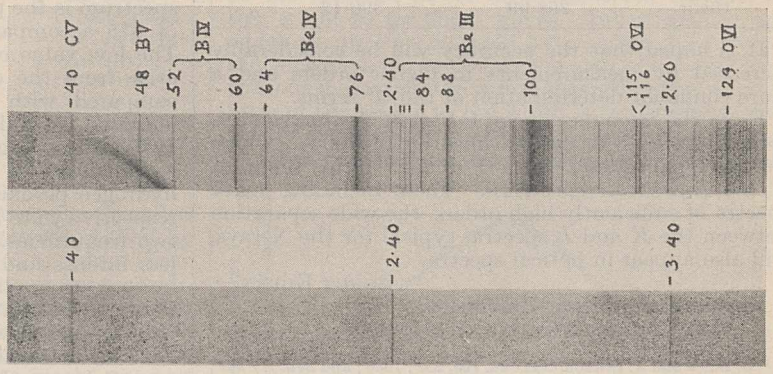


FIG. 1.

Of the series $1\,^2S - n\,^2P$ in the hydrogen-like spectra, there appear two lines of Be IV and one of B V. The wave-lengths in the table were calculated with regard to the fine structure according to the formula given by Penney,[3] and used as standards.

	Be IV.		B V.	
	ν	λ	ν	λ
$1\,^2S - 2\,^2P$	1,317,084	75·925	2,058,247	48·585
$1\,^2S - 3\,^2P$	1,560,962	64·063		

As shown in the second table, the helium-like series $1\,^1S - n\,^1P$ is considerably more strongly developed. The relative intensities can be estimated from Fig. 1, *a*.

	Be III.		B IV.		C V.	
	λ	ν	λ	ν	λ	ν
$1\,^1S - 2\,^1P$	100·25	997,500	60·31	1,658,100	40·28	2,482,600
$3\,^1P$	88·30	1,132,500	52·68	1,898,300		
$4\,^1P$	84·75	1,179,900				
$5\,^1P$	83·19	1,202,100				
$6\,^1P$	82·37	1,214,000				

From the series of Be III the quantum defect for the ^1P terms is calculated as $n - n^* = -0{\cdot}013 \pm 0{\cdot}001$. A comparison with He I and Li II indicates the numerical value to be constant or slightly diminishing with increasing atomic number. The simple assump-

tion of the same quantum defect for Be III, B IV, and C V gives the following term values:

	B IV.	C V.
$n - n^*$	$-0{\cdot}013 \pm 0{\cdot}002$	$-0{\cdot}013 \pm 0{\cdot}003$
$2\,^1P$	$433{\cdot}300 \pm 900$ cm.$^{-1}$	$677{,}000 \pm 2000$ cm.$^{-1}$
$3\,^1P$	$193{\cdot}400 \pm 300$,,	
$1\,^1S$	$2091{\cdot}500 \pm 1400$,,	$3{,}159{,}600 \pm 3300$,,

The ionising potentials, $1\,^1S \times 1{\cdot}234 \times 10^{-4}$, are in good agreement with the quantum theoretical values given by Hylleraas [4] in the formula

$$\text{I.P.} = Rh\left(Z^2 - \frac{5}{4}Z + 0{\cdot}31455 - 0{\cdot}0147\,\frac{1}{Z}\right), \quad Rh = 13{\cdot}54.$$

	B IV.	C V.
I.P. spectr. .	$258{\cdot}1 \pm 0{\cdot}2$ volts	$389{\cdot}9 \pm 0{\cdot}4$ volts
theor. .	258·09 ,,	390·12 ,,

It is hoped that the accuracy will be considerably increased by measurements in higher orders and a more confident determination of the ^1P terms.

From the resonance line of C V at 40 A. the region is completely bare of carbon lines up to 200 A., where the principal series $2\,^2S - n\,^2P$ of C IV forms the limit of the L-electron spectrum. Then, including spark spectra of sufficiently high orders, the wide separation between the K and L spectra, typical for the X-rays, will also appear in optical spectra.

BENGT EDLÉN.
Physics Laboratory, University,
Uppsala, Feb. 1.

[1] B. Edlén and A. Ericson, NATURE, **125**, 233; 1930; and *Zeit. f. Phys.*, **59**, 656; 1930.
[2] E. Ekefors, *Physik. Zeitschr.*, **31**, 737; 1930.
[3] W. G. Penney, *Phil. Mag.*, **9**, 661; 1930.
[4] E. A. Hylleraas, *Naturwiss.*, **17**, 982; 1929.

Fluorescence of Mercury Vapour under Atomic and Molecular Absorption.

IN the letter which appears in NATURE of Jan. 3, p. 10, Lord Rayleigh discusses the excitation of the green fluorescence of mercury vapour by wave-lengths near the resonance line λ2537. The discontinuity of intensity of the fluorescent radiation along the beam of the exciting light leads him to admit the atomic as well as the molecular absorption. The hypothesis of two kinds of absorption exciting the fluorescence was further confirmed by Lord Rayleigh's investigation of the influence of the hydrogen admixture. These experiments support the view that the fluorescence of mercury vapour is chiefly due to atomic absorption.

I should like to point out that this conclusion agrees with that which I have drawn from my experiments on the influence of the magnetic field on the fluorescence of mercury vapour.[1] In these experiments the fluorescence was excited by the light of the mercury line λ2537. The tube with the distilling mercury vapour was placed between the poles of a powerful electromagnet and the intensity of the fluorescent radiation was observed at different strengths of the magnetic field as measured at the place of excitation. The variation of the intensity of the green fluorescence was found similar to that of the resonance radiation investigated by M. Schein.[2] The maxima and minima of the intensity of both radiations appeared at equal magnetic fields, thus indicating that the region of the excitation of the fluorescence has exactly the same hyperfine structure as the exciting line λ2537. Hence the only possible conclusion seemed to be that, in the excitation of the fluorescence of mercury vapour at moderate densities by the line λ2537, the atomic absorption forms the first necessary step of the excitation.

The evidence of my experiments referred to above and the recent work of Lord Rayleigh are decidedly against the view often expressed that the fluorescence of the mercury vapour should be produced by the molecular absorption alone.

HENRYK NIEWODNICZAŃSKI.
Stefan Batory University,
Wilno, Poland, Jan. 30.

[1] *Zeitschrift für Physik*, vol. 55, p. 676; 1929.
[2] *Annalen der Physik*, vol. 85, p. 257; 1928.

Raman Spectrum of Hydrogen Peroxide.

THE Raman spectrum of hydrogen peroxide (Merck's perhydrol 30 per cent solution in water) has been photographed. The prominent feature of the spectrum is the presence of a sharp Raman frequency of 875 accompanied by a weak component at 903. The low value of the frequencies suggests that they arise from the oxygen atoms, and as such may be compared with the O_2 oscillation frequency 1552 obtained by McLennan (*Trans. Farad. Soc.*, **25**, 798; 1929). The large difference between the two values is indicative of the fact that the oxygen atoms in hydrogen peroxide (H_2O_2) and oxygen (O_2) molecules respectively are bound differently. Besides the above two frequencies, there appear other bands which are less intense and sharp, the origin of which is under investigation. A detailed discussion of the results obtained in relation to the structure of the molecule will appear elsewhere.

S. VENKATESWARAN.
210 Bow Bazar Street,
Calcutta, Jan. 17.

Resistance of *Eurytemora hirundoides* Nordquist, a Brackish Water Copepod, to Oxygen Depletion.

THE River Tyne estuary is polluted by crude sewage and manufacturing effluents to such an extent as to cause a serious depletion in dissolved oxygen. It is not unusual to find a complete absence of dissolved oxygen on isolated occasions during the summer months. The number of normal estuarine organisms able to withstand these adverse conditions is very limited.[1] Of these, *Eurytemora hirundoides* is the most abundant and the most hardy. Its region of maximum abundance lies between 9 miles and 13 miles from the river mouth, in the area of heaviest pollution and most noticeable oxygen depletion. At a survey held on July 22, 1925, it occurred plentifully in regions where the dissolved oxygen was nil, as determined by the Winkler method.[1, 2] During 1929 I obtained it freely in the water sampler on occasions when the oxygen content was again nil (these remarks apply to the sampling depth of 6 ft.).

There are, at the present time, several investigations being made into the oxygen requirements of certain marine animals. It may, therefore, be of interest to place on record the following additional observations upon *Eurytemora*, made incidentally in the course of other work.

In addition to determining the dissolved oxygen *in situ* of the River Tyne at Newcastle, I have for the past two years included an additional test described as the 'dissolved oxygen absorbed'. This is a modification by Jackson and Jee of the test recommended by the Royal Commission on Sewage Disposal.[3] A stoppered bottle of approximately 330 c.c. capacity is filled with the river water (taking the usual precautions to exclude all air) and 'incubated' by complete immersion in water at air temperature for a period of seven days. The oxygen remaining is de-

termined. Under existing pollution conditions, there are but few occasions in the summer when the residual oxygen exceeds nil. Varying numbers of *Eurytemora* are usually present in the river water when sampled, and are thus included in the sample put aside for this test. The following table gives a record of the ensuing mortality on these included copepods for certain dates during 1930:

Date sampled.	Oxygen *in situ* (gm. per 100,000 gm.).	Oxygen remaining after incubation (gm. per 100,000 gm.).	*Eurytemora*.
May 23 .	0·44	0·045	Most alive, some dead.
May 30 .	0·24	nil	All dead.
June 6 .	0·26	nil	All dead.
June 13 .	0·14	nil	All dead.
June 20 .	0·33	nil	All dead.
Aug. 1 .	0·50	0·004	Most dead, a few alive.
Aug. 8. .	0·76	0·45	All alive.
Aug. 15 .	0·74	0·006	Few dead, most alive.
Sept. 5 .	0·58	0·004	7 present at start, 7 still alive.

It is to be noted that on four of the nine occasions the dissolved oxygen has been completely utilised by oxidisable matter, and no *Eurytemora* remained alive. Toxic substances may have exerted an influence in addition to oxygen deficiency. It is evident that, although the copepod is regularly taken in the river under such conditions, it can survive total oxygen deprivation for short periods only. Its presence in the river at these times may be explained by the continual slight aeration of surface waters by river traffic, slight though the effect may be. It is clear from the table that this copepod may survive in brackish water, heavily polluted, when the oxygen concentration is no more than 0·004 gm. per 100,000 gm.

H. O. BULL.

The Dove Marine Laboratory,
Cullercoats, Northumberland,
Feb. 7.

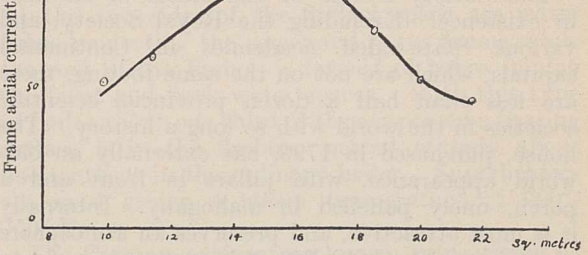
[1] Jorgensen, O. M., The Plankton of the River Tyne Estuary, *Proc. Univ. Durham Philosoph. Soc.*, **8**, 41-54.
[2] Gill, R., Pollution of the River Tyne, Rept. Dove Marine Lab., 1926, 28.
[3] Jackson, W. J., and Jee, E. C., 9th Tees Report, Min. Agric. and Fish., Serial No. 284, Report No. 183.

Optimum Dimensions of Short-wave Frame Aerials.

BECAUSE of the increasing use of short waves in present-day wireless practice, many investigators have studied the nature of the electromagnetic field at distances less than a wave-length from a radiating antenna. The importance of such investigations lies in the fact that a knowledge of the peculiarities of the field at these short distances enables designers of directive beam aerials to space correctly the units of the radiating and receiving systems. For example, for maximum forward radiation the critical spacing between a line of tuned radiating antennæ and a line of tuned reflecting wires is now known to be 0·33 or 0·85 of a wave-length and not 0·25 of a wave-length as was originally supposed.[1]

The erroneous argument which leads to the result that 0·25 of a wave-length is the best spacing between a Hertzian dipole oscillator and a reflecting antenna behind it, also leads to the conclusion that the best width of a frame aerial is 0·5 of a wave-length. A more rigorous theoretical treatment shows that, for a frame aerial, there are several different critical widths and heights which depend upon the wave-length in use, and that none of these critical values is half a wave-length. Although the critical dimensions are of little consequence in long-wave work, they are of outstanding importance in the design of frame aerials for short waves, because the resulting current for tuned aerials can be increased many thousand-fold by designing the frame with the optimum dimensions. Thus a square or circular frame is always less efficient than a correctly proportioned rectangular or elliptical frame of the same area.

Since both the optimum width and height are dependent on the wave-length, it follows that the optimum area of a frame is also critical when used for wave-lengths comparable with the dimensions. In the current literature it has been assumed hitherto that the larger the area of the frame, the greater will be the radiated power or the received current, but this is not so for short waves. Investigations upon which we are now engaged have shown, for example, that it is possible to double the area of a tuned frame without increasing the signal strength, even when the ratio of the height to the width is the optimum value for the particular wave-length in use. This is shown in the accompanying graph (Fig. 1), which is based



Area of frame with optimum dimensions

FIG. 1.

on measurements made on 8·65 metres with a tuned frame capable of being expanded in either or both dimensions. The current values are those obtained when the frame was adjusted to its optimum dimensions, and hence the currents recorded are the greatest that can be obtained with a frame of the given area. Thus the greatest possible current was approximately the same whether the area of the frame was 10 or 20 square metres, and this current was reduced by any change in the relative dimensions of these frames. The critical area was between 15 and 16 square metres, and then the maximum current exceeded that for frames of any other area. In all cases the frame was tuned to 8·65 metres.

A further point of interest is the fact that a frame designed for best reception on a given wave-length is not the optimum shape for maximum radiation on the same wave-length.

As we have ventured to think that these preliminary results may be of some interest, it was thought desirable to write this brief note now, but it is proposed to publish the work in detail shortly, when the theoretical and experimental investigations now in progress are completed.

L. S. PALMER.
L. L. K. HONEYBALL.

The University College,
Hull, Feb. 26.

[1] See publications in Great Britain by Wilmotte and McPetrie and by Palmer and Honeyball, in the United States by Englund and Crawford, in France by Mesny, Chireix, etc., in Germany by Meissner, Gothe, and others, and in Russia by Tatarinoff and also by Pistolkors.

The Manchester Literary and Philosophical Society.

By C. L. BARNES, Honorary Librarian.

THE centenary of a society being by common consent an occasion for pride, encouragement, and hopeful anticipation, it follows that at a sesqui-centenary these accompaniments should enjoy a proportionate increase. With this advantage in prospect, the Manchester Literary and Philosophical Society, founded in February 1781, will celebrate its one hundred and fiftieth anniversary on Tuesday, Mar. 17, when Sir J. J. Thomson—himself a native of Manchester and an alumnus of Owens College—will deliver an address at 4 P.M. in the Athenæum Hall. An honorary member since 1895, he will be presented with the Society's Dalton Medal, the last award of which was made in 1919 to Lord Rutherford, who, but for the call to Cambridge, would have been president for that and the following year. There will be a dinner the same evening in the Midland Hotel at 8 P.M. During the week, after Tuesday, the Society's house, No. 36 George Street, will be open to visitors from about 11 A.M to 5 P.M.

The Society is one of the oldest of its kind in existence. Excluding the Royal Society, and various State-aided academies in Continental capitals, which are not on the same footing, there are less than half a dozen provincial scientific societies in the world with so long a history. The house, purchased in 1799, has externally an old-world appearance, with pillars in front and a porch, finely panelled in mahogany. Internally it is most attractive, and preserves an atmosphere of studious calm in a district long ago given up to commercial activities. There are portraits in oils of Newton and Davy—copies of those in possession of the Royal Society—of Percival, Dalton, Joule, and other past presidents: marble, bronze, and plaster busts; and a large number of engraved portraits or photographs of distinguished men of science.

Of Dalton relics the Society has an unequalled collection. Here are to be seen nearly all the crude chemical apparatus with which he worked; his meteorological observations, begun at Kendal, and continued for more than fifty years; many MSS. of his papers; an orrery, a planetarium, and electrical appliances; his medals, including the Copley Medal of the Royal Society; and a few articles of personal property.

Dalton came to Manchester in 1793, as 'professor' of mathematics—in which he had some skill—at the then new Manchester Academy. He joined the Society in 1794, and read more than a hundred papers during his half-century of membership. From 1816 until 1844 he was president, but had previously filled almost all the other offices. He supplemented an exiguous income by taking pupils (at 1*s*. 6*d*. a lesson), by lecturing, and writing books. One on "The Elements of English Grammar" (1801) is said to have given him special satisfaction. Though none but caretakers ever lived in the house, Dalton was allowed the free use of a room in it, and a marble tablet commemorates the fact that here, out of his experiments and cogitations, the atomic theory was developed.

One of Dalton's pupils, though a paralytic stroke brought the tuition to a premature end, was James Prescott Joule, who worthily upheld the Society's prestige for about thirty years after Dalton's death in 1844. Two of the thermometers, with very large bulbs, very narrow bores, and nearly a yard long, used by Joule in his researches, are still carefully preserved, and when compared with a standard Tonnelot thermometer by Sir Arthur Schuster, about forty years ago, were found to be surprisingly accurate.*

The Society found a liberal benefactor in Dr. Henry Wilde, whose name is inseparably associated with the dynamo. He enlarged, improved, and strengthened the premises, and provided a substantial endowment.

