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Milk Supply in Relation to National Health

THE milk supply of Great Britain is engaging—as indeed it should—a large and increasing measure of public attention. The difficulty of securing a remunerative price for milk is vexing more and more the minds of dairy farmers and of all who hold that a prosperous agriculture is the corner-stone of an enduring edifice of national prosperity. Prominent members of the House of Commons, animated by a desire to increase the consumption of milk and to improve the health of the people, are advocating that all children in State-aided schools should receive a daily ration of milk. Many of the medical profession, whilst strongly in favour of this and other proposals designed to promote the drinking of more milk, insist as guardians of the public health that milk must be pasteurised. The recently formed Milk Board is preparing to engage in a campaign in which all the arts of publicity will be used to promote the milk-drinking habit; and to these present and prospective efforts the *Times* is lending public-spirited and invaluable support by opening its columns generously to correspondence from all quarters.

The Committee of the Economic Council, the appointment of which some time ago is proof of the Government's deep concern in questions relating to milk supply and consumption, has completed its labours, and its report will doubtless increase yet more public interest in a subject of which it is not possible to exaggerate the importance. The moment is therefore opportune for a consideration of the problem of the national milk supply from a biological point of view.

This consideration is to be justified on the ground that, apart from its political and economic aspects, the national milk supply is, in its essentials, a biological problem. At the very root of it lies the question: how to secure to the nation a copious and constant supply of milk of the highest possible quality?

The biologist will regard it as self-evident that the health and strength of mankind depend more on milk than on any other nutrient agent whatsoever: more perhaps than on all the other agents put together. In milk, health and strength have their origin and sustenance. To this conviction all the new and rapidly accumulating knowledge of the many and decisive parts played by vitamins and by minerals in promoting growth and maintaining health lend unequivocal support. It does

more. The new knowledge brings a new hope to the world. The new-born hope sees the vitamins, the children of light, fully engaged in the service of man. They prevail against the children of darkness. The microbes that make so many maladies are vanquished one by one. Mankind rejoices in an ever-growing freedom from disease. The new knowledge brings also as its first fruits a salutary uncertainty to science. It is a new wine that will burst many old bottles. The whole science of nutrition will have to be reconstructed on the basis of this knowledge, and the first step toward reconstruction must be a re-investigation of the nutritive value of milk.

At present no one knows how great that value is. The mystical opinion is prevalent that milk is a composite principle : an embodiment of good and evil. It will be discovered presently how to make it wholly good. The current opinion may be due to a simple cause. Experiments carried out before it was possible to make a physiological analysis of milk—and it is even now not yet possible to make a perfect analysis of it—led often to conclusions which cannot be accepted as final because of the uncertainty of the composition of the milk with which they were made. For, like Cleopatra, milk is of infinite variety. It may be rich or it may be poor in health-giving properties ; and so all the old experiments which seemed so conclusive must be redone with material of known and high quality.

Summer milk from cows grazed on pastures of young grass—the sweetest thing that grows—is rich in vitamin A and its precursor, carotene. It has a comforting and agreeable flavour. There is life in it. Winter comes. Growth of grass declines as the sun declines. The lowing herd winds from the pasture to the byre. Natural food gets scantier. As winter pursues its sunless tedious course the vitamin A and carotene in the milk from the stall-fed kine get progressively less, not to increase again until spring comes, and with the resurrection of the life of the pastures the dairy herd goes back to Nature for its food. Can it be doubted that other equally and even more important seasonal variations in the composition and virtue of milk still await discovery : seasonal variations in the amount of available bone-building lime, of phosphates, iodine, other minerals and other vitamins ! May not these seasonal deficiencies be the ultimate cumulative cause, generation after generation, of malnutrition and disease ? They come at a time when their effects are doubly disastrous ; in winter, when the sun itself grows pale and leaves health least fortified against attack.

If, however, these things are true of the children who drink the milk, they must be true no less of the cow that makes it. Like the pelican she gives her life's blood to feed the young. In summer the sacrifice is light, but in winter how severe ! May not bovine tuberculosis and other of the diseases which affect dairy herds be but the belated consequences of seasonal deficiencies of nutrition imposed by climate upon cattle ? In the lowered state of resistance, pathogenic micro-organisms find their occasion, and a symptom of malnutrition comes to be regarded as a cause of disease. "Where the carcase is the eagles will be gathered together."

It is said that tuberculosis is rare or non-existent among cows of the Jersey breed so long as they stay in that fortunate island ; but that when they go elsewhere they leave their immunity behind them. If this be so, must not the resistance and susceptibility alike have their origin in nutrition ? In the longer grazing season and in their fuller access to food from well-managed pastures the cows find strength, but in a shorter season of less nutritive pastures they lose it, and in losing it become a prey to disease. Whether the example be well-founded in fact or not this at all events is indisputable : the task of securing the best possible milk for the nation must be begun at the source—England's green and pleasant land, the green pastures. Jerusalem, if ever to be builded here, must be built on them. A defectively nourished people will never build it. No man who travels in autumn time from the radiant valleys of Savoy to the sullen highlands of Auvergne will ever doubt again that health and happiness come to mankind by a tortuous route ; from heaven via the earth.

The cultivation and management of pastures must serve as the basis on which a copious and consistent supply of rich milk must be established. Those pastures can be made to yield all things necessary to health and strength. The cows that graze them will give milk excellent in quality and delicious in flavour ; a flavour which children will be eager to enjoy.

The pleasant taste of milk and butter from cows fed on rich pastures is bound up with the presence of vitamin A and carotene, as though Nature were trying to coax the children of mankind to feed on what is good for them. If therefore

young England is to become a confirmed and heavy drinker of milk, palatability must be taken into consideration. For in this as in most matters the child has the last cry. Few mothers and fewer fathers dare impose their will on a reluctant babe.

This apparently trivial but really essential aspect of the subject bears on the problem of pasteurisation: a thorny subject. The biologist who approaches it finds himself like Issachar "a strong ass couching down between two burdens". On one side is the weight of his respect for medical opinion; on the other, the uneasy load of his belief that raw milk of high quality will prove superior to pasteurised milk. Accustomed to compromise by the baffling complexity of the phenomena with which he habitually deals, the biologist would accept pasteurisation of milk open to suspicion as a provisional and precautionary measure, provided that any enforcement of it were recognised explicitly as no more than precautionary and provisional. Nor would insistence on the safeguarding clause be dictated solely by doubt. It would also be inspired by the belief that search for other ways of preventing the carriage of pathogenic micro-organisms by milk would find better ones.

Finally, the biologist cares not at all if the views which have been expressed find little acceptance so long as what is implicit in the argument is made to take immediate effect. It is that a great national effort must be made to discover means of securing to the people, all the year round, plentiful supplies of the best milk that Nature and art can produce. The effort must not be confined to experts only. It must have "the help and advice of persons experienced in the right application of things". The effort must be initiated by the most powerful authority in the land—the Government itself. It must be directed to outlining and getting carried out a programme of comprehensive investigation extending from the pasture to the larder, and including dairy herd and farm water supply, cowman and milkman. There is old knowledge, massive and confusing, to be reviewed, and new knowledge to be won. The reapers are many but, though skilled, they are scattered. With these energies joined together the harvest would soon be plentiful.

Let the Government set up forthwith a small commission with large powers to lead the attack on a problem the solution of which would result in the rejuvenation of the race. F. K.

Biological Philosophy

Allgemeine Biologie: eine Einführung in die Lehre vom Leben. Von Dr. Max Hartmann. Zweite, vollständig neubearbeitete Auflage. Pp. xii + 792. (Jena: Gustav Fischer, 1933.) 38 gold marks.

IN the issue of NATURE of December 17, 1932, we had the pleasure of reviewing a bold and original work on general biology by Prof. Woltereck, and now we have before us a still longer and more elaborate work on the same subject by Dr. Hartmann, who is a member of the staff of the Kaiser Wilhelm Institute for Experimental Biology at Dahlem. Naturally the subject is treated very differently by the two authors, for whereas Woltereck has attained world-wide fame as a zoologist and embryologist, Hartmann's claims for distinction rest chiefly on researches on the Protista (Protozoa and Protophyta) and on the Thallophyta amongst plants. Then again, Woltereck came courageously into the battle, by asserting that in all living things there is a vitalistic factor regulating their actions which is not to be accounted for by the structure or mutual positions of their constituent molecules. Hartmann, on the contrary, whilst repudiating materialism as a system of thought unworthy to be regarded as a 'philosophy', nevertheless holds that science can deal only with living things as lumps of matter: it must argue 'as if' materialism were true.