Though these three names are more closely connected with the Society's history than any others, the bond between it and Owens College, afterwards the Victoria University of Manchester, which began in 1851, has always been very close. Among presidents from one or other of these bodies may be mentioned Roscoe, Crawford Williamson, Balfour Stewart, Sir Horace Lamb, Osborne Reynolds, Sir W. Boyd Dawkins, H. B. Dixon, F. E. Weiss, Elliot Smith, S. J. Hickson, Sir Henry Miers, and W. L. Bragg.

Nor have distinguished non-academic members been wanting. To dive into the past for a moment, Dr. Thomas Percival, M.D., F.R.S., the leading spirit among the founders, and president for several years, was a friend and correspondent of Benjamin Franklin, two of whose communications, on meteorological matters, were read in 1784. The Rev. William Gaskell, whose sterling merits have been eclipsed by his wife's greater fame, was a member; and William Sturgeon, inventor of the electro-magnet; also William Henry (Dalton and Henry's law is still on the chemist's statute-book), Stanley Jevons, and James Nasmyth, of steam-hammer fame. To these may be added the Rev. T. P. Kirkman (a distinguished mathematician whose name recalls the problem of the fifteen school-girls), John Hopkinson, Sir Joseph Petavel, and H. J. G. Moseley, whose untimely death in the War is still mourned; and even so the list is incomplete. It is worthy of note that Eaton Hodgkinson and Sir W. Fairbairn, both presidents in their day, were the two upon whom Robert Stephenson chiefly relied when planning the Britannia and Conway tubular bridges; one worked out the calculations, the

* The secular rise in the freezing-point of these instruments was examined both by Joule and Schuster. A more recent test by Dr. J. R. Ashworth (*Journal of Scientific Instruments*, Nov. 1930) shows that in the principal thermometer the reading is 15·48 of the arbitrary scale-divisions, or 0·66° C. higher than in 1844: it appears to be approaching a limit exponentially.

other provided the metal work. In more recent times, R. D. Darbishire, Sir W. Bailey, Charles Bailey, Cosmo Melvill, and Dr. H. Levinstein have occupied the chair. Mr. C. E. Stromeyer has held office since 1929.

The Society issues an annual volume of *Memoirs and Proceedings*, and many valuable papers are enshrined therein, as is testified by their inclusion in the Royal Society's catalogue.

A special lecture, to which a premium is attached, is given once a year, and such men as Sir George Stokes, Sir Michael Foster, Sir William Ramsay, Dr. Elie Metschnikoff, Prof. F. Soddy, the late Lord Rayleigh, Sir Joseph Larmor, Sir Charles Parsons, Sir William Bragg, and others of equal note, have responded to the Society's invitation. Sir J. J. Thomson's name is still to be added.

No mention of the Society would be complete without a reference to its library of 44,000 volumes, consisting mainly of the transactions of other scientific societies and institutions throughout the world. These have been acquired by purchase or exchange over a very long period, and in most cases are complete, or nearly so. The library is an outlier in connexion with the National Central Library.

It is hoped by this celebration to extend the Society's influence and membership, and to make more widely known a record of which it has every reason to be proud.

Experiments in Locomotive Design.

IN a paper on "High-Pressure Locomotives", read before a crowded meeting of the Institution of Mechanical Engineers on Jan. 23, Mr. H. N. Gresley, the chief mechanical engineer of the London and North-Eastern Railway, gave an account of the various high-pressure locomotives constructed in the United States, Germany, Switzerland, and England since 1924. Prefacing his remarks by observing that at no time during the history of the steam locomotive have such radical changes been introduced as during the past ten years, he said that in Great Britain alone there are 23,000 locomotives, on which a sum of £45,000,000 per annum is expended on maintenance, renewal, and running. About 25 per cent of this is the cost of fuel and another 25 per cent the cost of maintenance and renewal. It will be noted that the expense in maintaining locomotives is equal to the cost of the great quantity of coal they consume. From this it is clear that there is a wide field for economy if both the cost of fuel and maintenance can be reduced.

In locomotives with the type of boiler as developed from that incorporated in the *Rocket* by Stephenson, boiler pressures up to 325 lb. per sq. in. have been experimented with, but 250 lb. per sq. in. is approximately the maximum pressure which can be carried in such boilers, having regard to the cost of maintenance. It took a hundred years to increase the pressure from 50 lb. to 250 lb., but during the last few years pressures have leapt up to 450 lb., 900 lb., and even 1700 lb. But while high steam pressure gives greater economy in fuel consumption, it demands complications in design, and care has to be taken that the economies in fuel are not absorbed in the increased cost of maintenance of the boiler and of the machine as a whole. In all the latest high-pressure locomotives, reciprocating engines have been adopted and the use of a compound engine or of a uniflow engine is essential. Two-, three-, or four-cylinder compound engines have all been used in one or other of the engines described.

In the United States, the Delaware and Hudson Railway in 1924 built a main line locomotive with 325 lb. pressure with a two-cylinder compound engine. This locomotive, named the *Horatio Allen*, was followed by the *John B. Jervis* (1927) with 400 lb. pressure and the *James Archbald* (1930) with 500 lb. pressure. The weight of these engines is between 150 and 160 tons. In all three locomotives the barrel portion of the boiler differs little from the usual type. The firebox, however, is formed by flat front and back water spaces joined by four circular drums—two upper and two lower. At the two sides of the firebox space are water tubes connecting the upper and lower drums, while the roof of the firebox is formed of tubes joining the front and back water spaces. With this type of boiler about one-third of the evaporative heating surface is in the firebox, instead of only about one-tenth as in the ordinary boiler. Superheaters are used giving a steam temperature of 700°-750° F.

The German engines are known respectively as the Schmidt-Henschel three-cylinder compound locomotive and the Schwartzkopff-Löffler three-cylinder locomotive. The first Schmidt-Henschel locomotive was built in 1926, and since then four others have been completed or are under construction. The high-pressure locomotive of the London, Midland, and Scottish Railway is of this type. Four of the engines work with steam at 850 lb. and the other at 900 lb. The boilers of these locomotives consist of two—or, perhaps more correctly, three—distinct parts. Steam for use in the cylinders is generated in two separate boilers working at 850 lb. and 200 lb. respectively, but the greatest novelty in the arrangement consists of the method of heating the high-pressure boiler. All around the firebox are water tubes which are connected to elements in the high-pressure boiler, the elements and the tubes forming a closed circuit partially filled with distilled water Owing to the heat of the fire, saturated steam is generated in this circuit at 1200-1600 lb. pressure, and this very high pressure steam is used as a medium for heating the water in the high-pressure boiler. One advantage of this arrangement is that, owing to the use of distilled water, there is no scaling or corrosion to cause overheating of the tubes. The weight of the first Schmidt-Henschel locomotive was only 91 tons, but one now under construction for the Canadian Pacific Railway will have a weight of 206 tons.

The Schwartzkopff-Löffler locomotive with steam at 1700 lb. pressure is of still more novel construction. The boiler is a most complicated system of tubes and drums with a very large number of joints and connexions, and it is difficult to believe that such arrangements can ever become standard practice. Here again there are two distinct boilers, one working at 1700 lb. supplying steam to the two high-pressure cylinders and the other working at 225 lb. pressure supplying steam to the single low-pressure cylinder. Neither of these boilers is subjected to the heat of the fuel or gases, the heat for the high-pressure boiler being obtained from highly superheated steam generated in a high-pressure superheater surrounding the firebox, while heat for the low-pressure boiler is obtained from the steam exhausting from the two high-pressure cylinders. The locomotive of this type was built for the German State Railways in April 1930, but is apparently not running at the present time.

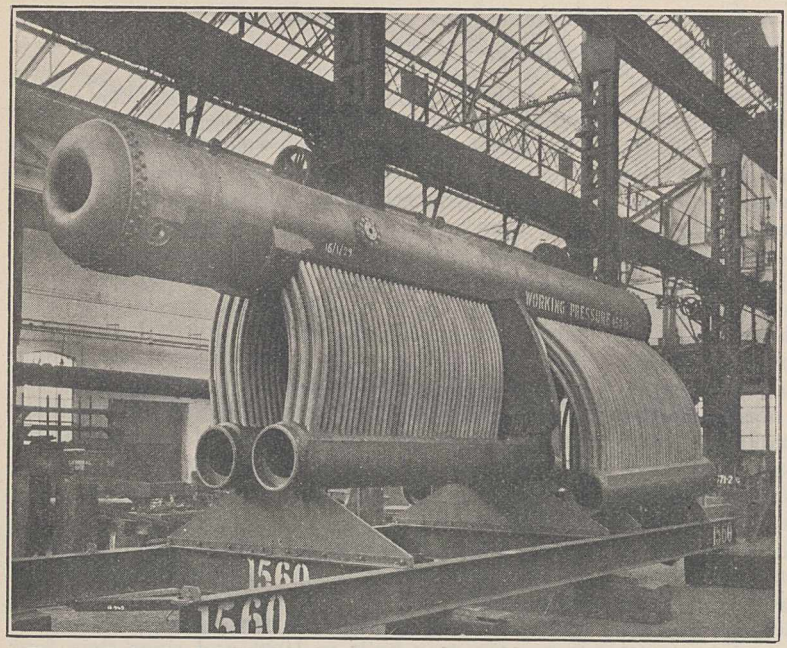


FIG. 1.—Boiler, constructed by Messrs. Yarrow and Co., Ltd., of the L.N.E.R. locomotive No. 10,000. By courtesy of Messrs. Yarrow and Co., Ltd.

The Swiss engine known as the Winterthur high-pressure locomotive was completed about the end of 1927. The locomotive weighs about 90 tons and is fitted with a three-cylinder uniflow engine with cam-operated poppet-valves, and exhaust passages round the middle of the cylinders. Steam is generated at 850 lb. pressure in a water tube boiler with one large upper drum and two small lower drums. Walls of water tubes form the sides of the firebox and other water tubes partially fill the flue space, which also contains a superheater and a feed heater. Trials of the locomotive have been made in Switzerland, Austria, and France, and during some recent runs a coal consumption of about $2\frac{1}{4}$ lb. per draw-bar horse power was recorded.

About half of Mr. Gresley's paper was devoted to the American, German, and Swiss locomotives; while in the second part he gave an account of the locomotive No. 10,000 which has been built to his designs for the London and North-Eastern Railway. The steam pressure in this locomotive is 450 lb. per sq. in. Completed in 1929, No. 10,000 has since worked trains of more than 500 tons weight for long distances at express speeds with consistent success and reliability. There are indications that it will prove more economical in fuel than express engines of the normal type, but economy in maintenance costs will only be apparent after the engine has run for some years. In this locomotive there are two high-pressure cylinders and two low-pressure cylinders. As in the other locomotives, the greatest interest lies in the boiler, which is the outcome of the collaboration of Mr. Gresley with Mr. Harold Yarrow. The boiler (Fig. 1) is essentially a variant of the well-known and very successful boiler first invented by Sir Alfred Yarrow for fast naval vessels. In locomotive No. 10,000 there is a single upper steam drum about 28 ft. in length and 3 ft. in diameter and two pairs of lower water drums 11 ft. and $13\frac{1}{2}$ ft. in length respectively—one pair for the sides of the firebox and one pair for the sides of the flues. Curved water tubes run from the four lower drums to the upper drum. The distances between the steam drum and the water drums at the firebox end of the boiler are such that the lines joining the centres of the drums approximately form an equilateral triangle. The water drums in the flue space are much closer together. One interesting feature of the design is the method of supporting the upper drum from the engine framing, so that while it is prevented from moving vertically or laterally, it can expand and contract longitudinally; while another is the means adopted for ensuring the deposition of the mud in the drums and not in the tubes. Experience has shown that the boiler can be worked for a much longer period than the ordinary type of boiler before requiring washing out; and although there are 1536 points at which the tubes have been expanded into the drums, there has been no case of leakage.

The ancillaries to the boiler include a feed heater and a superheater; while by surrounding the whole boiler with a double casing through which the air can circulate, all the air for combustion can be preheated to about 250° F.

A feature of the locomotive which has caused public comment is the forward end, where a short funnel is housed between blinker plates. This arrangement was adopted as the result of experiments made by Prof. W. E. Dalby with the object of finding some means of keeping smoke and steam clear of the cab windows.

Water Pollution Research.

MAINTENANCE of the purity of our rivers and streams becomes of increasing social importance with the growth of industry, of population, and the consequent use of water to carry away waste products.

On one hand is the desire to preserve the amenities of the country; to preserve fisheries providing open-air recreation to many and a valuable yearly yield of salmon from several of our rivers; to meet the increasing demand for water of good quality for domestic and industrial use requiring neither expensive treatment to free it from the effects of pollution nor long and expensive pipelines to bring it from distant unpolluted sources.

On the other hand lies the necessity of disposing of sewage and trade effluents in the most economical manner, without overburdening the rivers with putrefiable or poisonous discharges. Rivers can deal with relatively large quantities of such discharges, since they are soon oxidised after sufficient dilution in a stream of well oxygenated water; but when this is overstepped, death of fish, noxious-smelling by-products, and the growth of fungus on the river bed result.

Publicity has done much to allay the natural increase of harmful pollution during recent years. Many problems have arisen: When does pollution become so harmful that it is to the interest of the community to purify particular effluents, and what are the most economical means of doing so? Is it possible to do so in sufficient degree to restore or maintain the amenities of a river without putting an undue burden upon an industry or upon the local rates? In order to decide such questions, exact and accurate information, often of a very varied nature, is frequently required.

In the "Report of the Water Pollution Research Board, 1929–1930",[1] an account is given of several investigations now in progress. In order to obtain information of general application, especially concerning the effects on a river of sewage and trade effluents of various kinds and the quantity which can be allowed to enter without unduly retarding the process of self-purification, it was decided several years ago to make a thorough survey of the flora, fauna, and water of a typical river, and their variation throughout the seasons. For this purpose the River Tees and its estuary were chosen. The present Report gives a short account of the first year's work.

The head waters pass within half a mile of the river's source on to a limestone bed, where in the course of only a few yards the *p*H value rose from 4 to 7. The water remains at about this value until it mixes with the more alkaline sea-water in the estuary, throughout which the mixed waters oscillate backwards and forwards with the tides. In addition, a circulatory system is set up, the ebb tidal stream being strongest at the surface and the flood tidal stream strongest at depths below one fathom. This is very marked when much fresh water enters the estuary. Matter suspended in the water of the upper layer has a residual movement seaward, while matter suspended in the lower layers has a residual movement towards the head of the estuary.

Above the estuary the river suffers little pollution except from one tributary. Series of observations throughout periods of twenty-four hours have been made to determine the changes in the river water and in the quantities of dissolved gases during the day and night. Diurnal variations were found in the number of bacteria and dissolved nitrogenous compounds in the water; further investigations are being made with the aim of finding an explanation of this phenomenon.

The central portion of the estuary between Stockton and Cargofleet receives the discharge of many industrial effluents and the untreated sewage from 275,000 inhabitants, which gives rise to a heavily polluted zone oscillating up and down the estuary with the tides. The effluents undergo oxidation at the expense of the dissolved oxygen in the water, which may fall to below 20 per cent of saturation value during the summer, the minimum found during 1929 being 5 per cent in the central part of the polluted zone. Life is almost absent in this portion of the river, where the bottom-living animals and plants are also exposed to the greatest changes in salinity, while numerous species occur above it and below. Various marine fishes have been found dead and dying at the lower end of this polluted belt, and great numbers of salmon smolt at the upper end as they enter it during their migration to the sea. From the results obtained during the first year of the survey, the general changes in the composition of the river water at different times of year, and under different conditions of rainfall and states of the tide, have been ascertained. The nature of many effluents has been examined. Their poisonous constituents and influence on the water and fauna of the estuary continue to be the subject of investigation, which has proved increasingly fruitful during the second year's work.

The Report deals next with the purification of effluent from beet sugar factories. By using over again the wash water and by biological filtration of the effluent, this can now be rendered relatively harmless. The experiments have demonstrated the conditions under which percolating filters can be operated satisfactorily thoughout a beet sugar campaign for the requisite purification of pulp press liquor, suitably diluted with river water or with effluent from the filters.

The parts played by various organisms present in the filters continue to be investigated, with the object of isolating pure strains specially active in decomposing and oxidising the substances present in the effluents. It is noteworthy that the work has led to the discovery of new strains of nitrifying bacteria which belong to neither *Nitrosomonas* nor *Nitrococcus*.

The changes taking place in the zeolite process of water softening and the treatment of corrosive and plumbo-solvent waters are also the subject of

research. Water mains sometimes become so corroded that they burst when under pressure, or deposition of organic and inorganic substances may take place to such an extent as to diminish seriously their water-carrying capacity. There is a lack of exact information, not only as regards the best treatment of the plumbo-solvent waters, but also on the variation of this plumbo-solvent character with the composition of the water.

For the most economical working of the activated sludge process of sewage disposal, more precise knowledge of the various factors involved is required. As the relative importance of the parts played by the bacterial and the physico-chemical changes is unknown, experiments are being made with sewage effluent freed from bacteria. An investigation is also being carried out on the dissolved colloids and the conditions which affect their quantity and nature.

Although much of this varied research is still in the initial stage, it is abundantly clear that it cannot fail to yield many facts of scientific interest as well as of practical importance. The work of the Board on the treatment of effluents from beet sugar factories has already provided a solution to an urgent social problem.

The Committee appointed in May 1919 by the Ministry of Transport and the Ministry of Agriculture and Fisheries to investigate the question whether tarred roads are harmful to fisheries, has also published a report [2] containing a wealth of experimental results. The toxicity towards fish of aqueous extracts from various tars has been investigated, and also the toxicity of their various poisonous constituents, phenol and higher phenols, bases such as ammonia and quinoline, and hydrocarbons such as naphthalene. Similar experiments have been made with the drainage from tarred surfaces, which lose much of this toxic property after the first heavy rains have washed out the more soluble substances.

The major experiment consisted in passing the rain washings from an area of tarred road into small ponds stocked with trout, through which there was a flow of fresh water. These trials proved that undiluted washings from the freshly tarred roads were deadly to fish—unless diluted, for safety, with about ten times their volume of unpolluted water. The subsequent drainage from the road was less toxic, but rose again where the surface began to disintegrate. Parallel trials were made with rain washings which were stored or allowed to pass through a filter of cut turf, it being known that the phenols constituting tar acids and naphthalene are broken down by the action of bacteria which occur in soil. In both cases the treatment was found to reduce the injurious character of the rain washings.

As a result of these investigations, mostly carried out between 1920 and 1922, and the experience gained by this Committee, the Ministry of Transport warned all road authorities against the use of unsuitable tars on roads draining directly into streams. It cannot be doubted that there has been a diminution in destruction of fish during the last six years. The investigations are still proceeding, and include the examination of samples of home-produced coal-tar preparations which aim at being non-toxic, and so able to replace bitumen without danger to fisheries. H. W. H.

[1] "Report of the Water Pollution Research Board for the year ended June 30, 1930." Department of Scientific and Industrial Research. H.M. Stationery Office, 1930. 9*d*.

[2] "Detailed Biological and Chemical Reports on Tars used for Road-Surfacing." Ministry of Transport and Ministry of Agriculture and Fisheries. H.M. Stationery Office, 1930. 2*s*. 6*d*.

Obituary.

Lt.-Col. Sir Richard Temple, Bart., C.B., C.I.E.

WE regret to record the death of Lieutenant-Colonel Sir Richard Temple, the distinguished Oriental scholar, which took place on Mar. 3, at Territet, Switzerland. Sir Richard Temple was born at Allahabad on Oct. 15, 1850, and was educated at Harrow and Trinity College, Cambridge. He joined the Royal Scots Fusiliers in 1871, and after six years' service in India was transferred to the Indian Army, serving in the 38th Dogras and 1st Gurkhas. After a distinguished military and administrative career, in which he served in Afghanistan and Burma, in 1895 he was appointed High Commissioner of the Adamans and Nicobars and superintendent of the Penal Settlement of Port Blair, a post which he held until his retirement in 1904. On his return to England, Temple settled on his family estate in Worcestershire. During the War, as chairman of the Worcestershire Territorial Association, he took an active part in the recruiting, organisation, and training of reinforcements, and he also worked hard in connexion with the St. John's Ambulance Association, of which he was assistant director, his war services being recognised in 1916 by the award of the C.B.

Sir Richard Temple was a quick and indefatigable worker. A busy official career which would have left most men little leisure only served to afford him opportunities for increasing the range of his knowledge. There were few matters connected, however slightly, with Indian culture on which he was not qualified to speak as an expert—history, religion, ethnology, linguistics, numismatics, archæology, or folk-lore. His census reports for Burma in 1891 and the Andamans and Nicobars for 1901 contain many noteworthy contributions to the folk-lore and ethnology of these districts. He had, however, long before, taken a recognised place as an authority on folk-lore by his "Legends of the Punjab" (1883–1890) and his notes to Mrs. Flora Annie Steel's "Wideawake Stories" (1884). He had also founded and edited *Punjab Notes and Queries*. In Burma he made a special study of the Burmese belief in spirits, revising Burnell's "Devil-Worship of the Tuluvas", and publishing his own study of "The Thirty-Nine Nats". He also collaborated with the late E. H. Man in a work on the languages of the Andamanese, and he elaborated a "Theory of Universal Grammar applied to Savage Languages", a scheme of which the merits have not been fully recognised. An equal originality was shown in his studies of the currency systems of

backward peoples, which he maintained gave a key to the understanding of their culture. Here again the acuteness of Temple's views has been appreciated by only a few experts.

Temple was the author of many contributions to learned periodicals, and his wide range of knowledge made him an ideal editor of the records of early travellers and historians. He was responsible for volumes produced by both the Hakluyt Society and the Indian Records series. He also inspired others, and his reports as High Commissioner of the Andamans contain valuable notes made by his officers on punitive expeditions and visits of inspection among the, at that time, lesser known Andaman tribes. But his greatest service to Indian scholarship was the foundation of the *Indian Antiquary* in 1884, of which he continued to be editor-in-chief up to the time of his death, publishing it at his own expense. In the mass of material which appeared in its pages, invaluable to the student of Indian culture, Temple leaves a monument which will endure for all time.

On his retirement, Temple continued his literary and scientific activity with unabated energy. In 1913 he was president of Section H (Anthropology) of the British Association. His presidential address on "Anthropology as a Practical Science" was made the starting-point in a campaign of which he was the leading spirit in pressing for State aid for anthropological studies. This was interrupted only by the War. In 1920, when he was a member of council of many learned bodies, he was also appointed director of the Royal Asiatic Society, and in 1928 he was president of the Jubilee Congress of the Folk-lore Society. Unfortunately, the state of his health after the War obliged him to reside for the greater part of each year in Switzerland; but this had little perceptible effect on the volume of his work. He continued to produce innumerable papers and notes based upon the material he had collected in his earlier years. At the time of his death, he was also engaged on a series of monographs on Indian Muslim saints, in alphabetical order, of which two sections, from A to H, are complete. His mental vigour, his memory, and his mastery of detail were unimpaired to the end.

PROF. J. S. DUNKERLY.

THE untimely death in his fiftieth year of Prof. John Samuel Dunkerly, of the University of Manchester, inflicts a distinct loss upon British zoological science. Evading publicity, and having to his credit only a comparatively small volume of published research work, he aroused full appreciation of his capabilities only in the minds of the comparatively few with whom he worked in close intimacy.

Dunkerly owed the main part of his zoological training to the late Prof. E. A. Minchin, from whom he inherited alike his most conspicuous strengths and weaknesses as an investigator—fastidious care in matters of technique and accuracy of observation, combined with a modest diffidence in his own powers which was apt to result in hesitancy to commit himself to the ready acceptance of conclusions, either his own or those of others. His output of published research work suffered disastrous interference by the War, in which he did splendid service as a combatant officer—first in the Cameronians, then in the Machine Gun Corps, and finally in the Royal Air Force until shot down during the closing year of the War. The wound then received resulted in severe septicæmia which left him permanently crippled and subject from time to time to attacks of severe illness and much suffering. Those who were privileged to work with Dunkerly during his later years developed a profound admiration for the gay and light-hearted courage with which he faced his troubles, never losing heart until the very end.

Dunkerly's published researches, comparatively small in amount, deal mainly with obscure Protozoa. The Flagellata took first place in his interest during earlier years, and he devoted much time to the investigation of Choanoflagellates and of the protozoan parasites infesting the alimentary canals of insects. Latterly his interests centred rather on the Myxosporidia. He made the first study of *Agarella*, a common parasite of the testis tubules of *Lepidosiren*, and upon this work he eventually based his most important contribution to the literature of protozoology—his study of the development and relationships of the Myxosporidia—published in the *Quarterly Journal of Microscopical Science* for 1925. In this interesting and suggestive paper, attention is directed to the parallelism in structure between the Myxosporidian, in which the amœbula—the essential reproductive element—is enclosed in complicated multinucleate arrangements of an accessory kind, the whole forming the characteristic and complex 'spore', and the Metazoon, in which the reproductive material or gonad is contained within the multicellular soma. There is, of course, no suggestion of a Myxosporidian ancestry for the Metazoa: the thesis supported by Dunkerly is simply the very interesting one that "the origin of the Metazoan type was, as in Myxosporidia, a development of a body or soma, originally for protection of the real individual organism represented by the germ or gonad".

From 1911 until 1926 Dunkerly held the post of lecturer on zoology in the University of Glasgow, where his efforts met with high appreciation, and where he showed himself to be a teacher of unusual gifts and power of arousing interest on the part of his pupils. In 1926 he was appointed to the Beyer chair of zoology at the University of Manchester on the retirement of Prof. S. J. Hickson.

During the closing months of 1930 Dunkerly seemed to be at last restored to a fair measure of health and strength. He had completed the personnel of his junior staff and was looking forward, with their loyal and enthusiastic help, to being able to run his University department at the highest possible level of efficiency. It was shortly after Christmas that there became apparent the first foreshadowings of the approaching tragedy, in the form of symptoms pointing to some obscure infection of the pons region of the brain.

News and Views.

DR. WALTER ROSENHAIN, who has been superintendent of the Metallurgy Department of the National Physical Laboratory for the past twenty-five years, is leaving the Laboratory in June to take up consulting work. As a skilled physicist and microscopist, as well as metallurgist and engineer, Dr. Rosenhain has added greatly to the instrumental means at the disposal of the metallurgist for the prosecution of his researches, while his close acquaintance with modern developments in physics has enabled him to bring the latest knowledge of atomic structure to bear upon the specific problems of the metallurgist. A large amount of original research is associated with his name, especially in relation to the physical structure of metals and alloys and the mechanism of failure under stress. Before and during the War he was largely responsible for the development of light alloys as used in aircraft construction and for parts of explosion engines. In this connexion, he investigated the mechanism of age-hardening, and introduced improved methods of casting. He gave much attention to the production of metals in a high state of purity, for example, chromium, manganese, beryllium, and iron—the last, in particular, for the purpose of the researches on iron alloys carried out for the Alloys of Iron Research Committee of the Institution of Mechanical Engineers. Last year he was awarded the Bessemer Gold Medal of the Iron and Steel Institute. In connexion with his metallurgical work it was necessary to give much time to the study of special refractories, and many improvements in laboratory furnaces and in metallurgical processes dependent on the use of better refractory materials are due to his initiative. Dr. Rosenhain has acquired an international reputation as a metallurgist.

MR. C. DAVIES SHERBORN has had the degree of D.Sc. *honoris causa* conferred upon him by the University of Oxford in recognition of his work on the "Index Animalium", the final parts of which are now ready for, if not actually passing through, the press. It is just forty years since Dr. Sherborn began his self-imposed task of providing an index to the scientific names that have been given to animals by systematic zoologists since the time of Linnæus. The first part, containing the names published between 1758 and 1800, was issued by the Cambridge University Press, as a volume of 1254 pages, in 1902. The publication of the second section, bringing the record down to the year 1850, was begun by the Trustees of the British Museum in 1922, and twenty-four parts have been issued since that time, containing in all 6118 pages and carrying the index to midway through the letter 'S'. The total number of names so far indexed amounts to more than 400,000. These figures give some impression of the magnitude of the task. When it is added that the names had to be collected by laboriously searching the files of innumerable scientific periodicals and separate works, many of them rare and difficult to obtain, and that questions of authorship and date of publication often involved prolonged and difficult researches, it seems almost incredible that the task should have been accomplished single-handed. Every one with experience of bibliographical work will appreciate the courage required to plan such an undertaking, and the tireless industry and self-sacrificing devotion that could alone carry it to completion. Zoologists of the greatest eminence all over the world have borne testimony to the value of Sherborn's work, and letters expressing the most unqualified appreciation have recently been received from Stockholm, Copenhagen, Berlin, Frankfort, Paris, New York, and Washington. His many friends in Great Britain and abroad will learn with pleasure of the high, but abundantly merited, distinction that has been conferred upon him.

THE following were elected fellows of the Royal Society of Edinburgh at a meeting held on Mar. 2: W. A. Bain, assistant in the department of physiology of the University of Edinburgh; W. M. Baird, fellow and past president of the Faculty of Surveyors of Scotland; Dr. T. P. Black, head of mathematics department, Trinity Academy, Leith; Prof. J. A. Carroll, department of natural philosophy, University of Aberdeen; Dr. J. M. Cowan, assistant keeper, Royal Botanic Garden, Edinburgh; J. Crichton, assistant superintendent, Meteorological Office, Edinburgh; Dr. Shepherd Dawson, principal lecturer on psychology, Training College, Glasgow; Philip Eggleton, lecturer in biochemistry in the department of physiology, University of Edinburgh; Dr. W. R. D. Fairbairn, consultant physician and lecturer in psychology, University of Edinburgh; Robert Grant, publisher (Oliver and Boyd, Edinburgh; Gurney and Jackson, London); Dr. J. R. Greig, director, The Moredun Institute Animal Diseases Research Association, Gilmerton; J. Henderson, manager and secretary, Edinburgh Assurance Co., Ltd.; Prof. T. Johnson, Tomeg, Hillview, Corstorphine; Dr. J. du P. Langrishe, lecturer in public health, University of Edinburgh; N. M. H. Lightfoot, lecturer in mathematics, Heriot-Watt College, Edinburgh; Dr. W. J. McCallien, lecturer in geology, University of Glasgow; Dr. W. H. McCrea, lecturer in mathematics, University of Edinburgh; Dr. J. B. McDougall, medical director, British Legion Village, Preston Hall, Kent; J. H. Mason, veterinary research worker, London; F. C. Mears, architect, 3 Forres Street, Edinburgh; Dr. A. Nelson, lecturer in agricultural botany, University of Edinburgh; Dr. J. Phemister, senior geologist, H.M. Geological Survey of Scotland; W. Robb, director of research, Scottish Society of Research in Plant Breeding, Corstorphine, Midlothian; H. S. Ruse, lecturer in mathematics, University of Edinburgh; J. J. M. Shaw, lecturer in surgery and clinical surgery, University of Edinburgh; J. F. Shearer, lecturer in natural philosophy, University of Glasgow; G. A. Steven, assistant naturalist at the Plymouth Laboratory, Marine Biological Association of the United Kingdom; Dr. C. P. Stewart, lecturer in general biochemistry, University of Edinburgh; D. Cleghorn Thomson, Scottish regional director, British Broadcasting Corporation; Dr. W. J. Walker, research

chemist, H.M. Fuel Research Station, East Greenwich, London; Prof. John Walton, department of botany, University of Glasgow; Right Hon. T. B. Whitson, Lord Provost of the City of Edinburgh; Dr. J. Wishart, statistician, Rothamsted Experimental Station, Herts.

ON Mar. 2, the House of Commons passed, by a large majority, the second reading of a bill to regulate the protection of grey seals in British waters. At present the grey seal is protected during the greater part of its breeding season; but its protection comes up for review annually and depends for its continuance on the Expiring Laws (Continuance) Bill. If the new Bill becomes law, protection will be guaranteed, with this proviso, that the Minister of Agriculture and Fisheries for England and the Secretary of State for Scotland may withdraw protection during the breeding season, either wholly in any breeding period or during part of the period, or in any specified area during the whole or part of the breeding season. The statements made in the House by the official supporters of the Bill were admirably moderate and we have no doubt that the Ministers concerned will consult opinions other than those of interested parties before deciding upon any relaxation of the present protection. Other statements made in support of the Bill were less admirable. Sir Robert Hamilton cited against the grey seal the case of a gentleman who had shot about a thousand seals in re-establishing a salmon fishery. But surely the seal in question was the common seal, a coast-loving and estuarine species, the habits and distribution and frequency of which are very different from those of the seal which Sir Robert Hamilton was attacking. We direct attention to this false argument because we have on other occasions noted a tendency to drag in against the grey seal irrelevant accusations based on the well-known depredations of the common seal.

ON Mar. 7, and again more strongly during the early morning of Mar. 8, severe earthquakes were felt over a large part of the Balkan peninsula, causing much damage and some loss of life. Many buildings have been destroyed at Valandovi, Strumitza, and Demirkapu, and there has been some, if perhaps less, damage at places so far apart as Sofia, Kustendil, Nevrokop, Gorna Jumaya, and Svetivratch, that is, within an area about 100 miles in diameter. The shock was felt at Adrianople, Nish, and Salonika, and thus the disturbed area, as indicated by the early reports, must have been at least 350 miles long from east to west, extending in the latter direction to the neighbourhood of Skutari, and about 200 miles wide. The epicentre probably lies about 100 miles to the north of Salonika, and close to one of the most active zones (that of Rilski Monastir) in the central portion of the peninsula. One feature of the earthquakes that may prove to be of interest is their possible connexion with the Bulgarian earthquakes of three years before. A brief report on these earthquakes by Prof. G. Bontcheff has recently appeared in the *Matériaux pour les Études des Calamités* (No. 22, pp. 98-116; 1930). The epicentre of the earthquake of April 14, 1928, lay near Tchirpan, that of the earthquake of April 18 near Plovdiv (or Philippopolis), about 25 miles to the west. In the recent earthquake, the seat of activity was transferred about 80 miles still farther in the same direction.

ON Mar. 4, Sir William Bragg gave a lecture on Michael Faraday, which formed one of the series of National Lectures arranged by the British Broadcasting Corporation. As Fullerian professor of chemistry, Sir William spoke as Faraday's successor in the laboratories and lecture room of the Royal Institution, and a special interest invested his account of the great experimental philosopher's life and work in view of the forthcoming celebration of the most notable of his discoveries, that of electro-magnetic induction. Aug. 29, 1831, is the date of the first successful experiment in the induction of electric currents, and in this the centenary year some time was naturally given to an explanation of the nature and significance of the electrical researches; but within the limits of the time set for his talk, Sir William also gave a very interesting account of the man himself, of his early life as a bookseller's apprentice, his introduction to Davy and to scientific work, his lovable character, and of the vision which filled his mind and directed and informed all his experimental inquiries—that of the essential unity of Nature and of the relations to be sought between its different manifestations. Faraday could have had no more sympathetic interpreter, and many who listened must have caught something of the personal magnetism which gave to his own lectures their charm and drew Victorian audiences to the Royal Institution.