Hartmann clearly recognises that human consciousness is the foundation of all our knowledge, that what we call 'matter' consists of presentations to this consciousness, and that most of the qualities with which we invest 'objects' do not inhere in them, but are given to them by the human mind. But there is the further difficulty, that only one consciousness is directly known to us, and that is our own. We infer a similar consciousness in our fellow-men from their actions, that is, their movements, and if the view that the human race has grown out of some lower race of animals is correct, then it is impossible to deny something like consciousness, at least to the higher animals. Hartmann's limitation of the ambit of science to the study of material changes, if logically carried out, would condemn us to a philosophy of 'solipsism', which of all forms of philosophy is the most unpractical. We should be forced to attempt to explain the actions of our fellow-men by the chemical and physical structure of their bodies, leaving entirely out of sight their thoughts,

feelings and desires ; and an anthropology such as this would be worthy only of a madhouse. There can be no arbitrary restriction on the methods adopted by science : its aim is to establish general laws ; as Hartmann himself says, to refer the individual to its place in the general scheme of things ; and that method is to be preferred which gives consistent results and shows the fundamental similarity of widely differing living things.

We may perhaps illustrate the archaic quality of Hartmann's outlook by giving a brief account of the way in which he deals with the structure of Protozoa. He asserts that protoplasm is primitively a fluid, for he regards its semi-solid or 'gel' modification as secondary : he overlooks the fact that a fluid can have no organisation or definite arrangement of parts : its movements can only be controlled by its boundaries, and the only 'forces' which it can exert are those due to varying surface tension or increase in volume. So Hartmann is driven back on surface tension as the cause of amœboid movement, and still clings to the artificial amœbæ constructed by Bütschli out of oil drops impregnated with hygroscopic salts. Now the work of Jennings, Gray and Pantin has completely shattered this hypothesis, and has proved that surface tension plays no part in animal or plant movements, but that the fundamental factor in all movement is the change from the sol to the gel condition, or vice versa : that although the blastomeres of a rapidly dividing egg-cell *look* as if they owed their shape and arrangement to surface tension, this is an illusion : what really happens in a dividing egg is the 'jellification' of its outer layer at the moment of division, followed by a partial solution between divisions.

It is true that Hartmann does mention in passing Pantin's work, but he asserts that Pantin's conclusion, namely, that in a moving amœba the endoplasm is pressed forwards by the contracting ectoplasmic sheath, does not apply to his (Hartmann's) amœbæ—but this is incredible. The great value of Pantin's work is that it brings pseudopodial movement into line with muscular contraction and shows that the fundamental nature of all animal movement is the same. Hartmann even endeavours to persuade us that the myonemes or contractible filaments of Protozoa and Cœlenterata, smooth muscles and cross striated muscles, are essentially different things. This is unreasonable in view of the fact, for example, that the 'myonemes' of *Hydra* are replaced by 'smooth muscle' cells in *Obelia* and that smooth muscle has actually been converted into striated muscle by subjecting it to prolonged and increasing tension.

Hartmann gives a large number of extraordinarily interesting facts about the reproduction of the lower organisms : these alone would render the book of very great value. He shows that sex, in the form of conjugation of nuclei, is ubiquitous : his account of sexual and asexual reproduction in *Chlamydomonas* is especially interesting. He arrives at the extraordinary conclusion that even when the conjugating cells appear precisely alike, nevertheless, by means of suitable tests, a male and a female partner can be distinguished ; and that therefore the distinction between the sexes is not an 'adaptation' or division of labour gradually evolved in the more complicated organisms, but something fundamental involved in the very nature of life itself. As to the functions of sex itself, he comes to no very definite conclusion : he rejects the view that it is an arrangement made necessary by the gradual 'wearing out' of the vital processes ; citing against this theory the experiments in which asexual reproduction has been continued for years *under carefully controlled conditions* without deterioration of the stock. But it seems to us that the significance of sex—as of all other biological phenomena—cannot be understood merely by the exhaustive study of one or two cases, but only by a broad comparative view of the matter, and what such a survey teaches is that sexual reproduction intervenes as a response to the onset of unfavourable outer conditions to which the product of sexual congress, that is, the zygote, is specially resistant. As the experience of all breeders shows that the vigour of the offspring is diminished when it is the offspring of two nearly allied parents, the old view that sex is a device for restoring vigour by enabling the deficiencies of one partner to be compensated for by the excellences of the other seems unlikely to be transcended.

As was to be expected from a member of the staff of the Kaiser Wilhelm Institute, Hartmann accepts wholly the Mendelian interpretation of variation and heredity. He does not see that the modifications which he is forced to make in Mendel's original statement are really the *reductio ad absurdum* of the whole theory. The Mendelian rules were founded on the results of crossing two varieties separated from each other by clear and sharply marked distinctions. Mendel himself expressly stated that he would have nothing to

do with differences of 'a more or less character'. Since functional differences, which alone are significant in evolution, are always of a 'more or less' character, it is probable that Mendel would have agreed with some of us in regarding the mutations studied by him, however interesting, as having played no part in the formation of species. But when Hartmann invites us to believe that probably all mutations are due to the coincident action of a large number of 'genes' distributed at random, then it is obvious that any conceivable result obtained by the crossing of two races or species can be interpreted in accordance with the Mendelian rules, and such assumptions reduce the whole reasoning to a farce. In justice, however, to Hartmann, it should be added that even he balks at the theory of Morgan that paired chromosomes break at various places and that pieces of one are incorporated in the other. He asserts, and the most recent work bears him out, that the appearances relied on by Morgan, such as the apparent composition of the chromosome out of a linear series of granules, are optical illusions produced by the imperfect resolving powers of the microscope. He further insists strongly that there is no such substance as 'chromatin'—that the chromosome is a morphological structure, not a chemical compound.

In the concluding pages of his book, Hartmann conducts a polemic against Driesch as the leading vitalist. He finds, as others have found before him when they have marched up to it, that Driesch's position is impregnable. Hartmann admits that Driesch is right in saying that the developing embryo is not a machine, and that no mechanism founded on our present chemical and physical knowledge can be conceived to explain it; but he holds out vague hopes that Driesch's flank may be turned in the distant future by some as yet inconceivable development of 'colloid chemistry'. This, in our opinion, is equivalent to a withdrawal from the walls of the fortress defeated. But one of Hartmann's objections is worthy of further attention. He says that Driesch forgets that the only reason for regarding the embryo as a "harmonic equipotential" system is that every cell has the capacity for developing into the whole. In this sentence Hartmann crystallises the most profound discovery yet made by experimental zoology. Whilst in some eggs, such as those of Annelida, separate blastomeres have limited powers, this is not due to the quality of the nucleus, which is always totipotent, but, as Driesch has explained, to the specialisation or 'stiffening' of the cytoplasm. Now Brachet has shown that a frog's egg may be entered by six spermatozoa. One of the spermatozoa unites with the nucleus of the egg constituting the zygote nucleus, the rest become independent nuclei. All of them begin to divide and to organise the surrounding cytoplasm into cells. What horrific monster will issue from this confusion? The answer is a normal tadpole. If this is not 'control', what is it? And if it is control, does it matter with what term we label it, 'entelechy' or other?

E. W. MACBRIDE.

History of Engineering

The Newcomen Society for the Study of the History of Engineering and Technology. *Transactions*. Vol. 11, 1930–1931. Pp. xi+203+22 plates. Vol. 12, 1931–1932. Pp. xii+142+13 plates. (London: Newcomen Society, 1932–1933.) 20*s*. net each Vol.

THE Newcomen Society has but a comparatively small membership, its members are so scattered that few are able to attend the meetings in London and New York, but in spite of this its sphere of activity is a large one, and its *Transactions* bear the stamp of authority. The common interest of the members lies in the study of invention and craftsmanship, technological processes and engineering construction of all times. Thus in the two volumes recently published are papers on the origins of windmills, Roman mining in Great Britain, fire-extinguishing engines, railways and locomotives, straw handicraft, Hornblower and the compound engine, electric power supply in England and America, mining in Cornwall and the Midlands and other matters, most of the memoirs being excellently illustrated. The volumes also contain the annual reports, lists of members, accounts of summer meetings at Sheffield and Lichfield, notes on memorials to engineers, and lastly, Parts 9 and 10 of the valuable analytical bibliography of the history of engineering and applied science. It has previously been pointed out that some considerable time elapses between the reading of papers and their appearance in the *Transactions*. In the circumstances, this is largely unavoidable, but the publication of these two volumes within a few months of each other is a sign that efforts are being made to overtake the arrears. The work of the publications committee is not a light one.