TWO series of Faraday's electrical experiments were described in some detail: first, those on the induction of electric currents, leading up to the recognition, the real 'discovery' of electro-magnetic induction, that the induced current was only obtained at 'make' and 'break' of the inducing voltaic circuit; followed by the induction of electric currents in a closed conducting circuit by mere approximation of a permanent magnet. The second set of experiments were electrostatic, and culminated in the famous one in which he constructed a great 12-ft. cube, and by standing inside it with an electroscope proved that an electric charge resides on the outside of a conductor, or rather, as he saw it, exists as a state of tension in the medium which surrounds it. Sir William concluded his talk with a brief but most interesting reference to Faraday's religious life. He belonged to a small and little-known sect, the Sandemanians, the tenets of which he held faithfully throughout his life. Although it is a natural impulse to seek some connexion between his science and his religion, Faraday himself apparently regarded them as two separate and distinct things, and his reserve in religious matters was such that we are left with little upon which to base an opinion as to his personal attitude towards them.

IN his Friday evening discourse on Mar. 6 at the Royal Institution on "Ozone in the Upper Atmosphere and its Relation to Meteorology", Dr. G. M. B.

Dobson described the chief results which have been obtained from researches on the ozone in the upper atmosphere carried out in many parts of the world during the last five years. The methods were described whereby the amount of ozone can now be accurately measured with ease in a few minutes. The ozone, which is situated at a height of some 50 km. above sea-level, has a well-marked annual variation which is different in different parts of the world. At all places outside the tropics, there is a maximum in the spring and a minimum in the autumn, the range being greatest in high latitudes and least in low latitudes. In temperate regions there are also large changes from day to day which are closely related to the weather conditions, cyclones and anti-cyclones each having their own characteristic distribution of ozone. It is not at present understood how this relation is caused, since the ozone is much higher in the atmosphere than most of the processes affecting the weather. Neither is it known at present with certainty how the ozone is formed. The ozone in the upper atmosphere is responsible for shielding the earth from intense ultra-violet radiation from the sun, which would cause serious effects if it reached the surface. It further causes the upper atmosphere at a height of 40–50 km. to be at a temperature in the neighbourhood of the normal boiling-point of water. This, in its turn, gives rise to the zones of abnormal audibility of sound from large explosions at a distance of some hundred miles from the explosion itself.

THE British Optical Instruments Manufacturers' Association has issued an attractive booklet as a souvenir of the exhibit at the recent British Industries Fair. It gives a summary of some of the outstanding advances in optical instruments since the War, and includes an interesting section illustrating the multifarious uses of scientific instruments in various industrial operations. The industry is entitled to take a real pride in many of these recent achievements, and although no names are mentioned in the booklet, we find well-deserved references to the instruments and especially the interferometers of Messrs. Adam Hilger, Ltd., the $f/2$ anastigmat lenses of Messrs. Taylor, Taylor and Hobson, Ltd., the fine-adjustment mechanisms for the ultra-violet microscopes of Messrs. R. and J. Beck, Ltd., the wide-angle binoculars of Messrs. Ross, Ltd., and productions of other firms too numerous to mention here. It is certainly true to say that such advances have only been made possible by the most strenuous of efforts. As the president of the Association said in 1925, in reference to the post-War slump, "Then came the time of readjustment, of a dearth of orders that bordered on starvation; but the trade drew the belt tighter and tighter, hung on, and responded to that severe stimulus by an effort of experiment and development which is without precedent in its history". This effort still continues, and if, as we understand, it is now resulting in a rising level of activity and prosperity in the industry, then success will be well deserved.

THE optical trade has certainly enjoyed a measure of protection, but the opportunity has been taken to strengthen the foundations of scientific control; the activities of the British Scientific Instruments Research Association, the National Physical Laboratory, the Technical Optics Department at the Imperial College of Science and Technology, and the Optical Society have created an entirely new atmosphere in which progress is appreciated at its true value. The achievements are mainly, however, brilliant individual performances; unfortunately perhaps, the kind of competition that must be faced is a very large co-operation of brains, capital, and labour organised on a big scale. With the utmost pride in British firms and their unbeaten products, we must not forget the fact that big things are being done elsewhere. Planetariums, stereo-planigraphs, and the like, are no mere rumours. Even if sometimes these 'big noises' are more useful as advertisements than as commercial ventures, the trade cannot afford to forget the advertising power of spectacular things, or that two designers of experience, working whole-heartedly together, will usually achieve something much better than is possible to either working alone.

IT is announced in *Chemistry and Industry* for Feb. 20 that the International Atomic Weights Commission will meet for the first time since the War. In the issue of Jan. 30 it is stated that the Federal Council for Chemistry, in view of the progress made in ensuring the truly international character of the Union Internationale de Chimie, has decided to dissolve the existing committees on the chemical elements and to appoint a new international committee. This is to consist of G. P. Baxter (United States), O. Hönigschmid (Munich), P. Lebeau (Paris), R. J. Meyer (Berlin), and Mme. Curie. Prof. G. Urbain has been elected honorary president of the committee. The committee is charged with the duty of preparing an annual international table of atomic weights. New committees on isotopes and radioactive elements are in course of formation. A letter from Dr. F. W. Aston, which appeared in NATURE for Dec. 20, 1930, is of interest in this connexion. The 'unit' of atomic weights has for some time been oxygen (16), originally introduced because the values of Stas were based more or less directly on this standard. Very few of the newer values have, as a matter of fact, been referable directly to oxygen, and Dr. Aston has now directed attention to the further difficulty introduced by the recent discovery that oxygen is not a simple element but a mixture of isotopes. The use of a mixed element as the standard of atomic weights would seem undesirable.

BARON GIAN ALBERTO BLANC, professor of geochemistry in the University of Rome, has, during the past twelve years, successfully attacked the problem of extracting alumina and potash salts from leucite, a mineral consisting of a silicate of alumina and potash which exists in very considerable amounts in the volcanic rocks of central Italy and hitherto considered worthless. In the course of a public lecture before the Institution of Chemical Engineers at the Institution of Civil Engineers on Mar. 5, Baron Blanc said that the first problem with which he was confronted was to find a practical means of separating

the alumina and the potash from the silica. This was solved by a new method of attack of the silicate by acids, which allowed an easy and complete elimination of the colloidal silica from the solution. Some years ago, Prof. J. W. Hinchley directed the attention of the English technical world to this process, and it is at present used in England by Peter Spence and Sons for the manufacture of alum by the treatment of leucite with sulphuric acid. The problem of separating the salts obtained by the acid treatment, so as to produce the potash as a fertiliser and the alumina for metallurgical and chemical work, was then attacked. Finally, by thermal decomposition of the aluminium salt, a new type of chemically active aluminium oxide was obtained, which has proved much more suitable for the production of aluminium than the aluminium oxide obtained through calcination of the hydrate. One of the characteristic features of the Blanc process is that it requires only a very limited amount of fuel. A large plant for the treatment of one hundred metric tons of leucite per day is now being completed at Aurelia, near Rome, and will soon be working. The supply of leucite of which Italy can dispose is calculated in milliards of tons.

AT the close of the annual corporate meeting of the Institution of Chemical Engineers held on Mar. 6, the retiring president, Mr. Arthur J. Reavell, opened a discussion on the education and training of the chemical engineer. After referring to the pamphlet on this subject issued by the Institution in 1925, he expressed great dissatisfaction with the present method by which a student is now usually trained in chemical engineering, by first taking a degree course in chemistry. The result is an ill-balanced course, very deficient in engineering training. He thinks that engineering is the most important subject and should be taken first. A well-balanced training would consist of two years' work with the engineering, physics, and chemistry students, utilising the existing organisations in these subjects, followed by two years' work in the chemical engineering laboratories, and the final attainment of a degree in that subject. Such laboratories, however, should have far more comprehensive equipment than they have at present.

SIR FREDERIC NATHAN explained that the pamphlet on the "Training of the Chemical Engineer" published by the Institution in 1925 was produced by the assistance and approval of industrialists throughout Great Britain. Since that time, two schools in London—a third has just been started—have been giving instruction on the lines of this pamphlet. There is no difficulty in obtaining employment for such men, but Sir Frederic believes that students should be entered for chemical engineering right from the beginning of their university training. Sir Robert Robertson did not agree with Mr. Reavell: he thinks that the training should be essentially one of chemistry, to be followed by a 'top dressing' of engineering and chemical engineering; and he was supported by Mr. McKillop (British Dyestuffs Corporation). Mr. Heron Rogers is of opinion that a student of good calibre can be trained to be both a good chemist and a good engineer, and become an expert in these subjects and also in chemical engineering. After Mr. Rintoul had emphasised the fact that a university cannot produce chemical engineers, but that works training is essential, Dr. Dunstan (Anglo-Persian Oil Co.) explained how his company is training and utilising university graduates as chemical engineers. Mr. C. S. Garland (Steatite Products, Ltd.) emphasised the measure of agreement among the speakers with a demand for a special branch of university training so that the student may enter as a chemical engineering student and take a well-balanced course involving all those subjects necessary to the profession of a chemical engineer. The discussion was closed by Mr. Tizard, who pointed out that the problem is a special case of the adaptation of university training to industry an d industry to university training. He sees no reason why chemical engineering should not be accorded a similar organisation at the universities as electrical engineering and mechanical engineering.

AT the fifty-third annual general meeting of the Institute of Chemistry, held on Mar. 2 at the Institute, Russell Square, the president, Dr. G. C. Clayton, presented the Meldola Medal to Dr. R. P. Linstead, of Imperial College of Science, and the Sir Edward Frankland Medal and Prize, for registered students, to Mr. G. Broughton, of the Royal Technical College, Salford. In submitting the report of the council, the president remarked on the increase in membership, which now comprises over 5850 fellows and associates. The financial position is also satisfactory. The legal and parliamentary committee has been more than unusually active, having dealt with such matters as chemical patents, service agreements for chemists, the Dyestuffs (Import Regulation) Act, the regulations dealing with methylated spirits, and a proposal to present a petition to H.M. the King in Council for a supplemental charter, in order to acquire for the fellows and associates the right to use the title 'Chartered Chemist'. The Council is of opinion that it is desirable that members of the Institute should acquire this title, in order to distinguish them from pharmaceutical chemists. The meeting considered the adoption of the petition for the supplemental charter, but, although on a division supported by a decided majority, it was referred to a postal vote.

AN experimental room has been set up at the London School of Hygiene and Tropical Medicine in which it is possible to reproduce by means of an air-conditioning plant varied climatic conditions and any temperature, humidity, or air movement which may occur in factories or mines. Experimental subjects rest or work under the conditions to be investigated, and by observation of the pulse, body temperature, skin temperature, loss of weight due to sweating, and expenditure of energy by measuring the air breathed and oxygen used, it is possible to study the effect of such air conditions on the human body. Formerly the carbon dioxide percentage in the air was regarded as the best index of good or bad ventilation, until Sir Leonard Hill proved conclusively that it is not the percentage of carbon dioxide in a badly ventilated room which causes the sensation of discomfort and stuffiness, but the physical properties

of the air and their influence on the temperature regulating mechanism of the body. Sir Leonard Hill's kata-thermometer assesses the cooling effect of these environmental factors in one measurement, namely, the rate of cooling, or cooling power. It has been shown that certain cooling powers are suitable for sedentary work, or light or heavy manual work, and thus, so far as possible, the ventilation and heating systems in buildings or factories or mines should ensure that these desirable cooling powers are maintained. Investigations in mines by Dr. H. M. Vernon, of the Industrial Health Research Board, show that working capacity declines and accidents increase in frequency if the cooling power of the environment is too low and throws too great a strain on the body.

THE Council of the British Association has resolved to nominate Sir Alfred Ewing, lately Principal and Vice-Chancellor of the University of Edinburgh, as president of the Association for the year 1932.

AT the annual corporate meeting of the Institution of Chemical Engineers held in London on Mar. 6, the Osborne Reynolds Medal (1930) was presented to the retiring president, Mr. Arthur J. Reavell, by Sir Alexander Gibb. The Moulton Medal (gold) was presented to Mr. A. T. King for his paper on the "Treatment of Suint Liquors". The Junior Moulton Medal (silver) was awarded to Mr. L. W. Blundell for his paper on the "Manufacture of Hydrogen Peroxide".

WE have received a copy of the *Engineer* Directory and Buyers' Guide for 1931, which, besides classified lists of engineering firms advertising in that journal, with their telephone numbers, telegraphic addresses and the codes used, contains a list of the technical headings used in the directory, with translations in French, German, Italian, and Spanish. A list is also given of the British Standard Specifications and Reports. The directory is published annually and is issued free of charge.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:—A lecturer in natural and agricultural sciences at Harrison College, Barbados—C.A., The Secretary, Board of Education, Whitehall, S.W.1. Scottish candidates to C.A., The Secretary, Scottish Education Department, Whitehall, S.W.1 (Mar. 30). A lecturer in geography at St. Gabriel's Training College, Camberwell—The Principal, St. Gabriel's Training College, Camberwell (Mar. 30). A superintendent of the Metallurgy Department of the National Physical Laboratory—The Director, National Physical Laboratory, Teddington (Mar. 31). A lecturer in geography at the University College of Swansea—The Registrar, University College, Singleton Park, Swansea (April 11). A professor of brewing in the University of Birmingham—The Secretary, The University, Birmingham (April 20). A lecturer in natural philosophy in the University of St. Andrews — The Secretary, University of St. Andrews, St. Andrews (April 22). An assistant lecturer in metallurgy at the County Technical College, Wednesbury—The Director of Education, County Education Offices, Stafford (April 23).

Our Astronomical Column.

The Elongation of Eros.—The *Daily Science News Bulletin* for Feb. 6 issued by Science Service, Washington, D.C., contains some details of the elongation of Eros; they are based on a telegram from Johannesburg, transmitted through the I.A.U. Bureau, Copenhagen, and on observations by Mr. Leon Campbell at Harvard. It is concluded that the long diameter of Eros is 25 to 29 miles, and the axis of rotation 8 to 10 miles. The long diameter must be in the equatorial plane, and the earth must have been in this plane at the time when the light-variation was at a maximum, about last December; the slight dissymmetry between the two maxima would be explained by difference of albedo of the opposite faces. The exact time of rotation of Eros is given as $5^h\ 16^m\ 12{\cdot}94^s$, but there are two maxima and two minima in this period. *Bulletin* 187 of Kwasan Observatory, Kyoto, gives $2^h\ 38^m\ 4{\cdot}546^s$ for the half period.

The observations at Johannesburg were made by Dr. W. H. van den Bos and Mr. W. S. Finsen, using the 26-inch refractor of the Union Observatory. The explanation of the light-variation by the departure of Eros from a spherical form is antecedently more probable than by the hypothesis of variable albedo of different portions of its surface; the variations of albedo would have to be extremely great to produce so marked a change of light.

The Variable Star with the Shortest Known Period.—*Bull.* No. 214 of the Astronomical Institute of the Netherlands contains an account of the discovery of this variable, the position of which for 1900 is R.A. $8^h\ 19^m\ 38^s$, S. Decl. 18° 44·9′. Mr. H. van Gent, of Leyden Observatory, who is now at the Union Observatory, Johannesburg, detected the light-variation by comparing two plates in the blink-microscope. Several earlier plates containing the star had been sent to Leyden and these have been examined by Mr. A. J. Wesselink and Prof. E. Hertzsprung. The period is 0·069746 days, or 100·4 minutes. A difficulty arises, since the magnitude is about 14 to 15, and an exposure of some thirty minutes is needed to show it clearly when near minimum; this is such a large fraction of the whole period that photography is unsuitable for obtaining the light-curve. Visual observations have now been made at Johannesburg. The light-curve is drawn as a simple sine curve, the light-range being one magnitude.

Photographic Photometry of the Magellanic Clouds.—*Bull. Astr. Soc. Netherlands*, vol. 6, No. 209, contains a study of the Magellanic Clouds by G. van Herk, of the Lembang Observatory. The method was that of extra-focal images, the size and blackness of the images being measured. The images of the cloud are compared with those of stars of known magnitude.

Diagrams are given, showing the isophotic lines in the two clouds. Each has an elongated nuclear region of greatest brightness not far from the centre. The large cloud has a second, less bright nucleus, not far within the northern border of the cloud. The isophotic lines embrace each nucleus with an approach to regularity, and an ill-defined ligament connects the two nuclear regions. The structure of the small cloud is much simpler and more regular.

The integrated light of the large cloud is found to be 1·2 mag., of the small cloud 2·8 mag. Hubble had found 0·5 mag. for the large cloud, and Paraskevopoulos 1·8 for the small.

Research Items.

Bushman Paintings in Eastern Cape Province.—Mr. John Hewitt and Father P. Stapleton, *S.J.*, in vol. 4 of the *Records of the Albany Museum*, Grahamstown, South Africa, describe paintings and artefacts discovered in rock-shelters near Cala. Rock paintings in this area are very numerous, but have never been described in detail. The locality of the present investigation is Tembuland, which is east of the Drakensberg and south of the Stormberg. At Rebels' Kloof a great number of implements were found and the rocks were covered with paintings, some of fine technique but in poor preservation. In one case there were some very remarkable human figures with attenuated limbs in white. Other paintings of apparently the same age showed carnivores, elands, etc. Another series of human and animal figures was entirely in black, including a well-drawn black elephant. A rock shelter on the other side of the river contained a fine series covering nine or ten yards, with excellent decorative effect. The biggest figure is an eland in dark red and white. Yellow and white paintings here seem to be the most recent. Two human figures in chocolate, and faint, may be older. Not far distant was a hunting group in white. The hunter is approaching a herd of reboks, mostly at rest, with a 'gargantuan stride'. High up on the krantz, and inaccessible, near beautiful elands, were two human figures, remarkable for the fact that they wear skin capes reaching to the knees, giving the figures quite a European appearance. The faces are white, broadly bordered with chocolate bands, which is also the colour of the legs. As regards the artefacts, the major stone industry belongs to a group included in the Smithfield cultures. The pottery of Rebels' Kloof shows two distinct industries.

Uterine Cycle in the Marsupial *Bettongia*.—The species examined by Prof. T. Thomson Flynn, *B. cuniculus*, is one of the 'rat-kangaroos' of Tasmania, and the investigation adds usefully to the known facts concerning the reproductive phenomena of the diprotodont marsupials (*Proc. Linn. Soc. N.S. Wales*, vol. 55, 1930, p. 506). The species has several breeding seasons in the year, and there may actually be an overlapping of the gestatory and lactatory periods. Only one young is born at a time; but there are four teats in the pouch, so that three are unoccupied at a time, a condition the reverse of that in another marsupial group where the young exceed the teats in number. Hill and O'Donoghue have pointed out that marsupials show a progressive reduction in the number of teats present in the pouch, but there is also a progressive reduction in the number of the young, and this reduction has reached its limit in cases such as the present where reduction in number of young has proceeded in advance of teat reduction. Pregnancy is unilateral, and in normal circumstances occurs alternately in each uterus; but when one uterus is pregnant the other enters into and remains in a state of pseudo-pregnancy, which persists until parturition. In view of the likelihood that the ancestral marsupial was a placental mammal, it is interesting to find that this specialised form has only a small allantois, with no allantoic placenta; but the nutrition, respiration, and elimination of waste products of the fœtus are efficiently carried out by a yolk-sac placenta.

Hydromedusæ in the North Sea and Channel.—Dr. P. L. Kramp, in "Hydromedusæ collected in the South-western Part of the North Sea and in the Eastern Part of the Channel in 1903–1914" (*Mémoires du Musée Royal d'Histoire Naturelle de Belgique*, No. 45, 1930), describes the Hydromedusæ from those parts of the North Sea and Channel which were allotted to Belgium as its share in the International Plankton Research. The region is limited to the east by a line from the mouth of the river Schelde to Lowestoft, and to the west by a curved line from Fécamp to Newhaven. Most of the material was collected during the quarterly cruises (February, May, August, and November) at a number of fixed stations, supplementary collections being made in other localities and in other seasons. The rough results have already been published in the *International Bulletin*, but, so far as the medusæ are concerned, only a small part of the material was submitted to specialists. Twenty-nine species are now recorded, one of which is new to science. Five sections are recognised in the area investigated: the first in the eastern part of the Channel, the third in the shallow water along the North Sea coasts of France and Belgium; the second, in the Straits of Dover, being a transition area between two and three; the fourth, the mid-water region in the North Sea between the coasts of France-Belgium and England, which is a mixture of indigenous forms and species from the Channel; and the fifth, the English coastal region from Dover to Lowestoft, which is like the fourth, but less prolific. Conclusions as to the influence of 'Channel water' on the presence of medusæ show that indigenous North Sea species are particularly abundant there when there is little Channel water, and those few medusæ which come from the Channel are almost wholly found in the North Sea sections when the 35 per mille isohaline has a particularly extensive distribution. The new species *Trissocoma brownei* is of special interest. It was first observed by E. T. Browne—in the Channel and at the south-west coast of Ireland—who realised that it was a new species. Dr. Kramp has now found it in fair abundance in his fourth section in two localities between Zeebrugge and Orford Ness, and placed it in the new genus *Trissocoma*, having its natural position between *Cosmetira* and *Mitrocoma*.

Respiration in Higher Plants.—The *Proceedings* of the Seventeenth Indian Science Congress (Calcutta: Asiatic Society of Bengal), held at Allahabad in 1930, contains the presidential address to the Botany Section delivered by Prof. P. Parija. This deals chiefly with the respiration of cherry laurel leaves in air, in nitrogen, and in mixtures of oxygen and nitrogen, and with the interpretation of the results. In partially starved leaves, the effect of nitrogen was to increase slightly the respiration rate, and then, on returning the leaves to air, a considerable increase in carbon dioxide production was observed, the so-called 'after-effect'. In nitrogen (or anærobic) respiration, two atoms of carbon are assumed to accumulate as intermediates to every carbon atom appearing as carbon dioxide. If, on admitting oxygen, all the intermediate substances were oxidised to carbon dioxide, the maximum increase of carbon dioxide production in the 'after-effect' should therefore be twice the nitrogen respiration, and this is, in fact, the case after long periods (48 hours) of respiration in nitrogen. After shorter periods of two to thirty hours in nitrogen, however, the 'after-effect' is only of the order of 1·1 times the respiration in nitrogen, and it is assumed, in agreement with other evidence, that the difference between the theoretical value of 2·0 and the value given is due to the oxidative building up of the remainder of the intermediates. Prolonged exposure to nitrogen is supposed to inactivate the mechanism which brings about the latter method of disposal. On exposing the leaves to different mixtures of oxygen and nitrogen, it is found that there is a minimum production of carbon dioxide when the

mixture contains 5 per cent of oxygen, and maxima in pure nitrogen and in 33 per cent of oxygen. The 'after-effect' is only observed when the proportion of oxygen is below 5 per cent, although an increase in carbon dioxide production of a different type is observed when the proportion of oxygen is greater than that in air.

Oxidation and Reduction in Bacteria.—The influence of various conditions on acetic acid formation by *B. pasteurianum* has been further studied by Hiroshi Tamiya and Kiyoshi Tanaka (*Acta Phytochimica*, **5**, 167), with special reference to the suggestion that quinone may replace oxygen as a hydrogen acceptor in this type of fermentation. They find that carbon monoxide is wholly without influence on the production of acid in the presence of quinone, but greatly reduces it in the presence of oxygen. Toluol also delays the fermentation in the presence of oxygen, but influences the reaction only slightly in the presence of quinone or methylene blue. In the acetic acid bacteria, the indophenol reaction for oxidase is also reduced by carbon monoxide and toluol, although the latter was found to have no effect on the action of a *Lactarius* extract. The explanation given is that the normal function of cytochrome is disturbed by quinone and toluol, and it is concluded that the results agree with the theory that cytochrome acts as a regulator of oxygen pressure in this type of oxygen fermentation, as well as in the oxygen respiration of other plants and animals. The same publication (p. 119) also contains results by these authors and Tatsutaro Hida on the reduction of methylene blue by acetic acid bacteria (as an intracellular enzyme), by liver extract (as a free dehydrase), and various chemical agents (pyruvic acid and aceto-acetic ester). In all cases light is found to accelerate the reduction, a photochemical activation of methylene blue molecules being postulated as the cause. Carbon monoxide has no influence on the purely chemical reduction nor on the action of liver extract, but it markedly retards the action of *B. pasteurianum*. Quinone slows down all three types of action.

Bituminous Sandstone, Vernal, Utah.—Appropriately named "Asphalt Ridge", there occurs a series of low discontinuous hogsbacks of bituminuous sandstone, south-west of Vernal, Utah, U.S.A., which have recently been the subject of investigation by Mr. E. M. Spieker (*U.S. Geo. Sur. Bull.* 822-C). Most of the sandstone is of the Eocene age, and analyses show that the bitumen content ranges from 8 to 15 per cent by weight. Mechanical analyses were conducted to determine the various grade-sizes and proportions of such grades present in the sand; the average of the results given shows that the rock is of medium grade. The density varies from 1·99 to 2·03. The specific gravity of the sand as extracted is about 2·63, slightly less than that of pure quartz. Porosities are also variable, between 29·5 and 38 per cent. Apparently some samples gave exceptionally high porosity values, 47 to 49 per cent: it is pointed out that the usual pore-space of an aggregate of identical spheres is 47·64 per cent, but on the whole the evidence does not suggest that this particular sandstone is composed of markedly rounded grains, so that these high values are not characteristic. It is gratifying to note that so much attention has been given to mechanical and textural composition of these rocks, as frequently these vital properties to impregnation are passed over sketchily in favour of fuller description of the bitumen. It is anticipated that mining of this bituminous sandstone can be carried back some 1½ miles from outcrop, and thus over the area it is possible to estimate resources of some 1,970,000,000 tons of impregnated rock. The sandstone has already been successfully used for street-paving in Vernal. It is hoped to use the bitumen as a source of motor fuel by hydrogenation processes, but it is not clear whether the rock lends itself to easy and cheap extraction, or by what method this will be accomplished on a commercial scale.

Red Rain in Victoria.—Mr. Frederick Chapman, Palæontologist of the Australian Commonwealth, has continued his observations on red rain in south-eastern Australia which he began in conjunction with H. J. Grayson in 1903. We are unable to print Mr. Chapman's communication in full, but his observations are summarised below. On the night of Dec. 31, 1927, after a strong northerly wind had carried thick clouds of dust over Victoria and blown the finer particles southward over Bass Strait, there were heavy but irregularly distributed falls of red rain. Mr. Chapman estimated the amount deposited in Balwyn, a suburb 8 miles east of Melbourne, at 51¾ tons per square mile: the Commonwealth Meteorologist, Mr. H. A. Hunt, estimated the deposit at Elsternwick at 24 tons per square mile. The red dust on this occasion was exceptionally sticky, as the innumerable diatoms—*Nitzschia* and *Cocconeis*—still contained their endochrome. The red stains on leaves and flowers in the gardens were retained for days and even weeks. The impressions on glass indicate that each raindrop was coated by a thin film of the dust. On Nov. 3, 1920, after a northerly gale, showers of red rain fell at 7 P.M. and after 9 P.M. The amount of the red sediment collected in a vessel in Mr. Chapman's garden indicated a fall of 64 tons to the square mile, or if it had been equally distributed over Victoria, a fall of nearly six million tons in that State. Both the minute reddish flakes of sediment and the diatoms and sponge spicules show that the material had been derived from the arid regions in the north-west of Victoria and in Central Australia.

Climatic Changes in East Africa.—In a recent lecture to the Royal Geographical Society, Dr. L. S. B. Leakey gave an account of the old lake terraces of the East African rift valley lakes of Nakuru, Elmenteita, and Naivasha. All these lakes would appear to date from the mid-Pleistocene period. Dr. Leakey claims to be able to trace the following sequence of events in Lake Nakuru: a high-level lake left a terrace at 775 feet above the present level; this fell to 250 feet, rose to 510 feet, and, lastly, fell until it dried up completely. Afterwards, in a wetter climate, the waters rose again to 375 feet and then fell, and desiccation again occurred. Comparable evidence is obtained from Lake Naivasha and elsewhere in East Africa. It shows two major pluvial periods, with oscillations, separated by a dry period, during which faulting and volcanic activity were noteworthy. The first and second of these pluvial periods Dr. Leakey calls respectively the Makalian and Nakuran periods, and these he correlates with the Bühl and sub-Atlantic wet phases of Europe.

The Gyromagnetic Effect.—The University of California has issued, as a pamphlet of 43 pages, Prof. S. J. Barnett's Research Lecture delivered before the University on "Gyromagnetic Phenomena". When a magnet rotates about its magnetic axis, the gyrostatic action of the electrons brings their planes of rotation towards that of rotation of the material of the magnet and the rotations in the same direction. This changes the magnetisation of the magnet, and Prof. Barnett used two methods of measuring the change. The first depended on the change of the magnetic induction through a coil surrounding the magnet and connected

to a magnetic flux meter; the second on the change of the magnetic field produced by the rotating magnet at a magnetometer needle in its vicinity. Both methods gave results which agree in showing that the electricity in motion in a magnetic molecule is negative, and that the gyromagnetic ratio is 1·04 m/e for iron and 1·05 m/e for permalloy, while the theory of the planetary atom predicts 2 m/e. Prof. Barnett concludes that the electron is a negatively charged sphere spinning about its axis without distortion, which would give the ratio m/e, and that such electrons constitute the chief part of the elementary magnet.

Raman Effect for Water.—An application of the Raman effect to the study of the composition of water and of its variation with temperature and other conditions is described by I. R. Rao in the February number of the *Proceedings of the Royal Society*. Mercury arc excitation was employed, and the rather broad band which appears with a shift corresponding to about 3μ examined with a microphotometer. The explanation offered of the temperature changes is that water consists of single, double, and triple molecules, and that the relative number of the single ones increases with temperature. Addition of at least the electrolytes which have been studied also appears to increase the proportion of single molecules, but in this case there is the complication of a new hydrate band superposed on the pre-existing water band. The explanations of the changes which have been proposed by Dr. Rao bear a certain resemblance to those which have been offered for the existence of anomalies in the specific heats of solutions of electrolytes, although no comparison of the two sets of phenomena is presented in this paper.

New Measurements of Cosmic Radiation.—Some very accurate measurements on the absorption of the cosmic radiation, made with an electroscope containing gas at a pressure of 30 atmospheres, are reported by R. A. Millikan and G. H. Cameron in the first February number of the *Physical Review*. Their older results have been made more exact for all thicknesses of absorbing material and have also been extended both towards harder and softer components. The conclusions drawn are much as before. It is concluded, on the basis of the Klein-Nishina formula, that there is *quantitative* evidence that the strongest and most easily absorbed cosmic ray band arises from the formation of helium out of hydrogen, and it is considered that there is also good *qualitative* evidence that the three more penetrating bands are due to formation from hydrogen of the oxygen, silicon, and iron groups of elements. Prof. Millikan and Dr. Cameron take the view that some of their results require a participation of the nucleus in the absorption process and refer to some work which has been done upon ordinary gamma radiation as supporting this. The point raised is naturally a very important one, as it would imply that the Klein-Nishina formula is only approximate, and has also been referred to by Dr. L. H. Gray in a paper in the February number of the *Proceedings of the Royal Society*. Dr. Gray states that he has experiments now in progress which are designed to reveal any evidence for emission of a secondary radiation from such nuclear interaction.

Scattering of X-Rays.—An important development n the technique for the examination of scattered X-rays is described in the *Physical Review* for Jan. 15, by J. W. M. DuMond and H. A. Kirkpatrick. Two of the main difficulties which arise consist in the exact definition of the angle of scattering, and in obtaining a quantity of scattered radiation which can be recorded by photography in a reasonable time. These have been, to a large extent, overcome by the adoption of a new form of multi-crystal spectrograph. Fifty small perfect crystals of calcite are mounted with Seeman wedges on an arc of a circle, and so arranged that they all reflect a standard line—in this case the $K\alpha$ doublet of molybdenum—to exactly the same point on a photographic film coinciding with an opposite arc of the same circle; the geometry of this arrangement is then such that all other wave-lengths and orders will be in focus on the same circle. The scattering body is set so that each crystal is protected by a pair of baffles from all radiation except that scattered from a small area, and the X-ray bulb, scatterer, and spectrograph arranged so that all the crystals receive only radiation scattered through a range of less than one degree about the mean angle of scattering. The troublesome background of general scattered radiation is almost entirely eliminated by the baffles, and the radiation which is scattered without change in wave-length appears with excellent definition. The radiation which has undergone the Compton change in wave-length is, however, definitely spread over a range of wave-lengths, the breadth of which increases with increase in angle of scattering. This lack of sharpness, although not in complete agreement with the results of earlier investigations, appears to be real, and is ascribed to the fact that the electrons responsible for the scattering have an initial motion in addition to the speed imparted to them in the scattering process.

Resolution of *dl*-Menthol.—Although the naturally occurring *l*-menthol is fairly readily obtained by the resolution of *dl*-menthol, the method does not yield *d*-menthol in quantity. Read and Grubb, in the January number of the *Journal of the Chemical Society*, show that a mixture of *l*-menthyl-*d*-camphor-10-sulphonate and the corresponding *d*-menthyl compound, easily obtained by the interaction of *dl*-menthol and *d*-camphor-10-sulphonyl chloride in quinoline, yields the first of these esters in a state of purity after four crystallisations. The odour of pure *d*-menthol is fainter than that of *l*-menthol. The crystallographic data for *d*-menthol, which can be obtained from ethyl acetate solution in very large, magnificent prisms, are given in the paper.

Numerical Solution of Differential Equations.—In an extensive memoir (*Bulletin* of the Academy of Sciences of the Ukraine, 1930-31, in the Ukraine language), E. Remes gives a comprehensive survey of previous work on the numerical solution of differential equations, and contributes some valuable new methods. The methods of Runge and of Adams (or, as the Russians say, Adams-Störmer) are of great practical value; but they have the defect that they do not indicate exact limits between which the error must lie. A method for the determination of such limits was given by Piaggio—but in a form unsuitable for practical application. Remes has now combined the advantages of both methods. The memoir has several worked examples, showing the application to single differential equations and also to systems of such equations. The work is complicated, but in cases where great accuracy is desirable, the results justify the labour involved. As an alternative to Adams's method, little-known formulæ, due to Steffensen-Stekloff, are given. (Mr. Remes and his colleagues at Kieff have sent to University College, Nottingham, a quantity of Russian work on the numerical solution of differential equations, including A. N. Kryloff's valuable book on this subject, together with manuscript translations or summaries in French or German. These may be borrowed for a short period by university librarians.)

Electrical Industry and Research.

SEVERAL notable developments have taken place in the research laboratories of the Metropolitan Vickers Electrical Co., Ltd., during the past year. The investigations on the 'creep' or deformation of metals under stress at high temperatures have led to definite results which are of importance in mechanical engineering. It has been proved that even at the lower stresses and temperatures of turbine practice steels cannot be regarded as permanently elastic materials. They are subject to gradual stretch or other permanent distortion. A quick method of testing steels has been developed in the laboratories, and they can now be placed in order of merit after a duration test of only a few days. 'Creep' tests as ordinarily applied may last for months. A particular sample was subjected to test for twelve months and was found to creep at the rate of one part in a hundred million per hour. For the next two months, however, after the year was completed, it only increased at a tenth of this rate. The limit of sensitivity of the apparatus has now been reached, but it is not yet possible to say definitely that creep has ceased. If we consider a turbine cylinder 100 inches in diameter and subject to a rate of increase of one part in a hundred million per hour over a period of ten years, its diameter would have increased by nearly one-tenth of an inch, and this increase would seriously limit the life of the turbine. Other useful mechanical researches are being made in the laboratory as to the effect of surface hardening on the fatigue resistance of gear-wheel teeth. The results obtained are of great use in designing the best driving gears for electric trams and locomotives.