The Society has been very fortunate in bringing to light original unpublished records ; the value of such material is admirably shown in Mr. J. G. H. Warren's paper on "John Nuttall's Sketch Book". While one generally associates the locomotive with a few great names such as those of Trevithick, Blenkinsop, Stephenson, Gooch and others, to its gradual improvement in all its details a host of individuals have contributed. One of these individuals was a smith, John Nuttall (1818–90), a craftsman whose work, Mr. Warren says, is "a lasting challenge to some educational theories of our time when a Master of Arts is held in higher esteem than the master of an art". The profound satisfaction Nuttall found in his daily tasks led him to add to a sketch in his note book : "Making this kind of work I was in my glore". In early locomotives the wheels gave an infinite amount of trouble, and one can realise the pride with which Nuttall drew in his book a sketch of the "Forst wrought iron wheel that was made". Mr. Warren reviews the whole history of locomotive wheel construction, and in doing so establishes the fame of John Nuttall as a worthy not to be forgotten.

The work of another such worthy is recalled by Mr. F. Bland's paper on "John Curr, Originator of Iron Tram Roads". Born in 1756, from 1774 until his death in 1823 Curr was mineral agent to the Duke of Norfolk's collieries in Sheffield, and it was while holding this post that he used cast iron plate rails fixed to the wooden sleepers of a tramway. James Outram made the rails, but his name has nothing to do with 'tram roads', as is often supposed.

Among other papers read before the Newcomen Society in 1931 were two on early electricity supply undertakings, Col. R. E. Crompton dealing with "The First Installation of House-to-House Electricity Supply in the United Kingdom", and Mr. G. A. Orrok with "Pearl Street Station, the First Central Station in the World". Mr. Orrok's paper was based largely on the manuscript left by Dr. J. W. Lieb (1860–1929), who had worked at the Pearl Street Station directly under Edison. These papers were read in London on April 15 and in New York on April 16, and created considerable interest, the discussion in New York eliciting some interesting reminiscences from Mr. F. J. Sprague, who as a midshipman in the U.S. Navy attended the Electrical Exhibition held at the Crystal Palace in 1882 and was secretary to a jury including Fleeming Jenkin, Grylls Adams, Abney, Edward Frankland and Horace Darwin. In the discussion in London it was recalled that the *Engineer* in 1882 said that "probably no one has done more to make the electric light a popular success than Mr. R. E. Crompton".

Another side of engineering history is represented by the biographical sketch by Prof. J. K. Finch of "John B. Jervis, Civil Engineer" (1795–1885), "who did more than any other man to make engineering in America a profession", and Mr. H. W. Dickinson's paper on "Jolliffe and Banks, Contractors", the latter paper being suggested by the centenary of the opening of London Bridge, for which they were the contractors. The "Dictionary of National Biography" says little about Sir Edward Banks and nothing about his partner, the Rev. W. J. Jolliffe, yet they were both remarkable men carrying out many important public works, and "indeed they were the foremost firm of contractors in an age of big achievements". Banks began life in the North, building dykes, making canals and cutting tunnels. Going to Surrey, he assisted in laying down the Surrey Iron Railway and then, joined by Jolliffe, secured contracts in various parts of the country. Their most notable constructions included Waterloo, Southwark, London and Staines Bridges and Sheerness Dockyard. They both died in 1835, Jolliffe being buried at Merstham and Banks at Chipstead close by. One of the results of the reading of Mr. Dickinson's paper was that through the generosity of Mr. J. J. Edwards, chairman of the Bridge House Estates Committee of the City of London, the fine tomb to Banks at Chipstead has been rescued from neglect and thoroughly reconditioned. This is only one example of the preservation of a monument through the action of the Newcomen Society.

Fossil Vertebrates

Vertebrate Palæontology. By Prof. A. S. Romer. Pp. vii+491. (Chicago : University of Chicago Press ; London : Cambridge University Press, 1933.) 26*s*. 6*d*. net.

THIS well-printed textbook has been carefully prepared, and will be welcomed by both zoologists and geologists. The letterpress begins with a brief recapitulation of some elementary geology to refresh the memory of the zoologist ; while each chapter is prefaced by enough anatomy and zoology to enable a geologist to appreciate the meaning of his fossils. Though nearly all the illustrations are taken (with acknowledgment) from other authors, most of them have been

re-drawn in uniform style, and a few have been improved for the student by making them more diagrammatic. The whole bears the impress of a teacher who is actually engaged in research and has himself made many contributions to our knowledge of the fossil vertebrates about which he writes. The book is well up to date, as shown by the beautiful sketches of the restored skull of the oldest known amphibian, *Ichthyostega*, which was discovered recently in Greenland.

Prof. Romer sometimes enlivens his descriptive matter with speculations and suggestions about various possible courses of evolution. At the outset he favours the theory that the echinoderms and the vertebrates had a common ancestry. Next he speculates as to why so many of the earliest vertebrates were heavily armoured when the jaws of all their kin were feeble. He thinks they may have been thus protected against the contemporary aquatic scorpion-like invertebrates, the eurypterids, which would doubtless have fed on them. In the chapter on birds he points out how at the beginning of the Tertiary period there was real rivalry between mammals and running birds for the possession of the land, which was left vacant by the disappearance of the dinosaurs. The course of evolution, indeed, might have been different if birds had succeeded in the conquest.

To emphasise the relationships of some of the great groups, Prof. Romer also makes an innovation. Instead of treating all the earliest members first, he relegates to the end those forms which seem to be the direct ancestors of the next higher grade. The crossopterygian and dipnoan fishes, for example, are placed after the teleosteans, so that they may be discussed immediately before the amphibians. At the end of the reptiles the dinosaurs are next to the birds, which are said to be "so close to the archosaurians that we are tempted to include them in that group". The Theromorpha, or mammal-like reptiles, are removed from the other reptiles and placed between the birds and mammals.

The volume concludes with a bibliography and a synoptic classification of vertebrates, in which the geological and geographical range of the extinct genera is indicated. The localities of the various fossils, however, are always only vaguely given, and we think that Prof. Romer would have made his valuable work still more useful, at least to advanced students, if he had recorded the sources of the chief specimens more precisely.

A. S. W.

University Omnibus

The Yearbook of the Universities of the Empire, 1934. Edited by Sir H. Frank Heath. (Published for the Universities Bureau of the British Empire.) Pp. 24+xxxii+1010+vi. (London: G. Bell and Sons, Ltd., 1934.) 15*s*.

THOUGH the crisis of distribution may not be so intense in the world of knowledge as in its commercial counterpart, it is yet sufficiently well-marked to make us grateful for anything that serves to lessen the labour involved in its acquisition. There are, so we are informed by the preface of the 1934 Universities Yearbook, seventy universities within the confines of the British Empire—and each takes a growing interest in the affairs of the other. This interest has been forced upon them by such facts as that, in 1933–34 (excluding Trinity College, Oxford, from which no return was received), there were 5,180 students from other countries in the universities and university colleges of Great Britain and Ireland.

Like a pudding in the eating, the measure of the value of a reference book lies in its use. It is hard otherwise to appraise it, but this being the last number to be produced under the editorship of Sir Frank Heath, who retires from his post of honorary director of the Universities Bureau of the British Empire this summer, it may not be amiss to note some of the changes that have taken place in the make-up of the "Yearbook" during his five years of office.

If a reference book is to be judged by its index, the "Yearbook" has a good claim to praise. To prepare an adequate index of names, it is true, is but a matter of care, but the compilation of a general index is another matter. Here, if anywhere, the skill and knowledge of the editor is displayed. Compared with what it was in 1929, the general index of 1934 is a vast improvement.

Other alterations have been introduced by Sir Frank into the appendixes, of which there are now thirty. For example, the section dealing with professional bodies has been considerably enlarged. This year there has been collected in one place (Appendix XXII) on a uniform system, information dealing with admission to the several universities of Great Britain and Ireland. It is a damning indictment of unregulated effort. It is a wonder that any student has the temerity to attempt entrance, so diverse are the exempting examinations, special exemptions, special regulations and the like.

Very valuable collections of information are to be found in Appendixes XXIII and XXIV. The former gives particulars of the less 'limited' aids to advanced work such as postgraduate scholarships, fellowships and research grants (mostly tenable by British subjects) in Great Britain, the Dominions and foreign countries. The latter gives a short account of the purpose of the more important centres of scientific research and information within the Empire.

If one criticism and one suggestion be permitted, it is that though science is adequately covered, there is no reference whatever to archæology, history, economics, or, in short, the social and humane sciences. There should be.

With advantage, too, the section devoted to Industrial Scientific Research (pp. 849–859) might be developed into something as big as the American National Research Council's publication on industrial research laboratories. Admittedly it would add fifty more pages to the "Yearbook", but it would be worth while. Teachers want to know where they are likely to be able to place promising students; or what firms are prepared to admit advanced students and research workers and under what conditions; and lastly, such an amplification would have the intangible but very real effect of bringing industry and scholarship closer together.