Noise problems are being specially studied in the acoustics laboratory of the Metropolitan Vickers Electrical Co., Ltd. The results of this work have been applied in the design of several new sizes of silent type, direct current motors. These motors have proved specially useful for ship ventilation. Good progress has also been made in building alternating current motors that will run quietly.

In the high voltage laboratory a comprehensive research has been made on various kinds of dielectric material when subjected to different kinds of stresses, namely, ordinary alternating voltages up to a million volts at low frequencies, impulsive voltages, high frequency voltages, and steady unidirectional voltages. By means of a new cathode ray oscillograph, impulse rushes having definite characteristics can now be applied to the materials. The results obtained in this way will be of use in protecting transmission lines and connected apparatus against abnormal voltage rushes. These are produced by the steep-fronted surges which sometimes arise in the lines and are due either to switching operations or to lightning discharges in the neighbourhood of the line. These rushes of electricity are specially serious when they cause resonance effects in the circuit owing to capacitance and inductance. An ordinary oscillograph would be useless for studying these phenomena, which last only a few millionths of a second. The new cathode ray apparatus developed in the laboratory during two years' research is now in everyday use in conjunction with the million-volt lightning generator. The rapidity of the response of the oscillograph depends on the great speed of the electron beam, the complete response only taking the two hundred millionth part of a second. A reasonable deflection can be obtained with only a few hundred volts.

Equally interesting developments in the work of the General Electric Company are recorded in the February issue of the *G.E.C. Journal*. Progress in research and technical development is largely independent of trade cycles. In a progressive country, the fact that business conditions may be difficult acts more as a stimulant than as a deterrent to scientific advancement. Although there has been no epoch-making discovery during the last year, yet the total progress made by the G.E.C. compares very favourably even with years containing spectacular achievements.

Advances have been made in electric discharge tubes for lighting purposes. Neon tubes need no replenishing, as this gas does not disappear appreciably even after running for thousands of hours. When pure it gives an orange red colour, but the introduction of a small quantity of mercury makes it a brilliant blue. By tinting the glasses and using various mixtures, several new colours have now been introduced. A few months ago the 'ripple' type of discharge was discovered. The luminous glow in ripple lamps only fills a fraction of the diameter and forms a luminous cord which, instead of remaining stationary along the axis of the lamp, wavers about with a strange but attractive sinuous motion. The discharge tubes require high voltages but take very little current. A low voltage tube has been invented which operates on low voltages but takes a large current.

Improvements have been made in the manufacture of the loading coils used for long telephone cables. The cores of these coils are made of a new alloy called 'gecalloy'. The manufacture of this alloy involves new methods of making a nickel iron alloy powder. Special precautions are necessary to insulate the particles so as to prevent eddy currents. By insulating and compressing the iron dust, cores with a permeability lying between 20 and 35 have been obtained. One great advantage of these new coils is their small size, as hundreds of coils may need to be installed in a small manhole.

A productive research has been made by the G.E.C. Research Laboratories on photo-cells, as there is a considerable demand for them by the sound film industries. A valuable device has been perfected, and is now produced in bulk, for the protection of railway substations from voltage rises. It depends for its action on the operation of a neon valve of high current capacity which becomes a conductor at 160 volts. It is capable of carrying 3000 amperes for three minutes without undue heating.

It is interesting to read that two Diesel-electric locomotives were shipped for the Indian State Railways during the past year, and that much development work has been done in connexion with omnibuses operated from overhead trolley wires. The most important work was done in connexion with the Manchester-Altrincham line electrification. This is the first suburban electric railway in Great Britain to be operated at 1500 volts on the direct current system. The trial runs have been entirely satisfactory. The electric heating of the coaches from a 1500-volt supply proved to be a difficult problem, as the operation had to be 'mistake proof'.

The requirements of the artificial silk industry have led to the production of a motor for driving spinning bowls at 10,000 revolutions per minute. This gives a peripheral speed of $3\frac{1}{2}$ miles per minute. Enormous lamps, some of them taking 10,000 watts, have been sold to British and Continental cinema studios. Very satisfactory progress has been made in the manufacture of oil filled underground cables. Three-core cables, oil filled, can now be made for 66 kilovolt working.

In the article on the mass production of incandescent electric lamps at the G.E.C. factory at North

Wembley, a spirited defence is made of mass production. The chief complaint about this method is that the products lack individuality, and hence the inference is sometimes erroneously drawn that they are 'inferior'. From the economic and from nearly every other point of view, mass production is the best. Unfortunately, there seems little prospect of voltage standardisation—even in Great Britain seven voltages lying between 200 and 260 are in use—and there seems no hope of world agreement. Although great efforts have been made to standardise the diffusing 'pearl' finish for the bulbs, many users cling obstinately to the time-honoured glare of the unshaded bulb. The factory produces no less than 84 different types of product. This large number is made necessary by the lack of standardisation in the country.

Biological Oxidation.

ON Mar. 6, Prof. H. Wieland gave the second Pedler Lecture before the Chemical Society, his subject being "Recent Researches on Biological Oxidation". Attempts have been made, he said, to formulate the vital process of combustion according to a single scheme. A 'respiratory ferment' catalysing the process is considered by Warburg to be related to hæmin, and Liebig put forward the hypothesis that iron accelerates vital oxidations. If we adopt this view, we are faced with the difficulty of understanding why the activated oxygen does not indiscriminately oxidise every substance which the cell presents to it. Yet if the process of biological hydrolysis is not carried out by any single ferment system, each kind of substrate being split by its own specific enzyme, it is unlikely that a single catalyst will suffice for the much more complicated process of the oxidative destruction of organic molecules.

No fundamental difference is encountered in the nature of enzymes throughout the vast range of living organisms, ascending from unicellular fungi to man; yet we lack the means with which to accomplish the complete degradation, by dead material, of a substrate familiar to the cell. Hence it would appear that the available enzymatic activity of respiration is closely connected with that regulating principle which, for want of more exact knowledge, we can but describe by a circumlocution called life. Since the higher we go up the phylogenetic scale the more delicate and complex becomes the nature of biological oxidation, a preliminary study should be concerned with the aerobic fungi.

Prof. Wieland discussed the mechanism of the acetic acid fermentation, characterising the transformation as a dehydrogenation process, since quinone or methylene blue may replace the oxygen. The aerobic process is inhibited by quinone as well as by hydrocyanic acid, the difference being that only the former participates in the enzymic reaction. The intermediate formation of hydrogen peroxide as a primary product of biological oxidation is not easy of demonstration, on account of the presence of catalases which cannot, as a rule, be separated from the dehydrases and are also sensitive to hydrocyanic acid. The study of milk, however, affords such an opportunity. Prof. Wieland said that the observation of reducing action in the cell does not necessitate postulation of the existence of special reducing ferments, for reduction products would be formed by the intervention of various hydrogen acceptors in the process of dehydrogenation. The enzyme reactions of milk have also contributed to an understanding of catalase action, which appears to be biologically related to the utilisation of oxygen by the cell. The two dehydrogenating ferments of milk are clearly of general biological importance, since they have been found also in the liver and other organs.

A third enzyme system, found in muscle, is concerned chiefly with the dehydrogenation of succinic to fumaric acid, and both oxygen and methylene blue act as acceptors of the hydrogen. This reaction can be followed further biologically to the pyruvic acid stage, and probably even beyond this. Pyruvic acid, as a product of the dehydrogenation of lactic acid, is on the main line of biological degradation. If we accept enzymic reactions involving hydrogen peroxide, with hydrolysis and condensation, as conditions governing cellular metabolism, we facilitate an understanding of the energy changes which constitute the life of the cell.

Discussing the correlative oxidation and reduction of aldehydes, Prof. Wieland referred to the aldehydrase, which was first described as a reducing enzyme in milk, was later also recognised as an oxidase, and is moreover able to dismute aldehydes into acid and alcohol. Although the theory that a heavy metal—more particularly iron—takes part in biological oxidations has acquired a certain measure of probability, the recognition of iron as a constituent of oxidising enzymes in no way implies that it functions as an oxygen activator. Ferrous iron rather associates itself with the substrate of the oxidation, forming a complex in which the hydrogen atoms to be removed in the dehydrogenation process become labile. A clear understanding of the complex course of biological oxidation has, however, not yet been obtained. We must advance step by step by the study of such chemically intelligible partial reactions as can be followed accurately.

Plantation Rubber Research.

THE Annual Report of the Rubber Research Institute of Malaya for 1929 covers the third completed year of active operation, as although the Institute came into existence on Sept. 1, 1925, its activities can only be said to date from the appointment of a director in September 1926. The revenue of the Institute is nominally provided by the Governments of the Straits Settlements, Federated Malay States, Johore, Kedah, Kelantan, and Trengganau from a cess on exported rubber, but with the exception of the last, the cess has not been levied, equivalent payments out of revenue having been made. Since July 27, 1929, Major B. J. Eaton has acted as director, an appointment which has recently been confirmed: and changes in personnel and shortage of staff hindered the work of the Institute in several directions during the year, notably in the advisory work on behalf of estates. A considerable proportion of this advisory work on problems such as manuring, budding, and seed selection, replanting and rejuvenation of rubber areas, is essentially applied research, and useful and valuable results are anticipated. Such practical work may indeed require to precede the slower process of scientific development, and the film propaganda among small-holders, for which a motor van and apparatus have been approved, should materially help in the development of better conditions on small-holdings.

An important division of the Institute is concerned

with soil investigations. Our knowledge of and methods of soil investigation are, however, not sufficiently advanced, particularly in connexion with permanent crops such as rubber, to enable recommendations to be made in many cases from the results of a soil analysis alone. Short and rapid methods of analysis are being investigated, and valuable information is being obtained as to probable soil deficiencies, particularly in nitrogen and potash, from field observations. The problem is specially important in relation to the manuring or rejuvenation of very poor areas of rubber. Other work in the same division is concerned with soil conservation and bacteriology, and studies of the relation of soil fungi and bacteria to the soil humus and of the value of leguminous and green cover crops to soil bacteria have been commenced.

The botanical division has reported considerable progress in such practical problems as budding, and investigations on the artificial pollination of flowers (from various classes on Pilmoor estate) and on seed selection have continued. No new diseases of importance are reported, but the pathological division directs attention to the urgent need for a thorough investigation of the relative value of well-known fungicidal chemicals compared with proprietary fungicides. Many of the latter are equally effective, and their use is determined chiefly by relative cost. A determination not only of the fungicidal properties but also of their penetrative effect on the parts of the plant treated is required. Differences in penetrative power affect the toxicity, and this is specially important in regard to bark renewal on the tapping panel. The problem of 'mouldy rot' caused by the fungus *Sphæronema fimbriatum* is one of special interest in regard to fungicidal treatment, which is also important in the case of secondary leaf fall due to the mildew fungus *Oidium Heveæ*, owing to the danger of the fungus becoming more adapted to the host.

Investigations at the Institute have thrown new light on the origin and incidence of 'brown bast'. Chemical and bacteriological investigations of the production of white sole crepe—the demand for which is regarded as retrograde—the preservation of latex, effects of moulds on rubber, and on various factory problems are reported; while considerable progress has been made on the experimental station, 905 acres out of the approximately 2000 acres having now been opened: 571½ acres of this have been planted and preliminary records of value should be available during 1930. The value of treating young rubber with cattle manure on a particular type of soil has already been demonstrated.

University and Educational Intelligence.

CAMBRIDGE.—The Appointments Committee of the Faculty of Physics and Chemistry has appointed Mr. P. M. S. Blackett, King's College, to be University lecturer in physics; Dr. P. J. Durrant, of Selwyn College, and Dr. F. P. Bowden, of Gonville and Caius College, to be University demonstrators in chemistry.

The General Board has recommended that a readership and a University demonstratorship in geophysics be established in the Faculty of Mathematics, and that Dr. H. Jeffreys, of St. John's College, be appointed reader.

Dr. J. Wishart has been appointed University lecturer in statistics in succession to Mr. G. Udny Yule, who has been appointed reader in statistics.

The Sedgwick Prize for 1931, for an essay on geology, has been awarded to Dr. C. E. Tilley, of Emmanuel College.

LONDON.—The following doctorates have been awarded: *D.Sc. in Chemistry* to Mr. A. M. Ward, Birkbeck College, for a thesis entitled "Investigations on the Bivalency of Carbon", consisting of four published papers (*Jour. Chem. Soc.*, 1927, 1929, 1930); *D.Sc. in Physics* to Mr. S. H. Piper, King's College, for a thesis entitled "X-ray Studies of Long-chain Compounds", comprising three published papers (*Jour. Chem. Soc.*, 1929; *Trans. Far. Soc.*, 1929; and *Proc. Roy. Soc.*, A, 1930); *D.Sc. in Entomology* to Mr. W. J. Hall, Imperial College—Royal College of Science, for a thesis entitled "The South African Citrus Thrips in Southern Rhodesia" and "Observations on the Coccidæ of Southern Rhodesia", parts 1-3, and eight subsidiary contributions; *D.Sc. in Geology* to Dr. A. Brammall for a thesis entitled "Gold and Silver in the Dartmoor Granite" (*Min. Mag.*, vol. 21, 1926), "The Dartmoor Granite" (*Proc. Geol. Assoc.*, vol. 27, 1926), "Dartmoor Detritals—A Study in Provenance" (*Proc. Geol. Assoc.*, vol. 39, 1928), "Notes on Fissure-Phenomena and Lode-Trend on Dartmoor" (*Trans. Roy. Geol. Soc. of Cornwall*, vol. 16, 1928), and eight subsidiary contributions.

DURING the seventh year of the Ella Sachs Plotz Foundation for the advancement of scientific investigation, seventy-eight applications for grants were received by the trustees, sixty-two of which came from twelve different countries in Europe and Asia, the remaining sixteen coming from the United States. The total number of grants made during this year was twenty-five, one of these being a continued annual grant. Twenty-one of the new grants were made to scientific workers in countries outside the United States. In the seven years of its existence, the Foundation has made one hundred and twenty grants and investigators have been aided in the United States, Great Britain, France, Germany, Austria, Hungary, Switzerland, Italy, Sweden, Esthonia, Czechoslovakia, Poland, Chile, Syria, and Belgium. Applications for grants to be held during the year 1931–32, to be sent to Dr. Joseph C. Aub, Collis P. Huntington Memorial Hospital, 695 Huntington Avenue, Boston, Massachusetts, should be in the hands of the Executive Committee before May 1, 1931.

THE Carnegie Trust for the Universities of Scotland has allocated, as grants for the quinquennium ending September 1935 for universities and extra-mural institutions respectively, £224,700 and £34,325. Since the Trust's operations began, in 1902, the total grants have been distributed as follows: for libraries, £159,850; buildings and permanent equipment, £905,101; endowment of chairs, lectureships, and pension schemes, etc., £437,701; other purposes, £143,730. A noticeable feature of the last quinquennial allocation is the assistance towards such student purposes as residential halls, students' unions, and playing fields, which have always specially appealed to the Trust. Assistance to students in payment of class fees for 1929–30, accounting for nearly half of the Trust's expenditure, amounted to £56,316, distributed among 4531 beneficiaries. Voluntary repayments by 54 former beneficiaries (21 men and 33 women) amounted during the same year to £2036. Apart from the quinquennial grants scheme and assistance to students, the Trust spent last year on fellowships, scholarships, and other grants for the endowment of research, £19,516. Under its research scheme the Trust recently instituted senior scholarships, of the annual value of £200, to provide, in particular, for the Ph.D. candidate, who must generally be engaged for three years at post-graduate work before he presents his thesis for that degree.

Birthdays and Research Centres.

Mar. 15.—Prof. C. V. BOYS, F.R.S., past president of the Physical Society of London.

In NATURE of July 13, 1929, p. 54, I gave a diagram of a more powerful camera for observing the progressive movement of lightning. Since then I have had one of these cameras made by Messrs. Ross, Ltd. I have not been able to try this on real lightning, but last spring Mr. Goodlet, late of the Metropolitan-Vickers Electrical Co., Ltd., allowed me to photograph their high tension sparks. I never expected that I should be able to observe any 'progress' in this artificial lightning five feet long only, but running the film at approximately 100 miles an hour I obtained sharp rather over-exposed images. With Tesla sparks the photographs show perfectly sharp but very pale images of extraordinary tenuity. The real object of the experiment was to prove the satisfactory running of the instrument and its optical perfection. In these respects it could not be improved upon. I sent this to Mr. Loomis, and he and Prof. R. W. Wood have had it for the greater part of one summer, but they have so far not succeeded in catching anything. However, I succeeded in obtaining a photograph during the great storm on Aug. 29 last with my original camera, but only when the lightning was too close. Moreover, the two flashes caught were very much to one side and the nearer one had the greater part of one image off the plate altogether. The other pair of images gives some stereoscopic indication of progress, but it must be remembered that the longer the image on the plate the less conspicuous will this be. For this reason it is desirable that lightning should not be nearer than five or six miles. The short focus lenses in the new camera and the higher speed attainable make this instrument ten or more times as powerful as the original camera which I made in 1900. As I had to wait twenty-eight years before obtaining my first picture, which was taken in America (see NATURE, Nov. 20, 1926, p. 749), and got only a useless one last year, it would seem desirable that more than one of the new cameras should be available in suitable observatories; for information as to the progress of a lightning flash can be obtained in no other way, and any information so obtained is unassailable.

Mar. 17, 1876.—Dr. F. J. W. WHIPPLE, superintendent of Kew Observatory.

The principal subject of investigation at Kew Observatory at present is the circulation of atmospheric electricity. In fine weather, there is a continuous, though small, current of positive electricity from the air to the ground; in disturbed weather, currents in the reverse direction are the more frequent. There is much to learn about these currents and their relation to other atmospheric conditions, such as potential gradient, dust content, ionisation, conductivity, and radioactivity.

My own attention has recently been given to questions raised by the observations of the propagation of air-waves to great distances, and especially by the numerous observations which have been made during the last four years of the air-waves from gunfire. It is hoped to obtain from such observations reliable information as to the variations in the temperature of the atmosphere at heights of 40 km. and upwards, where the absorption of ultra-violet light by ozone heats up the air.

Mar. 19, 1871.—Prof. WILLIAM ARTHUR BONE, F.R.S., professor of chemical technology in the Imperial College of Science and Technology.

At present I am working on: (1) The chemical constitution of coals, as a problem in organic chemistry, with the object of ascertaining the essential molecular structure of the coal substance, its relation to the lignins, etc., from which it originated, the chemical aspects of its maturing, and the development of the coking propensities of bituminous coal. (2) Gaseous combustion and explosions, more particularly: (*a*) the slow combustion of hydrocarbons; (*b*) the function of steam in the combustion of carbonic oxide; (*c*) the photographic analysis of 'detonation' in gaseous explosions; and (*d*) gaseous explosions at very high initial pressures, for example, between 500 and 1000 atoms. (3) Catalytic gas reactions at high pressures. (4) The chemical reactions involved in the blast furnace smelting of iron ores, with the view of providing a fundamental basis for fuel economy and control in this operation.

I believe that the proper function of university departments of applied science is to carry out systematic researches of a fundamental character into general problems underlying industrial practice, rather than investigations of particular works' problems, which can best be tackled by industrial research organisations.

Societies and Academies.

LONDON.

Royal Society, March 5.—**W. L. Garstang** and **C. N. Hinshelwood**: The kinetics of the combination of hydrogen and oxygen: the influence of iodine. The surface reaction in vessels of silica and porcelain is accelerated by iodine. The amounts of iodine required are small. The efficiency of collisions with iodine in breaking chains is, however, less than about 10^{-4}. Water vapour lowers the upper critical limit of the low pressure explosion region and, in sufficient amount, inhibits the explosion altogether. Commercial hydrogen appears to contain no inhibiting substances.—**D. R. Hartree**: Optical and equivalent paths in a stratified medium, treated from a wave standpoint. Wave treatment is essential for the interpretation of some of the phenomena of reflection from the Heaviside layer. Expressions for the optical and equivalent paths in terms of the solutions of the equations of wave propagation are obtained, both for normal and oblique incidence, and exact expressions are obtained for the optical path for normal incidence on stratified media with certain simple variations of refractive index. Approximate expressions are obtained for the optical and equivalent paths in a totally reflecting medium.—**H. J. Phelps**: The adsorption of substances by fuller's earth. The adsorption of weak solutions of various organic acids and bases has been studied; in particular, attention is directed to a study of the adsorption of such substances from solutions of various hydrogen-ion concentrations. The adsorption of the simple amines is molecular, or 'apolar', in solutions of reaction more alkaline than *p*H 9, while it is ionic, or 'polar', in solutions more acid than about *p*H 8. The adsorption of bases and also of oxalic acid falls to zero in solutions more acid than *p*H 3, due to the fact that the calcium salts in fuller's earth, the presence of which is essential for adsorption to take place, are soluble under these conditions.—**L. J. Mordell**: The arithmetically reduced indefinite quadratic form in n variables. A simple method is given for finding inequalities satisfied by the coefficients of a reduced indefinite form. When the coefficients are integers a simple proof is given that the class number for forms with given determinant is finite. A normal type is also found for the reduced forms.—**A. E. Moelwyn-Hughes** and **C. N. Hinshelwood**: The kinetics of reactions in solution (1, 2). The decom-

position of chlorine monoxide in carbon tetrachloride solution proceeds at the same rate, possesses the same heat of activation, and apparently takes place by the same mechanism as in the gaseous state. The retardation of bimolecular reactions by solvents thus appears to depend upon a specific influence of particular solvents, and need not occur in an 'ideal' solution. The aim of the experiments was to determine whether constancy of rate and heat of activation with change of solvent can be regarded as the usual characteristic of a unimolecular reaction. It is concluded that it is only true of certain 'ideal' solvents.—**F. R. Terroux**: The upper limit of energy in the spectrum of radium *E*. The velocities of the fastest β-rays from radium *E* were determined from the curvature of the tracks in a magnetic field and the distribution of the rays obtained in the region extending from 4000 to 10,000 $H\rho$. The complete spectrum of radium *E* was obtained by combining the present observations with previous work, and the resulting curve shows no trace of the hitherto accepted end point at about 5000 $H\rho$. The spectrum appears to tail off very gradually and to extend at least to 12,000 $H\rho$, which corresponds to an energy of 3,000,000 electron volts. The number of particles above 5000 $H\rho$ is about 4 per cent of the total number emitted. An energy distribution curve was obtained, and from this the average energy per disintegration is estimated at about 473,000 volts, with a probable error of 20 per cent, which is in fair agreement with the values obtained from heating measurements. It appears probable that the β-particles from radium *E* are emitted from the nuclei according to a simple distribution law which resembles the Maxwellian form, and that there is a finite probability for the emission of a particle with any velocity.—**K. R. Rao and J. S. Badami**: Investigations on the spectrum of selenium—(1). The spectrum of selenium has been investigated from λ7000 to λ650, mainly using different intensities of discharge through capillary tubes containing vapour of selenium. Between λ1400 and λ400, vacuum spark spectra have been taken with and without inductance. With the aid of these data the doublet system of trebly-ionised selenium has been identified. A few singlets and inter-combination lines in Se V have been added to the triplet system that was already known. The largest term, $4s\ {}^1S_0$, is found to be 589,781 cm.$^{-1}$, leading to an approximate ionisation potential of 72·8 volts.—**J. K. L. Macdonald**: Stark effect in molecular hydrogen in the range 4100-4770 A. Certain complex structures reported by Kinti are resolved into independent lines. Displacements of line components are measured and the observations are considered from a theoretical point of view. Certain groups of *P*- and *R*-branch lines with common initial levels are found to be adequately described, as regards number and polarisation of components, by a theory which is briefly discussed.—**T. Alty**: The reflection of vapour molecules at a liquid surface. The rate of evaporation from a water surface is measured as a function of the vapour pressure above the evaporating surface. By extrapolation to zero pressure the rate of evaporation into a vacuum is found. On comparing this experimental result with the formula of the kinetic theory of gases for the number of vapour molecules striking a water surface per second from the saturated vapour, it appears that only about 1 per cent of the molecules incident on the surface are able to enter the liquid.

PARIS.

Academy of Sciences, Jan. 19.—H. Douvillé: The eruptive rocks of the Pic de Rébenacq.—**André Blondel**: The improvement of the present system of electromagnetic units. If the units of E.M.F. and current are taken as 10 volts and 10 amperes and the power unit as the hectowatt, leaving the ohm and the farad unchanged, then such a system contains only 10^9 and 10^{-9} in all its elements. In the C.G.S. system the new prefixes 'nea' for 10^9 and 'cato' for 10^{-9} are suggested. The deficiencies of the present system of nomenclature are fully discussed.—**C. de la Vallée Poussin**: The conformal representation of multiply connexe plane areas.—**W. Vernadsky**: Isotopes and living organisms. A discussion of the possibility of living organisms possessing the property of separating isotopes, in the course of their life.—Richard Fosse was elected a member of the Section of Rural Economy in succession to the late A. Th. Schloesing, and Eugene Fabry *correspondant* for the Section of Geometry in succession to the late M. Riquier.—**A. Norden**: The inclusion of the metric and affine theories of surfaces in the geometry of specific systems.—**Rachevsky**: Congruences with several dimensions.—**G. Gourewitch**: The divisibility of trivectors and quadrivectors by a vector.—**Mlle. Marie Charpentier**: A certain class of Peano points.—**Basile Demtchenko**: A mixed problem in the ring.—**Raphael Salem**: The necessary and sufficient conditions that arbitrary constants a_n, b_n should be Fourier coefficients of a function capable of summation.—**Emile Belot**: The origin and formation of Pluto according to the dualist cosmogony.—**Gr. C. Moisil**: Wave mechanics of fields of waves.—**L. Brüninghaus**: The electrical conduction of liquid hydrocarbons in thin layers. A drop of fresh vaseline oil, inserted between two electrodes 11 μ apart, closes a 110-volt continuous circuit "as if it were a drop of mercury". This conducting state is abolished when the electrodes are 15 μ apart.—**J. M. Cork**: Change of wave-length of the X-rays traversing an absorbing medium (observed in the direction of transmission). An attempt to repeat some experiments recently described by B. B. Ray (NATURE, **125**, p. 856) has given only negative results, possibly due to the different screens employed.—**J. Dourgnon and P. Waguet**: Remarks on certain photometric properties of ground and grained glass.—**J. P. Mathieu**: A method of measuring circular dichroism.—**Jean Loiseleur and Léon Velluz**: The association of biochemical constituents and certain cellulose esters. Details of technique for preparing membranes containing cellulose acetate and casein or other proteins.—**A. Travers and J. Aubert**: The potential of passive iron. From the results of the experiments described, it is concluded that the term 'passive iron' has no absolute meaning; there are degrees of passivity. The film of oxide theory of passivation cannot apply in all cases, since the potential of iron immersed in different oxidising agents depends on the nature of the latter.—**André Michel and Pierre Benazet**: The reheating of rapidly tempered steels.—**P. Brauman**: The alkyl-oxyvanadylsalicylates of alkyls and aryls.—**Raymond Furon**: The geology of the Gabon (French Equatorial Africa).—**R. Bureau**: A recording radiogoniometer. Its application to atmospherics. Ranzi's neon lamp method has been modified to record not only the variations of the atmospherics but also their direction. Two diagrams are reproduced.—**Louis Dangeard**: The lower algæ in the Limagne limestone.—**Jules Amar**: Hydrodiffusion and deadly fogs.—**Pierre Lavialle**: The stamen in *Knautia arvensis*. The polymorphism of the flowers and flower heads.—**Emile Saillard**: The precipitation of lime by sulphurous acid in sugar solutions.—**Ph. Joyet-Lavergne**: The conditions of metabolism permitting the realisation of the change of sex.—**Georges Blanc and Jean Valtis**: The sensibility of *Spermophilus citillus* to experimental tuberculous infection.—**F. Dienert and P. Etrillard**: The sterilisation of water by metals.

Official Publications Received.

BRITISH.

The Proceedings and Transactions of the Nova Scotian Institute of Science, Halifax, Nova Scotia. Vol. 17, Part 4, Session 1929-1930. Pp. xxxiii-lvii+213-275+xvii. (Halifax, N.S.) 50 cents.

Indian Central Cotton Committee: Technological Laboratory. Technological Bulletin, Series B, No. 11: Random and Systematic Selections of Warp Specimens in Cloth Sampling. By Dr. A. James Turner. Pp. 21. (Bombay.) 8 annas.

Department of Scientific and Industrial Research. Building Science Abstracts. Vol. 3 (New Series), No. 12, December 1930. Abstracts Nos. 2183-2377. Pp. 411-531. (London: H.M. Stationery Office.) 9d. net.

Biological Reviews and Biological Proceedings of the Cambridge Philosophical Society. Edited by H. Munro Fox. Vol. 6, No. 1, January. Pp. 132. (Cambridge: At the University Press.) 12s. 6d. net.

Southern Whaling: Presidential Address delivered at the Anniversary Meeting of the Linnean Society of London on the 24th of May 1930. By Sir Sidney F. Harmer. Pp. 85-163. (London: Linnean Society.)

A List of International Fellowships for Research. (Pamphlet No. 4.) Pp. 223. (London: The International Federation of University Women.) 1s.

The Indian Forest Records. Botany Series, Vol. 16, Part 1: Illustrations of Indian Forest Plants. Part 2: Five Species of Dipterocarpus. By R. N. Parker. Pp. ii+16+10 plates. (Calcutta: Government of India Central Publication Branch.) 1 rupee; 1s. 9d.

The Hannah Dairy Research Institute. Bulletin No. 2: Reactors in Tuberculin-Tested (Licensed) Herds. By Alexander B. Fowler and Dr. Norman C. Wright. Pp. 51. (Auchincruive.)

Empire Cotton Growing Corporation. Report of the Executive Committee to be submitted to the Meeting of the Administrative Council on February 5th, 1931. Pp. 7. (London.)

FOREIGN.

Library of Congress. Report of the Librarian of Congress for the Fiscal Year ending June 30, 1930. Pp. vi+420+12 plates. (Washington, D.C.: Government Printing Office.)

Agricultural Experiment Station: Michigan State College of Agriculture and Applied Science. Special Bulletin No. 204: Investigations of Corn Borer Control at Monroe, Michigan. By A. R. Marston and C. B. Dibble. Pp. 47. Technical Bulletin No. 108: Influence of Soil Conditions, Fertilizer Treatments and Light Intensity on Growth, Chemical Composition and Enzymic Activities of Sugar Beets. By James Tyson. Pp. 44. (East Lansing, Mich.)

Mémoires du Musée Royal d'Histoire Naturelle de Belgique. Mémoire No. 43: Mollusques des couches à Cyrènes (paléocène du Limbourg). Par Dr. Émile Vincent. Pp. 43+8 planches. Mémoire No. 45: Hydromedusae collected in the South-Western Part of the North Sea and in the Eastern Part of the Channel in 1903-1914. By P. L. Kramp. Pp. 55. Mémoire No. 46: Études sur les mollusques Montiens du Poudingue et du Tuffeau de Ciply. Par Dr. Émile Vincent. Pp. 115+6 planches. (Bruxelles.)

United States Department of the Interior: Geological Survey. Bulletin 813-D: Notes on the Geology of Upper Nizina River, Alaska. By Fred H. Moffit. (Mineral Resources of Alaska, 1928.) Pp. ii+143-166+plate 3. 15 cents. Bulletin 817: Boundaries, Areas, Geographic Centers and Altitudes of the United States and the several States; with a Brief Record of Important Changes in their Territory and Government. By Edward M. Douglas. Second edition. Pp. vii+265+12 plates. 50 cents. Bulletin 821-A: A Graphic History of Metal Mining in Idaho. By Clyde P. Ross. (Contributions to Economic Geology, 1930, Part 2.) Pp. ii+9+3 plates. 10 cents. Bulletin 822-C: Bituminous Sandstone near Vernal, Utah. By E. M. Spieker. (Contributions to Economic Geology, 1930, Part 2.) Pp. ii+77-100+plates 7-9. 10 cents. Bulletin 824-A: Mineral Industry of Alaska in 1929, and Administrative Report. By Philip S. Smith. (Mineral Resources of Alaska, 1929.) Pp. ii+109. 20 cents. (Washington, D.C.: Government Printing Office.)

CATALOGUES.

A Catalogue of Important and Rare Books on Botany, Agriculture, Forestry, Fruit-Culture, Gardens and Gardening, Herbals, Early Medicine and Surgery, Tobacco, Original Water-Colour Drawings by Ehret and Van Huysum, and an Important Collection of Pamphlets. (No. 443.) Pp. 148. (London: Bernard Quaritch, Ltd.)

Useful Gardening Books. Pp. 8. List of Gardening and Botanical Books, including Materia Medica, Pharmacy, Perfumery and Scent, etc. (No. 183.) Pp. 20. (London: Dulau and Co., Ltd.)

Taylors Bee Supplies. Pp. 44. (Welwyn: E. H. Taylor, Ltd.)

Diary of Societies.

FRIDAY, MARCH 13.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Scottish District Meeting) (at City Chambers, Edinburgh), at 11.30 A.M.—W. B. Scott: The Proposed National Standard Practice for the Employment of Structural Steel in Building, as Delegated by the British Steel Work Association.

BIOCHEMICAL SOCIETY (Annual General Meeting) (at University College), at 3.—Prof. C. Lovatt Evans, Chiao Tsai, and F. G. Young: A Note on the Estimation of Liver Glycogen.—R. A. McCance and H. L. Shipp: The Colorimetric Determination of Sodium.—E. Stedman and Ellen Stedman: Studies on the Relationship between Chemical Constitution and Physiological Action. Part III. The Inhibitory Action of Certain Synthetic Urethanes on the Activity of Liver Esterase.—B. C. J. Knight: An Electrolytic Method for Poising the Oxidation-reduction Potential of Culture Media.—G. F. Marrian: Observations on the Physiological Potency of Crystalline Tri-hydroxy Œstrin.—Prof. T. P. Hilditch and J. J. Sleightholme: The Glyceride Structure of Butter Fats.—H. R. Ing and R. N. Kekwick: A Note on Acyl Derivatives of Creatine and Creatinine.—I. S. MacLean and M. S. B. Pearce: Oxidations of Oleic Acid *in vitro* and their Bearing on the Biological Oxidation of Oleic Acid.—C. Kimington and A. M. Stewart: A Pigment from the Suint (Sweat Fraction) of Raw Sheep's Wool.

ROYAL SOCIETY OF ARTS (Indian Meeting), at 4.30.—Dr. H. H. Mann: The Tea Industry of India in its Scientific Aspects.