The "Yearbook" is essentially a reference work purchased by institutions, and it is not intended for armchair reading. Price and bulk, therefore, need not cause too great anxiety to the editorial staff. Indeed the fuller the information, the greater the value and the greater the possible sales. In any event, even now, every university, every college and every British embassy and consulate ought to have a copy as a matter of course. Its uses are infinite, and abroad it would help to bring foreign students to England and into closer touch with our learning and culture, and thus make for better international understanding.

The publication of the "Yearbook" is one of the primary objects and justifications for the existence of the Universities Bureau of the British Empire. Sir Frank Heath will be able to retire, not to inactivity we hope, secure in the knowledge that the "Yearbook" has grown in scope and usefulness under his care, and that his successor will have the incentive of successful achievement of high aims.

Short Reviews

(1) *Secret Ways of the Mind: a Survey of the Psychological Principles of Freud, Adler and Jung.* By Dr. W. M. Kranefeldt. Translated from the German with a Preface by Prof. Ralph M. Eaton. Pp. xl+188. (London: Kegan Paul and Co., Ltd., 1934.) 6*s.* net.

(2) *A Survey of the Science of Psychology.* By Prof. J. R. Kantor. Pp. xvii+564. (Bloomington, Ind.: The Principia Press, Inc.; London: Williams and Norgate, Ltd., 1933.) 16*s.* net.

WE consider these two books together, because, although they are scarcely comparable in any other sense, they both take up a definite attitude as to scientific method. Prof. Eaton, the translator of the first book, points out that the official psychology, craving for the methods of the exact sciences, and concentrating on what can be measured, has forgotten its original subject, which is human nature. This is one reason why the unofficial psychology of Freud and Jung and Adler has swept over Europe and America. Dr. Kranefeldt's monograph, with an introduction by Jung himself, may be recommended as an excellent critical survey of this movement.

Prof. Kantor also aims at a truly scientific method, but he is too wise to be content with quantitative measurement, with the statistics of learning curves and intelligence tests, when human nature at large, with its joys and its sorrows, its loves and its ambitions, is the real subject of investigation. Also, though he admits that the behaviouristic is more scientific than the mentalistic psychology, he is no behaviourist. His 'organismic' or interactionist point of view, he claims, enables him to steer clear of the mistakes of both these other schools. We believe he justifies his claim, and we are quite sure that his conception of psychology has enabled him to present a very broad and suggestive treatment.

The Organism of the Mind: an Introduction to Analytical Psychotherapy. By Dr. G. R. Heyer. Translated by Eden and Cedar Paul. Pp. xiii+271+37 plates. (London: Kegan Paul and Co., Ltd., 1933.) 15*s.* net.

MIND and body are not two distinct spheres of being. Their mutual influence is shown, among other phenomena, by neuroses which occur when the psychogenic disturbances from which a patient suffers manifest themselves chiefly as impairments of bodily functions. In elaborating the experimental foundations of this view, the author attempts to show the existence of a series of psychophysical 'cycles' or 'spheres' in which life variously and progressively discloses itself as it

moves from the primitive to increasingly differentiated phases and forms. A description of the chief psychotherapeutic methods completes the technical exposition of the volume.

Besides the qualified opinions of the author about the various points raised, the book will be found most interesting and useful as an introduction to the new psychological theories such as autosuggestion, analysis of the unconscious, psychoanalysis, individual psychology and analytical psychology, which have done so much in bringing psychology and medicine together. The unitary view of life adopted by the author, which he rightly traces back to the pre-Socratic thinkers, gives an added interest to his general exposition.

Leçons sur les fonctions univalentes ou multivalentes professées à la Sorbonne. Par Prof. Paul Montel. Recueillies et rédigées par F. Marty; avec un Note de Henri Cartan. (Collection de monographies sur la théorie des fonctions.) Pp. iv+159. (Paris: Gauthier-Villars et Cie, 1933.) 40 francs.

THERE are two methods of studying analytic functions. The first consists in examining the points where the function becomes peculiar—its singularities. These points characterise functions of the same group and at the same time give them individuality. The second consists in examining properties at ordinary points—the region of regularity. This interesting book adopts the second method. The author seeks to classify functions according to their order of multivalence, that is to say, the number of times which the function takes the same value. The univalent functions are particularly important since they are fundamental in the theory of conformal representation. A univalent function when substituted for the variable leaves the order of multivalence invariant.

The book is founded on a course of lectures given at the Sorbonne by Prof. Montel and has been ably edited by M. Marty, who has made many original contributions. In an appendix, M. Cartan considers the possibility of extending the idea of univalence to functions of several variables.

Functions of a Complex Variable. By Prof. Thomas M. MacRobert. Second edition. Pp. xv+347. (London: Macmillan and Co., Ltd., 1933.) 14*s*. net.

THE second edition of this useful book will be warmly welcomed. The theory of functions of a complex variable plays an increasingly important part in the applications of mathematics to physical problems. The student who desires to make these applications without delving too deeply into abstract theory will find here just the material which he requires, clearly set out and with sufficient rigour for his needs. Bearing in mind the difficulties of the beginner, Prof. MacRobert has tempered the arithmetical approach to the subject with a wise admixture of geometrical intuition, and has thereby succeeded in producing a book which may be easily consulted on any particular point such as contour integration, special functions, or the linear differential equation of the second order. The new edition differs mainly from its predecessor in the addition of appendixes on the hypergeometric function, Legendre functions and Fourier integrals.

The New Psychology and Religious Experience. By the Rev. T. H. Hughes. (Halley Stewart Publications, 2.) Pp. 332. (London: George Allen and Unwin, Ltd., 1933.) 10*s*. 6*d*. net.

IT can be safely said that religion has now weathered the storm of scientific criticism. If it has beaten back the forces of materialistic philosophy, it is because of its reliance on the reality of religious experience. In this very able book, Principal Hughes defends that experience against the disintegrating criticism of the new psychology, especially of behaviourism and psychoanalysis. He discusses the origin and meaning of religion in the light of these systems, and shows that God and conscience are not mere projections of the self, but independent realities which give a real value to religious experience in general and to Christianity in particular. The expert way in which the various problems raised are treated is a tribute to the ability of the author and to the great importance of his subject. T. G.

(1) *La géométrie à la portée de tous.* Par J. Poirée. Pp. 117. (Auch: Imprimerie Cocharaux, 1931.) 20 francs.
(2) *L'Arithmétique à la portée de tous: nombres entiers, fractions, calculs approchés.* Par J. Poirée. Pp. v+97. (Paris: Gauthier-Villars et Cie, 1932.) 25 francs.
(3) *L'Algèbre et la trigonométrie à la portée de tous.* Par J. Poirée. Tome 1: *Calcul algébrique et équations.* Pp. v+57. 15 francs. Tome 2: *Étude de la variation des fonctions.* Pp. vi+44. 15 francs. (Paris: Gauthier-Villars et Cie, 1933.)

THESE four little books represent the limit of simplification and are intended for those who have never studied mathematics at all. For these they are probably too difficult. To the teacher of the elements they might offer some useful ideas of simplified exposition.

Vorlesungen über Boden-Mikrobiologie. Von Prof. Dr. August Rippel. Pp. viii+161. (Berlin: Julius Springer, 1933.) 6.90 gold marks.

THIS handy and accurate book is packed with facts concerning a wide range of the bacteriology of soil and water. It would make an excellent foundation for a course, though its value to the student is reduced by the absence of any references except to textbooks. The names of many authors are given, but most of them are Central European. The language and planning of the book are clear, and the work can be cordially recommended.

Physics and the Public Mind

By PROF. HERBERT DINGLE, Imperial College of Science, South Kensington

AN epoch in science is invariably followed by a general change of attitude towards life as a whole, which is none the less profound because it lacks the dramatic suddenness of its precursor. Newtonian mechanics had no direct bearing on vulgar hopes and fears, yet the popular reaction to the appearance of a comet in the eighteenth century was not that of the sixteenth, even among those who knew nothing of gravitation. Organic evolution was not obviously concerned with sociology, yet to Spencer the word 'progress' meant something other than it meant to Rousseau. No scientific idea lives to itself or dies to itself.

The responsibility which this fact lays on the shoulders of the man of science weighs not on his researches but on his treatment of their results. By the very essence of his calling he is consecrated to truth, and he must know all her ways, whatever their effect on human institutions and beliefs. But, by the same token, he must see that his report on what he finds does not mislead ; above all, that it does not contain a denial of the spirit of research itself.

> For I say, this is death and the sole death,
> When a man's loss comes to him from his gain,
> Darkness from light, from knowledge ignorance.