ROYAL ASTRONOMICAL SOCIETY, at 5.—Sir A. S. Eddington: A Theorem concerning Incomplete Polytropes.—J. Young: Occultations of Stars by the Moon observed at Birmingham University during 1930.—T. Matukuma: Relativity Effect in the Problem of Latitude Variation.—J. Dufay: Effect of Atmospheric Absorption in Stellar Spectrophotometry.—J. H. Hindle: A New Test for Cassegrain and Gregorian Secondary Mirrors.—V. V. Narliker: The Significance of Bode's Law in Relation to Satellite Systems.—L. H. Thomas: The Slow Contraction and Expansion of a Fluid Sphere. II. Stability.—S. Chandrasekhar: The Dissociation Formula According to the Relativistic Statistics.—C. S. Beals: Wave Lengths of Oxygen and Nitrogen Lines in the Stellar Region.—Royal Observatory, Greenwich: Observations of Solar Flocculi, made with the Spectroheliroscope during 1930.—Dr. H. H. Plaskett: The Formation of the Magnesium *b* Lines in the Solar Atmosphere.—B. Strömgren: The Possible Solutions of the "Equations of Fit" on the Standard Model.—T. G. Cowling: Note on the Fitting of Polytrope Models in the Theory of Stellar Structure.—S. Chandrasekhar: The Highly Collapsed Configurations of a Stellar Mass.

ROYAL SOCIETY OF MEDICINE (Ophthalmology Section) (at Middlesex Hospital), at 5.—Clinical Meeting.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of Specimens illustrating the Anatomy, Physiology, and Pathology of the Œsophagus.

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

MALACOLOGICAL SOCIETY OF LONDON (at Linnean Society), at 6.—H. H. Bloomer: On the Anatomy of *Brazzœa* cf. *anceyi*, Bourguignat.—J. R. le B. Tomlin: Two New Species of *Rhiostoma*.—C. Oldham: Some Scalariform Examples of *Arianta arbustorum*.

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle upon-Tyne), at 6.—S. F. Dorey: Some Factors Influencing the Sizes of Crankshafts for Double-Acting Diesel Engines.

INSTITUTION OF ELECTRICAL ENGINEERS (London Students' Section), at 6.15.—C. J. F. Tweed: Aspects of the Transmission and Reception of Still Pictures.

INSTITUTE OF FUEL (North-Western Section) (at Engineers' Club, Manchester), at 7.—Dr. G. E. K. Blythe: The Industrial Application of Pulverised Fuel.

INSTITUTION OF LOCOMOTIVE ENGINEERS (Manchester Centre) (at Literary and Philosophical Society, Manchester), at 7.—Dr. E. G. Ritchie: Steam Storage in Relation to the Locomotive.

OIL AND COLOUR CHEMISTS' ASSOCIATION (Manchester Section) (at Milton Hall, Manchester), at 7.—Dr. F. A. Mason: Recent Lines of Advance in Lake and Pigment Chemistry.

JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—L. Clegg: Phenol Formaldehyde Moulding Compositions, Manufacture and Use.

SOCIETY OF CHEMICAL INDUSTRY (Chemical Engineering Group) (at Chemical Society), at 8.—W. J. Rees: The Manufacture of Lime.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—J. C. Squire: Parody.

SATURDAY, MARCH 14.

INTERNATIONAL SOCIETY OF LEATHER TRADES' CHEMISTS (British Section) (at University, Leeds), at 10 A.M.—R. F. Innes: Determination of Water in Vegetable Tanned Leather.—Dr. A. C. Russ: New and Improved Method of Moisture Determination and its Application to Leather.—Dr. D. Burton: Note on the Determination of Moisture in Leather.—H. G. Bennett and others: Discussion on Mineral Acids in Vegetable Leather.—Demonstration of a New Form of Tintometer, by Dr. J. G. Parker.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford: Recent Researches on the Alpha-Rays (2).

BRITISH PSYCHOLOGICAL SOCIETY (at Royal Anthropological Institute), at 3.30.—R. Sedgwick: A Brief Restatement of the Case for Psychological Hedonism and an Examination of some Fundamental Concepts in Affective Psychology.

MONDAY, MARCH 16.

VICTORIA INSTITUTE (at Central Buildings, Westminster), at 4.30.—Col. F. C. Molesworth: History of Practical Astronomy.

ROYAL GEOGRAPHICAL SOCIETY, at 5.—W. V. Lewis: The Effect of Wave-Incidence on the Configuration of a Coast.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—C. E. Shattock: Demonstration of Specimens illustrating Affections of the Kidney.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Section), at 6.45.—C. Day: Heavy Oil and Diesel Engines (Lecture).

SOCIETY OF CHEMICAL INDUSTRY (Edinburgh and East of Scotland Section) (Annual General Meeting) (at 36 York Place, Edinburgh), at 7.—Dr. H. Hepworth: Invention in Chemical Industry.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting), at 7.—Dr. A. Rosen and others: Discussion on Some Difficulties in A.C. Bridge Measurements.

INSTITUTION OF ELECTRICAL ENGINEERS (Mersey and North Wales (Liverpool) Centre) (at Liverpool University), at 7.

INSTITUTION OF ELECTRICAL ENGINEERS (Tees-Side Sub-Centre) (at Cleveland Technical Institute, Middlesbrough), at 7.—B. Leggett: The Medical and Surgical Applications of Electricity.

SHIPLEY TEXTILE SOCIETY (at Technical School, Shipley), at 7.30.—Prof. Barker: South Africa: its Sheep and Wool (Lecture).

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.—C. R. Peers: The Treatment of Old Buildings.

ROYAL SOCIETY OF ARTS, at 8.—Capt. A. G. D. West: The Recording and Reproducing of Sound (Cantor Lectures) (2).
EUGENICS SOCIETY (at 20 Grosvenor Gardens, S.W.1), at 8.15.—Study Circle.

TUESDAY, MARCH 17.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. M. Critchley: The Neurology of Old Age (Goulstonian Lectures) (3).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15—Dr. C. D. Darlington: The Cytological Theory of Heredity and Variation (2).
ROYAL SOCIETY OF MEDICINE, at 5.30.—General Meeting.
MINERALOGICAL SOCIETY, at 5.30.—A. J. P. Martin: On a New Method of Detecting Pyro-electricity.—Dr. D. R. Grantham and F. Oates: On the Mbosi Meteoric Iron, Tanganyika Territory.—Dr. S. R. Nockolds: On the Dhoon (Isle of Man) Granite: a Study of Contamination.—A. G. MacGregor: On Clouded Felspars as a Result of Thermal Metamorphism.—C. N. Fenner: On the Residual Liquids of Crystallising Magmas.
ZOOLOGICAL SOCIETY OF LONDON, at 5.30.—Dr. R. Broom: On the *Pygocephalus*-like Crustacean of the South African Dwyka.—Dr. P. R. Lowe: On the Anatomy of *Pseudocalyptomena* and the Occurrence of Broadbills (Eurylæmidæ) in Africa.—J. St. Leger: A Key to the Families and Genera of African Rodentia.—B. W. Tucker: (*a*) Note on a Skull of *Sus gargantea* Miller, in the Cambridge Museum; (*b*) On the Occurrence of *Rana græca* at Small Altitudes in the Naples District, with some Observations on Habits.
INSTITUTE OF METALS (Birmingham Section) (in Chamber of Commerce, Birmingham), at 7.—Dr. C. J. Smithells: The Metallurgy of Some of the Rarer Metals.
ROYAL SOCIETY OF MEDICINE (Pathological Section) (Annual General Meeting), at 8.

WEDNESDAY, MARCH 18.

GEOLOGICAL SOCIETY OF LONDON, at 5.30.—W. B. R. King: A Fossiliferous Limestone Associated with Ingletonian Beds at Horton-in-Ribblesdale, Yorkshire.—Prof. O. H. Schindewolf: On the Septal Development and the Genotype of the Coral Genus *Petraia* Münster.
ROYAL MICROSCOPICAL SOCIETY (at B.M.A. House, Tavistock Square), at 5.30.—Dr. W. E. Cooke and C. F. Hill: Microscopical Studies in Pernicious Anæmia. (3) The Macropolycyte; (4) Nuclear Degeneration in Blood Stream Cells.—F. G. Wood: Micro-polarising Crystals and their Projection.
NEWCOMEN SOCIETY (at Caxton Hall), at 5.30.—J. G. H. Warren: John Nuttall's Sketch Book and Notes on Wrought Iron Detail for Early Locomotives.
OVERHEAD LINES ASSOCIATION (at Institution of Electrical Engineers), at 5.30.—W. C. Bexon and others: Discussion on Overhead Line Difficulties.
LIVERPOOL ENGINEERING SOCIETY (at 9 The Temple, Liverpool), at 6.30.—G. S. Baker: Horse-power of Ships as Affected by Rudders and Propellers.—R. F. Leggat: Notes on Water Power Development in Canada.
INSTITUTION OF ELECTRICAL ENGINEERS (Sheffield Sub-Centre) (at Royal Victoria Hotel, Sheffield), at 7.30.—W. Redmayne: Cable Fault Localisation by Telephone Methods.
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Botany and Biology Section) (jointly with Leicester Branch of British Empire Naturalists' Association) (at Leicester Museum), at 7.30.—Mr. Bastard: Why is there no Darwinian Morality?
ROYAL METEOROLOGICAL SOCIETY, at 7.30.—Commander E. C. Shankland: Navigation from Viking Period to Present Day in Relation to Science and Meteorology (G. J. Symons Memorial Lecture).
FOLK-LORE SOCIETY (at University College), at 8.—A. M. Hocart: Caste in Fiji.
LEICESTER LITERARY AND PHILOSOPHICAL SOCIETY (Chemistry Section) (in College of Technology, Leicester), at 8.—Dr. G. Lawton: Some Metallurgical Problems in the Electrical Industry.
ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY (at Northampton Polytechnic Institute), at 8.15.—A. W. Hothersall: Some Investigations in Copper Deposition.
ROYAL SOCIETY OF ARTS, at 8.30.—Lt.-Gen. Sir William Furse: Some Aspects of Inter-Imperial Trade (Trueman Wood Lecture).
SOCIETY OF GLASS TECHNOLOGY (at Stourbridge).

THURSDAY, MARCH 19.

LINNEAN SOCIETY OF LONDON, at 5.—Prof. J. Stanley Gardiner: Photosynthesis and Solution in the Building of Atolls.—Dr. Max Bernhauer and Dr. H. Scott: Coleoptera, Staphylinidæ of Abyssinia.
ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Sir William Willcox: Toxic Jaundice (Lumleian Lectures) (1).
ROYAL INSTITUTION OF GREAT BRITAIN, at 5.15.—Prof. J. B. S. Haldane: Respiration (5).
INSTITUTION OF MINING AND METALLURGY (at Geological Society), at 5.30.
CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—Miss Marion Richardson: Children's Drawings.
ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 6.30.—Dr. W. Hoff: Research in the Berlin Technische Hochschule.
ILLUMINATING ENGINEERING SOCIETY (at Institution of Electrical Engineers), at 7.—H. T. Young: Modern Domestic Lighting.
INSTITUTE OF RUBBER RESEARCH (at "Manchester Ltd.", Manchester), at 7.—S. A. Brazier: Some Problems in Sponge Rubber Manufacture.
SOCIETY OF CHEMICAL INDUSTRY (Bristol Section) (Annual Meeting) (at University, Bristol), at 7.30.—Chairman's Address.
CHEMICAL SOCIETY, at 8.—F. M. Rowe and A. T. Peters: A New Reaction of Certain Diazosulphonates Derived from β-naphthol-1-sulphonic Acid. Part IV. The Constitution of the Condensation Products of Diazo-compounds with β-naphthol Derivatives Substituted in the 1-position.—F. M. Rowe, Miss E. Levin, and A. T. Peters: A New Reaction of Certain Diazosulphonates Derived from β-naphthol-1-sulphonic Acid. Part V. The 4′-nitro- and 4′-amino-derivatives of 4-methyl-3-phenylphthalaz-1-one.—F. M. Rowe and C. Dunbar: A New Reaction of Certain Diazosulphonates Derived from β-naphthol-1-sulphonic Acid. Part VI. Preparation of Phthalazine, Phthalazone and Phthalimidine Derivatives from 2:6-dichloro-4-nitroaniline.—F. M. Rowe and N. H. Williams: A New Reaction of Certain Diazosulphonates Derived from β-naphthol-1-sulphonic Acid. Part VII. Preparation of Phthalazine, Phthalazone and Phthalimidine Derivatives from 2:6-dibromo-4-nitroaniline.—K. N. Menon and R. Robinson: Strychnine and Brucine. Part XII. The Constitution of Dinitrostrycholcarboxilic Acid.
ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Royal Army Medical College, Grosvenor Road, S.W.), at 8.15.—Laboratory Meeting.
HARVEIAN SOCIETY OF LONDON (at 11 Chandos Street, W.1), at 8.30.—Sir Percy Sargent: The Romance of the Pituitary Gland.
BRITISH INSTITUTE OF RADIOLOGY (at 32 Welbeck Street), at 8.30.

FRIDAY, MARCH 20.

PHYSICAL SOCIETY (at Imperial College of Science) (Annual General Meeting), at 5.—Presentation of Duddell Medal, 1930, to Sir J. Ambrose Fleming.
ROYAL SANITARY INSTITUTE (at Technical College, Lincoln), at 5.—L. O. Need and others: Discussion on Houseboats on Inland Waterways.—S. C. Baggott and others: Discussion on Refuse Collection and Disposal.
ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Sir Arthur Keith: Demonstration of the Anatomy and Nerve Supply of the Diaphragm.
INSTITUTION OF MECHANICAL ENGINEERS, at 6.—R. S. Allen and W. E. W. Millington: Modern Methods of raising Water from Underground Sources.
NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at Mining Institute, Newcastle-upon-Tyne), at 6.—T. Millican: Corrosion with Reference to Boilers.
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section) (Informal Meeting), at 6.30.—W. Lawson and others: Discussion on Should the Bottom Bearings of Meters be Oiled?—W. Holmes and others: Discussion on Are Cobalt Steel Magnets Desirable for Use as Permanent Magnets for Instruments?—Lt.-Col. K. Edgcumbe and F. Hope-Jones: Discussion on Are Synchronous Motors or Clocks More Suitable for Time Service?—J. W. Record and W. Phillips: Discussion on Are Long Scales Preferable to Short in Indicating Instruments?
INSTITUTE OF CHEMISTRY (Manchester Section) (Annual General Meeting) (at "Manchester Ltd.", Manchester), at 7.—Prof. R. M. Caven: Lecture.
INSTITUTION OF ELECTRICAL ENGINEERS (Meter and Instrument Section), at 7.—Informal Discussion.
INSTITUTION OF MECHANICAL ENGINEERS (jointly with Institution of Automobile Engineers) (at Merchant Venturers' Technical College, Bristol), at 7.—Dr. J. S. Davies: An Experimental Investigation into Induction Conditions, Distribution and Turbulence in Petrol Engines.
SOCIETY OF CHEMICAL INDUSTRY (Newcastle Section) (at Armstrong College, Newcastle-upon-Tyne), at 7.30.—H. W. Howes: Pyrex Glass, its Properties and Application.
JUNIOR INSTITUTION OF ENGINEERS, at 7.30.—W. S. Roberts: Some Token Systems of Railway Signalling.
ROYAL SOCIETY OF MEDICINE (Electro-Therapeutics Section), at 8.30.—Dr. Chalmers Watson: Radiation in Relation to Human and Animal Life.
ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Prof. E. N. da C. Andrade: Sound, Sand, and Smoke: New Light on Old Problems.
GEOLOGISTS' ASSOCIATION (North-East Lancashire Group) (at Technical College, Blackburn).—J. Ranson: The Structure of the Alps (Lecture).

SATURDAY, MARCH 21.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS (Yorkshire and North-Western Districts) (at College of Technology, Manchester), at 2.30.—Dorman, Long and Co., Ltd.: The Building of the New Tyne Bridge, The Building of Imperial Chemical House, and The Sydney Harbour Bridge.
MATHEMATICAL ASSOCIATION (at Bedford College), at 3.—S. Inman: Contracted Methods in Arithmetic.
ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Lord Rutherford: Recent Researches on the Alpha-Rays (3).

PUBLIC LECTURES.

FRIDAY, MARCH 13.

BRITISH MEDICAL ASSOCIATION (Tavistock Square), at 8.—Prof. E. Mellanby: Diet and Health (Sir Charles Hastings Lecture).

SATURDAY, MARCH 14.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—D. Martin Roberts: London in the Augustan Age.

MONDAY, MARCH 16.

KING'S COLLEGE, LONDON, at 5.30.—Prof. K. S. Lashley: Problems in the Physiology of Behaviour. (Succeeding Lectures on Mar. 18 and 19.)
UNIVERSITY COLLEGE, at 5.30.—Prof. B. Brouwer: The Central Nervous System. (Succeeding Lecture on Mar. 17.)

TUESDAY, MARCH 17.

UNIVERSITY COLLEGE HOSPITAL MEDICAL SCHOOL, at 5.15.—Dr. C. H. Andrewes: Immunity in Virus Diseases (1).

WEDNESDAY, MARCH 18.

LONDON SCHOOL OF HYGIENE AND TROPICAL MEDICINE, at 5.—Lt.-Col. G. E. F. Stammers: Tropical Hygiene for Men and Women proceeding to the Tropics. (Succeeding lectures until Mar. 27.)
KING'S COLLEGE, LONDON, at 5.30.—Dr. V. T. Harlow: The Great Age of Discovery: The Search for El Dorado.

FRIDAY, MARCH 20.

INSTITUTION OF PROFESSIONAL CIVIL SERVANTS (at Chartered Surveyors' Institution), at 5.30.—C. S. Wright: The Scientific Purposes of Antarctic Exploration.

SATURDAY, MARCH 21.

HORNIMAN MUSEUM (Forest Hill), at 3.30.—J. E. S. Dallas: Peasant Life in Alpine Districts.