Difficult as it must always be properly to estimate current events, it is clear beyond question that the post-War years have seen a development of fundamental physical ideas such as history has rarely recorded. Already the theoretical physicist of middle-age, if he has time to muse at all, contemplates the outlook of his youth with something of the feelings with which he regards medieval thought. It is only fitfully that he realises, with a mild shock of surprise, that this archaic attitude was once natural to himself and is still part of the mental equipment of most of "that section of his contemporaries which is called the public". On the world at large the impact of the new ideas must necessarily work more gently and slowly, but no less inevitably. Sooner or later, social institutions, literature, art, religion will reflect the change, and it is not too early to inquire how the public mind is reacting to the scientific revolution itself, for on that reaction will depend the more subtle developments in the various fields of practical human interest.

At first sight the omens are pleasing. Thanks largely to broadcasting and the great skill in exposition shown by certain of our physicists, popular attention is given to things scientific probably in greater measure than ever before. Not only so, but the recognition is general that science has something vital to contribute to the various departments of thought, feeling and action, and there is a genuine desire to know what that contribution might be. Superficially this is all very satisfactory.

When we look deeper into the phenomenon, however, grounds for misgiving appear. The remarkable fact that books of science have become best sellers admits of two possible explanations : either the most widespread desire of the public has changed, so that it is now for scientific thought instead of thoughtless diversion, or else books of science have changed so as to provide thoughtless diversion instead of scientific thought. Unfortunately the latter alternative appears to be nearer the truth.

There was a time when the writer of science for the public demanded considerable mental effort from his readers, as a tribute befitting the dignity of his subject. He showed them the steep and thorny way to heaven. Nevertheless he led them there if they were willing to follow him. To-day we are only too familiar with the primrose path to the everlasting bonfire. Writers such as Ball and Lockyer not only described the achievements of science ; they indicated also the steps towards those achievements, appealing to reason to approve the course as well as to admiration to applaud the goal. The modern successors of these men are too prone to present the achievements, made alluring by their plumage of paradox, and to prevent access to the steps by a mysterious guardian who, finger on lip, whispers in hushed tones the magic word, Mathematics. The consequence is inevitable. The reader not only enjoys the fun, but also feels at liberty to claim science in support of whatever philosophical or religious dogmas he may hold, paradox lending itself readily to favourable interpretation by contradictory creeds. Any scruples of conscience he may feel at taking this royal road to learning are allayed by the assurance that he need not think for himself since in any case the argument is beyond him. Small wonder that the age when science is most difficult is the age when it is most popular.

To make the point definite, let us concentrate attention on one of the most prominent elements of the new nescience—the doctrine of indeterminacy. It is widely preached that modern science is essentially indeterministic, and that therefore we may not only believe in human free will if we like—which, of course, we could always do—but also claim scientific support for it. This idea, emanating from men of science with the highest credentials, has spread, both directly and through various grades of intermediary expositors, to the pulpit, the newspaper and the market-place. Authority for the idea is everywhere ; evidence for it, however, is far to seek. As an example we may cite an earnest little book recently written by a doctor of science with the object of showing the plain man the trend of modern science and philosophy. "The work of Dirac," he writes, "suggests a somewhat transcendental nature of matter, while that of Heisenberg is particularly

significant because it has knocked the bottom out of the idea of predestination, put probability in its place, and shown that there is even a physical basis for the belief in free will as a factor of existence." When we seek for evidence for this remarkable statement, all we meet with is the following. "The mathematicians are among the most trustworthy of intellectual guides. Physics is essentially a mathematical subject, and over some of the ground we have to traverse the experimental physicist will still accompany us, but eventually we may have to trust the mathematician alone." When a doctor of science (who, it may be said, implies that he himself is unable to follow the mathematical arguments) can write in these terms, we may wonder whether the twentieth century differs intellectually from the sixteenth except in the substitution of the mathematician for the medieval philosopher.

The protest will at once be raised: 'What can one do? Theoretical physics is indisputably beyond expression in popular terms, and is one to keep some of the greatest intellectual adventures of history as a secret possession because they cannot be described in their fullness without mathematical language?' The reply is that the evil does not lie in the incompleteness of the presentation—that must always exist—but in its character. Conclusions are presented as mathematically demonstrated which mathematics has not only not demonstrated but is also inherently incapable of demonstrating. Mathematics is thus portrayed as the magic wand of the few instead of the concentrated reason of all. Once the supreme expression and inspired Word of Reason, it has become an indulgence, granting absolution for the wildest excesses of irrationality. Instead of being a mental tonic, its very name has become a mental opiate, and elementary fallacies which a generation ago would have been detected by the most ordinary of thinkers, now deceive the acutest minds, which lie bemused under its spell.

To exemplify this it is not necessary to take the more outrageous application to human free will, which in actual fact has not yet been shown to bear any relation at all to physics. We can go deeper and look at the purely inorganic indeterminacy. The basic expression of this doctrine is to be found in Prof. Dirac's "Quantum Mechanics". "When an observation is made on any atomic system that has been prepared in a given way and is thus in a given state, the result will not in general be determinate, i.e., if the experiment is repeated several times under identical conditions several different results may be obtained." Let us see how this astonishing conclusion has been reached.

The whole of quantum mechanics, of which this is a part, has been built up as an attempt to explain the results of experiment. Now not only is it true that not one experiment has ever been repeated several times under identical conditions without the same result having been obtained (allowing, of course, as has always been done, for the small errors inevitable in human experiment), but the very statement which Dirac makes is based on this constancy. It will not do, for example, if he can say merely that a spectrum produced in Prof. Fowler's laboratory on such and such a date contained a line of which the wave-length on the following day appeared to Prof. Curtis to be so many units in terms of a scale which some years before had been found by an employee of Messrs. Hilger to bear a certain relation to a still earlier state of the standard metre. Unless he can say quite generally and definitely that the wave-length of $H\alpha$ is that and nothing else, the whole system of quantum mechanics collapses for want of evidence. If, then, the conclusion quoted is true it automatically knocks away its own support and all reason for believing it vanishes.

This argument is very simple, and it is irrefutable. It makes no appeal to the algebra of matrices or group theory, but rests on the elementary logical principle that an argument whose conclusion violates its premises cannot be sound. Twenty years ago it would have occurred at once to any person of ordinary intelligence, but to-day what do we find? Half the world proclaim with joy that at last the most exact of sciences has established the freedom of the will, while the rest sit in bewildered silence, restraining the protest they long to make from fear that mathematics might have ways of disproving the obvious. The spectacle would be amusing if it were not so serious.

Let us understand the position clearly. It will not do to scoff at quantum mechanics and look upon the modern developments of physics as a malignant growth from which science may recover under the surgeon's knife; they are, on the contrary, a mutation in the authentic line of development of thought. Dirac is not the fool he may superficially appear; he possesses one of the very greatest minds our age has produced. The fault is not that we are living in an age of darkness, but that the brilliance of the time is making us blind, that loss comes to us from our gain and ignorance from our knowledge. What is wanted is a reformulation of the philosophical foundations of science, so that sense shall not have to express itself in nonsensical terms. The philosopher may give it to us but there is more hope from the man of science, for in the present situation it is not so difficult for him to acquire sufficient philosophical knowledge and acumen as it is for the philosopher to familiarise himself with physics. But the manner of its coming is of minor importance: the great thing is to get it.

We are not unfamiliar with this demand or with attempts to satisfy it, but there is little sign that the real desideratum is properly understood. It is not sufficient to impeach Victorian assumptions and declare how much wiser we are now. The new philosophy must not merely reveal the falsity of the old; it must embody all its truth. To resort once more to imagery, the relation of what we are offered to what we need is somewhat

as follows. In surveying the physical landscape we have discovered certain facts which we cannot fit into the same plan as the more familiar ones: every attempt to co-ordinate them involves us in absurdity. There are two ways out of the difficulty. The first, which appears to be the only one attempted—or, at any rate, popularised—so far is to assume that the landscape *is* absurd, and that instead of marvelling that we cannot make a rational conception of it, we should rather pity our former inability to see that absurdity is the essence of Nature. The second way, which at least seems worth trying, is to change our point of view until the spectacle again becomes coherent. To do this is not easy: it is much pleasanter to lie in a bed of chaos and smile at our folly in thinking reason worth while. But the time may come when we shall regret such a choice.

It is a question for the specialist now, but in a few decades it will be a matter of universal importance; for the abstract thought of one generation, operating unperceived by the majority, directs the practical activities of the next. It is not merely scientifically indefensible, it is socially tragic when a tremendous forward leap in human thought, about which the public is curious to a degree never before witnessed, is represented as a negation, by an unintelligible formula, of all that has been proved trustworthy in the past; when a man like Sir Arthur Eddington, who is responsible for the most valiant attempt yet made to form a positive unity of the new ideas, can for public instruction give as a summary of the whole situation the vague and inaccurate phrase, "Something unknown is doing we don't know what"; when Sir James Jeans can so far forget his own admirable work as to write, "Heisenberg now makes it appear that Nature abhors accuracy and precision above all things"; and when the only means the truth-seeker has of detecting the falsity of these statements—namely, the exercise of the reason with which he is naturally endowed—is made impotent by the suggestion that mathematics, which he has no time to learn, has discovered how to prove the illogical. There is here a situation far more serious in the long run than many of the problems which agitate public life to-day.

Freedom of thought may be attacked in two ways. Many recently have been moved to protest against the use of external force for this purpose. But, regrettable as such control is, it cannot by its very nature constitute a real limitation. Stone walls do not a prison make, and history has shown that the blood of the martyrs is the seed of the Church. Infinitely more dangerous is the menace to thought from thought itself. When, in the name of science, criticism is not chained but drugged, and unreason, in robes not its own, receives the homage meant for reason, thought is enslaved indeed. Those who are wise enough to see how the social life of a people is related to its mental state will scarcely contemplate the future with equanimity.

Diet and Dental Disease in Man

IT is now well established that there is an intimate relationship between the structure of the teeth in animals and the composition of their food supply, as well as between the latter and certain forms of dental disease. The work of Mrs. Mellanby on these problems has already been referred to in these columns (NATURE, 125, 604; 1930. 127, 977; 1931). The results of these researches led naturally to an investigation of the problem of dental caries in human beings, along original lines, with the view of determining whether a similar relationship between diet and structure and disease held here also. An interim report of a clinical trial by the Committee upon Dental Disease was issued in 1931 (NATURE, 129, 83; 1932) and is now followed by the full account of Mrs. Mellanby's experiments upon the effect of diet on dental structure and disease in man*.

An account is given first of normal and abnormal development and structure of the teeth: by normal is meant the perfect structure which can be obtained in animals receiving vitamin D and a sufficiency of calcium and phosphorus. The normal tooth is creamy white, smooth and shiny in appearance, the enamel is relatively thick and regular in outline, with a more or less regular, systematic arrangement of the prisms and comparatively little pigmentation. The dentine is relatively thick and shows no poorly calcified areas (or interglobular spaces). Such spaces are rare in animals living under natural conditions, but in civilised man, who lives under artificial conditions, their presence is the rule rather than the exception. Teeth can be graded according to the surface character of the enamel, even while still in the mouth: good correlation was found between surface texture and minute structure in the shed or extracted teeth submitted to microscopical examination, so that it is possible to infer the histological structure of teeth while still in the mouth.

In a collection of more than 2,000 shed and extracted teeth, it was found that, whether assessed by surface or histological examination, the majority of the deciduous teeth were defective (hypoplastic) in structure, the incisors being the best and the second molars the worst formed. Teeth collected from private sources were better calcified than those from public elementary school children. The majority of the permanent teeth were also hypoplastic. The teeth of two groups of children were also examined, the first in a hospital

* Medical Research Council. Special Report Series, No. 191: Diet and the Teeth; an Experimental Study. Part 3: The Effect of Diet on Dental Structure and Disease in Man. By May Mellanby. Pp. 180. (London: H.M. Stationery Office, 1934.) 5*s*. net.

for surgical tuberculosis (1,684 deciduous and 1,453 permanent teeth) and the other in cottage homes (12,807 deciduous and 14,078 permanent teeth). 21 per cent of the deciduous teeth of the latter group and 7 per cent of those of the former had no defects ; 32 per cent of the former's but only 5 per cent of the latter's were very hypoplastic. As regards the permanent teeth, 1 per cent were normal in the hospital children and 24 per cent in the cottage homes children, 43 and 8 per cent being very hypoplastic respectively. Histological examination indicated that in the majority of deciduous teeth the part formed before birth was well calcified, the defects beginning to form, however, soon after birth.

As regards caries, of which three degrees were arbitrarily recognised, it was found that 27 per cent of the deciduous teeth of British children were free from the disease, while 42 per cent were very carious. 67 per cent of the incisors but only 4 per cent of the second molars were caries-free ; 10 per cent of the incisors and 63 per cent of the second molars were severely affected. The teeth collected from private sources were less carious than those of the children from public elementary schools. Caries was also more prevalent in the children in hospital than in those in the cottage homes : 47 per cent of the teeth in the former group and 73·5 per cent of those in the latter were free from the disease. Caries was extensive in 22 per cent and in 7 per cent respectively in the two groups. 68 per cent and 83 per cent of the permanent teeth were healthy. The incisors and canines were the least and the first molars the most affected.

The data given above suggest that there is a close relationship between the structure of the teeth and their liability to caries. It was found on analysing the figures more closely that, of the deciduous teeth diagnosed as normal by surface appearance or by the histological structure of the enamel or dentine, 77–83 per cent were free from caries, whilst 2–10·5 per cent were severely affected. On the other hand, of those diagnosed as very hypoplastic, only 7–9 per cent were free from caries, 60·5–73 per cent being severely affected. The same general association holds also in the case of the teeth examined in the mouth, including the permanent teeth. Mrs. Mellanby concludes : "It can therefore be stated as a general hypothesis that there is a close direct association between structure and caries."

Only in 11·2 per cent of the deciduous teeth was no direct association found, 5·1 per cent being too carious for the structure and 6·1 per cent less carious than might have been expected from the structure. Examination of the sections for the presence of secondary dentine and its structure when present showed that teeth of poor structure yet free from caries had well calcified dentine, whilst the latter was usually imperfectly formed when caries appeared in a tooth originally well-formed. In other words, the defensive reactions of the teeth after eruption play a part in the association between structure and caries. Only about 2 per cent of the 1,500 teeth examined were gross exceptions to the two hypotheses of direct association between structure and incidence of caries and that there may be a change in the resistance of the teeth after eruption which is indicated by the character of the secondary dentine.

The next step was the experimental confirmation of the relationship between diet and structure and so between diet and caries in human beings. Four successive investigations were made in a Sheffield Hospital for surgical tuberculosis and afterwards two concurrent tests on children in the Birmingham Cottage Homes, one lasting for two years and the other for a year and a half. The ordinary diets given the children were those commonly considered adequate in all respects : the modifications made were additions of oatmeal, olive oil, cod liver oil or radiostol (irradiated ergosterol), and milk, butter and eggs, or removal of oatmeal and other cereals. The energy value, fat, protein and carbohydrate content, as well as the amounts of calcium and phosphorus present, were kept as constant as possible in the different diets ; on the cereal-free diet the carbohydrate was reduced and the fat proportionately increased. In the Sheffield investigations, considering only the children less than six years old (as the average age in the earlier investigations was about eight years), it was found that the average number of teeth per child showing initiation or spread of caries was reduced from 5·0 on the diet containing no extra vitamins A and D, but with increased oatmeal, to 0·37 on the cereal-free diet with addition of cod liver oil and radiostol solution daily. The average number of teeth per child in which caries showed hardening was increased from 0·2 to 4·7. The Birmingham results bore out those previously obtained in Sheffield and showed that vitamin D is an important factor in checking the initiation of fresh caries, diminishing the spread of old caries and arresting the infective process in many carious teeth.

Following the discussion of the experimental evidence in favour of the thesis that diet and dental disease are intimately related through the variations in structure of the teeth which can be produced by changing the diet, the report considers the racial distribution of caries, since the thesis ought to be capable of explaining the relative immunity or susceptibility of races and communities in various parts of the world. A review of the available evidence suggests that the main conditions responsible for immunity from dental decay are prolonged breast-feeding with a supplementary diet often for three or even six years and a high intake of vitamin D (or exposure of the body to the sun) together with a sufficiency of calcium and phosphorus. A high carbohydrate diet (cereals or potatoes) is compatible with good teeth provided the supply of vitamin D, calcium and phosphorus is also sufficiently great. Caries is especially rampant where cereals form a large part of the diet, breast-feeding is short, the intake of milk, eggs and animal fats is small and

sunshine is negligible or rendered ineffective by clothing.

It has thus been shown that perfectly calcified and regularly arranged teeth can be produced by including in the maternal diet during pregnancy and lactation, and in the diet of the offspring at the time of dental development, substances containing much vitamin D, calcium and phosphorus, such as milk, eggs, fish and animal fats, and that cereals, especially those rich in embryo such as oatmeal, tend to produce hypoplastic teeth and call for a correspondingly larger supply of calcifying foods for good development. It has further been established that the teeth of the majority of children in Great Britain are imperfect in structure: that dental caries is more likely to attack such teeth than perfect teeth with normal enamel and dentine and a smooth surface; that the resistance to caries can be increased independently of the original structure by giving a diet containing much vitamin D, calcium and phosphorus or decreased by a diet rich in cereals. If these general principles of feeding were widely adopted, there is little doubt that dental caries (and also pyorrhœa, to which a deficient intake of vitamin A predisposes) "will cease to be the scourge they are at the present time". It may finally be pointed out that none of these conclusions conflicts with the generally accepted idea that the *exciting* cause of caries is the growth of micro-organisms in the mouth: the novelty is the proof that the tooth can resist the onslaught of the microbes by the absorption and assimilation into the body tissues of certain specific dietary factors.

Obituary

Mr. E. M. Eden

EDGAR MARK EDEN died on February 10 at the age of sixty years. He was the eldest son of William Eden, an artist, and was educated at University College, London. After a period with Messrs. Willans and Robinson, ended by ill-health from which he was never wholly free, he became a demonstrator at University College under Prof. Hudson Beare, by whom he was greatly influenced. In 1907 he became lecturer at Armstrong College, where he remained until his life-work began in 1915.

The National Physical Laboratory had undertaken the testing of all gauges for the manufacture of munitions. The old methods were inadequate to deal with the immense number of gauges, and especially screw gauges; entirely new and simpler methods were necessary. Here Eden's genius found its appropriate field. Many others shared in the work; but they would agree that every method finally adopted owed something to his inspiration, and that many of the most important owed everything. The simple machines that he devised for the most intricate measurements did much more than solve an urgent war problem. They enabled British manufacturers to test their own products and to raise appreciably their standard of accuracy. In the list of those who have led the post-War reconstruction of our industries Eden's name should stand high.

In 1919 Eden joined the original staff of the newly founded Research Laboratories of the General Electric Co., Ltd., as head of the workshops. His work now covered a much wider range, but knowledge of it was necessarily confined to a narrower circle. Discerning visitors to the Physical Society's Exhibition will have realised that its quality remained unchanged; but only his colleagues know how much of any success they may have achieved is due to it.

It is impossible to describe examples of his work in a few words; reference must be made to published accounts, for example, in Rolt's "Gauges and Fine Measurements" and in the *Journal of Scientific Instruments* (May 1922, and vol. 2, p. 119). All his work had a common feature, an economy of means and of material characteristic alike of the best science and the best art. Among modern Englishmen only Rayleigh and Horace Darwin can be compared with him in this matter. Like them he always went straight to fundamentals; he would not even take a hackneyed formula from a textbook; he always worked it out for himself. The colleague who brought him a sketch was often disconcerted to find the final apparatus shorn of all his cherished ingenuities; but it always worked at a first trial, and achieved exactly what was required of it, neither more nor less.

The same hatred of elaboration and ostentation inspired Eden's private life. He loved wild flowers, but not the formal garden; the elegance of Mozart, but not the grandeur of heavy orchestration. It made him a true peace-lover; only his duty to his young family persuaded him, after a bitter struggle, to take even an indirect part in hated strife. Yet he was no shrill pacifist; quarrels vanished like smoke before his genial smile and kindly, but caustic, humour. He was a perfect host; and his accounts of workshop doings at staff meetings were so entertaining that they became recognised as among the Laboratory treats. We are all much poorer for his loss, though the world at large may never know it. He leaves a widow and four sons.

Dr. H. M. Cadell

THE sudden death of Dr. H. M. Cadell on April 10 at the age of seventy-three years has deprived Edinburgh and its neighbourhood of a distinguished scientific worker and of one who played a conspicuous and most useful part in the life of the community. Born in 1860, he was educated at the University of Edinburgh and at

Clausthal Royal Mining Academy, Germany. He was one of the first band of students who studied under Archibald Geikie, and at the age of twenty-three years he became a member of H.M. Geological Survey. He always regarded it as a privilege that he was sent to the field as a junior member of the staff under Peach and Horne in the survey of the north-west Highlands, and an account of his laboratory experiments illustrating the mode of production of the complicated tectonics of that region is included in their classic memoir. On succeeding to the family estate in 1888 he retired from the Survey after only five years' service, but his interest in geology and geography continued unabated, and he was the author of a long series of geological and geographical papers, many of which were the results of observations made during his frequent and extensive travels.

Cadell's more important publications dealt with the oil-shale field and general geology of West Lothian, and with the geological history of the Forth valley. He was essentially a practical geologist and took an active part in the development of the coal- and oil-shale fields of West Lothian, and in the reclamation of the muddy foreshore along parts of the Firth of Forth. He was also interested in the exploitation of the coal resources of Spitsbergen.

The various scientific societies in Edinburgh, particularly the Royal Scottish Geographical Society, the Royal Society of Edinburgh, and the Edinburgh Geological Society owe Dr. Cadell a great debt of gratitude for many services rendered and for generous financial support. He led the life of a country gentleman and became a county magnate, serving in various capacities on the County Council of Linlithgow, and becoming Deputy-Lieutenant. He also served in the 'volunteers' for twenty-four years and retired in 1906 with the rank of Lieut.-Colonel and Hon. Colonel, V.D.

Cadell's services to the University of Edinburgh were many, and special mention may be made of the interest he took in the founding of the chairs of mining and of geography. As a recognition of his scientific attainments and public work he was awarded the honorary degree of LL.D. by the University in 1932.

It is rare to find combined in one personality gifts of such a varied nature, and he will be greatly missed in Edinburgh. T. J. JEHU.

DR. J. P. VAN DER STOK

JOHANNES PAULUS VAN DER STOK was born on January 14, 1851, at Zuilen, near Utrecht. He studied at the University at Utrecht and took his degree of doctor in physics and mathematics in 1874. In 1877 he went to Java as sub-director of the Magnetic and Meteorological Observatory at Batavia, was appointed director in 1882 and retired as such in 1899.

Van der Stok's first publications dealt with periods in terrestrial magnetism and meteorology in relation to the sun and moon, and the observatory at Batavia co-operated in many international researches in seismology, terrestrial magnetism and cloud studies. His most important work, however, were his tidal studies, based on Darwin's method. By a skilful arrangement of direct readings of tide gauges at well-chosen hours, and many original methods of discussing the results, he was able to disentangle completely the very complex tidal phenomena in the Archipelago. The results have been published in a series of sixteen papers and in the atlas "Wind, Weather, Tides and Tidal Streams in the East Indian Archipelago". Tide prediction, highly important for shipping especially near Sourabaya, has since been carried out by Van der Stok's methods largely by native assistants.

After his return to Holland, Van der Stok became director of the oceanographical department of the Meteorological Institute at De Bilt and remained so until 1923. There his principal work was the supervision of the publication of oceanographical atlases of the Indian and Atlantic Oceans, but he continued also his tidal work and published an "Elementary Theory of the Tides" with numerous tidal constants for the East Indian Archipelago, which has been translated into German. He also published through the Amsterdam Academy of Sciences many studies in climatology and dynamical meteorology. He was the first to introduce 'stability' as a numerical indication of the degree of variability in direction of wind- and current-vectors, and one of the first to use and investigate frequency tables and curves in climatology—we need only mention his treatment of tides in the North Sea and of the climate of the North Sea deduced from lightship observations. After several years of illness, borne with exceptional patience and cheerfulness, he died on March 29, 1934, at the age of eighty-three years. Throughout the world his name will be gratefully remembered.

E. VAN EVERDINGEN.

THE death is announced of Frederick William Christian, anthropologist and explorer, city librarian of Christchurch, New Zealand, which took place at the age of sixty-six years at Wellington, N.Z. F. W. Christian, the son of E. H. Christian, was born at Putney Hill on June 15, 1867, and educated at Eton and Balliol College, Oxford. After taking his degree he became interested in the exploration of the Pacific, and more particularly of the islands of Micronesia. His ethnographical observations in this area were of enduring value and continue to be the best and most authoritative account of some of the lesser-known islands. His best-known and most frequently quoted work is "The Caroline Islands" (1899). He also published "Eastern Pacific Lands" (1910) and a comparative study of a number of the Oceanic languages. He was a frequent contributor to the publications of the Polynesian Society and other scientific journals.

News and Views

Sir Sidney Harmer, K.B.E., F.R.S.

SIR SIDNEY HARMER, who received the Linnean Medal at the anniversary meeting of the Linnean Society on May 24, has had a long and distinguished career as a zoologist, and is still actively engaged in research. His published works deal for the most part with two widely different groups of animals, the Polyzoa and the Cetacea. His first paper (1884) described the anatomy of *Loxosoma*, and his most recent, issued this year, was the third instalment of his great report on the Polyzoa of the *Siboga* expedition. Perhaps his most outstanding contributions to science have been the demonstration of the chordate affinities of *Cephalodiscus* (published in an appendix to McIntosh's *Challenger* Report, 1887), and his discovery of embryonic fission in cyclostomatous Polyzoa (1893). While superintendent of the University Museum of Zoology, Cambridge, Harmer, in collaboration with the late Sir Arthur Shipley, planned and edited the great "Cambridge Natural History", the ten volumes of which appeared between 1896 and 1909.

IN 1909 Harmer left Cambridge to become keeper of zoology in the British Museum (Natural History), and ten years later he was appointed director of that institution. Shortly after he went to the Museum, he devised a scheme, with the co-operation of the Board of Trade and the Coast Guard, for recording the occurrence of Cetacea stranded on the British coasts, and in the course of twenty years a vast amount of information has accumulated in regard to the distribution, migration, and seasonal occurrence of the various species. Much of this information, but not the whole of it, has been embodied in the ten reports published by Harmer. From the beginning of his association with the Museum, Harmer also took a leading part in pressing on successive governments the urgent need for the regulation of the whale fisheries, particularly in the Antarctic. His efforts were largely responsible for the organisation of the very important scheme of oceanographical research now being carried out by Dr. Stanley Kemp and his staff for the "Discovery" Committee, an undertaking which can only be compared in importance with the *Challenger* expedition.

Prof. W. B. Scott

THE Boston Society of Natural History has awarded the Walker Grand Honorary Prize of 500 dollars to Prof. William Berryman Scott, of Princeton, New Jersey, for "his half century of conspicuous effort to advance the science of vertebrate paleontology in North America". Prof. Scott is professor emeritus at Princeton University, where he held the Blair professorship of geology and palæontology from 1884 until 1930. He was born in Cincinnati, 1858, received his bachelor's degree from Princeton, Ph.D. from Heidelberg, LL.D. from the University of Pennsylvania, and honorary doctorates of science from Harvard and Oxford. He is a past president of the Geological Society of America and the Paleontological Society of America, his specialty having been vertebrate palæontology. He is the author of a well-known geological textbook, also of the "History of Land Mammals in the Western Hemisphere", and of the "Theory of Evolution", and has written some fifty monographs on geological and palæontological subjects. The Walker Grand Prize is awarded by the Society from the trust fund given by Dr. William J. Walker in 1864 not oftener than once in five years, for such scientific investigation or discovery in natural history as the Society may think deserving thereof, providing such investigation or discovery shall first have been made known and published in the United States. The award is made solely for merit.

Henry Francis Blandford, F.R.S. (1834–93)

HENRY FRANCIS BLANDFORD, the distinguished meteorologist and geologist, brother of William Thomas Blandford (1832–1905) president of the Geological Society, was born in Bouverie Street, Whitefriars, London, on June 3, 1834. Like his brother, he was trained at the Royal School of Mines under De la Beche, Smyth and Percy, and at the Mining Academy of Freiburg, and in 1855, with his brother, joined the Geological Survey of India. After serving for seven years, ill-health compelled him to resign from the Survey and he became a professor at Presidency College, Calcutta, a post he held from 1862 until 1874. From 1867 he was also meteorological reporter to the Government of Bengal, making a close study of cyclones, and in 1874 was appointed chief of the Meteorological Department of India. Retiring in 1888, he took up his residence at Folkestone. He died on January 23, 1893, at the comparatively early age of fifty-eight years. Elected F.G.S. in 1862, and F.R.S. in 1880, in 1884 he was elected president of the Asiatic Society of Bengal. He wrote some fifty papers on meteorology and geology, and his work as a meteorologist caused him to be elected an honorary member of various foreign meteorological societies.

Francesco Denza, 1834–94

ON June 7 the centenary occurs of the birth at Naples of Father Francesco Denza, the eminent Italian astronomer and meteorologist. At the age of sixteen years, he joined the order of Barnabites and studied at Rome, where he came under the influence of Secchi, the astronomer. From 1856 until 1890 he was attached to the Barnabite College at Moncalieri, where in 1859 he established an observatory. Keenly interested in meteorology, he did much to further its study in Italy, founding the *Bolletino mensile de Meteorologia*, and in 1881 was chosen to be the first president of the Italian Meteorological Society. He was also well-known for his observations on meteors and his researches in terrestrial magnetism. He represented the Pope at

the Congress of Scientific Societies held in France in 1884, and again at the Paris Congress held in 1887 to inaugurate the Astrographic Chart of the heavens. Through him the Vatican Observatory was chosen as one of the eighteen observatories to take photographs for the preparation of the Chart, and in 1890 he was appointed as its director. He died at the Vatican on December 14, 1894, at the age of sixty years. He had been elected an honorary member of the Royal Meteorological Society in 1870, and at the time of his death was president of the Accademia dei Nuova Lincei.

Prof. Ernst Küster

PROF. ERNST KÜSTER, who has been for thirty-one years editor of the *Zeitschrift für Wissenschaftliche Mikroskopie*, has been elected to honorary fellowship of the Royal Microscopical Society. Prof. Küster is professor of botany in the University, and director of the Botanical Institute and Gardens, Giessen. He was previously assistant in the Botanical Institutes at Munich and at Halle, professor of botany in the University of Kiel, and later in the University of Bonn. He is the author of "Pathologische Pflanzenanatomie" (3rd Ed., Jena, 1925), "Anleitung zur Kultur der Mikroorganismen" (3rd Ed., Leipzig, 1921), "Ueber Zonenbildung in kolloidalen Medien" (2nd Ed., Jena, 1931), and other botanical treatises, and of numerous scientific papers.

Economics of Nutrition

In the report of the Committee on Nutrition of the British Medical Association published last winter, the daily requirement of food was assessed at 3,400 Calories, and it was recommended that it should contain 50 gm. of animal or first class protein. These figures differed from those of the Committee of the Ministry of Health, which were 3,000 Calories and 37 gm. of animal protein. A controversy arose as to which set of data was correct. A conference of representatives of the two committees has since met and published a joint report (London : H.M. Stationery Office. 2*d*. net). The Ministry's Committee gave 3,000 Calories as a guide for the energy value for large communities and institutions. The figure of 3,400 Calories of the British Medical Association Committee was meant to apply to families with children with the man performing a moderate amount of muscular work, and to be subject to an allowance of 10 per cent for waste. As was stated in an article discussing the position in NATURE of January 13, p. 53, there is no real difference between the figures. The joint committee points out that no hard and fast line can be taken for differences in age and differences in work, and it gives a scale of Calories for different people. It is agreed that 80–100 gm. of total protein suffices for the daily need, the precise amount depending upon physique, occupation, habits, taste and climate. As regards the amount of animal protein, it is pointed out that there has never been any exact determination of the desirable proportion of animal to vegetable protein, and that 37 gm. is the lowest value obtained from statistics ; 50 gm. is recognised as a good value for families with growing children, who need relatively more animal protein than adults.

Helium and Other Rare Gases

IN the second Research and Development Lecture delivered under the auspices of the British Science Guild at the Royal Institution on May 30, Lord Rutherford said that there is no more interesting story in the history of science than the sequence of events, towards the close of the last century, which led to the discovery and isolation of a new group of rare gases existing in the atmosphere by Lord Rayleigh and Sir William Ramsay. The discovery that argon is present in the air in about one per cent by volume was rapidly followed by the discovery of a whole new group of inert gases, namely helium, neon, krypton and xenon. Neon is present in the air in only about one part in 100,000 by volume, and helium, krypton and xenon are present in still smaller quantities. In the early stages, these gases could only be separated in small quantities after much expense and trouble, and in a sense were regarded as scientific curiosities. The subsequent development of large liquid air plants for the separation of pure oxygen from the atmosphere, in which many thousands of tons of air are liquefied annually, made possible arrangements for the separation of argon and neon in considerable quantities. On account of their characteristic properties, some of these gases have been found exceedingly useful to industry. For example, more than 30,000 cubic metres of argon are used annually in Europe in the production of the highly efficient gas-filled electric lamps. In all, about 45 million of these lamps are made each year, requiring the separation of argon from more than 5,000 tons of air. The ease with which an electric discharge passes through neon, and its characteristic luminosity, have led to a great development in the use of this rare gas for the illuminated signs with which we are so familiar in our cities to-day.

IN some respects, however, the history of the use of helium is still more striking. The presence of this gas was first detected in the sun by Sir Norman Lockyer in 1868, and for this reason he named it 'helium'. The presence of helium on the earth was first observed by Ramsay in 1895 in the gases released from old radioactive minerals. In the course of the next ten years, a few cubic metres of helium were laboriously extracted from radioactive minerals. During the War, the Board of Invention and Research of the Admiralty recognised that it would be much safer if observation balloons and dirigibles could be filled with a light, non-inflammable gas like helium rather than with hydrogen, for there is only eight per cent difference in their respective lifting powers. At the suggestion of the Board, Prof. J. C. McLennan, of the University of Toronto, made a systematic examination of the helium resources of the Empire. It was found that large supplies of helium were available in the natural gas fields of southern Alberta,

and arrangements were made on a semi-commercial scale to purify the helium by liquefying the methane and other gases present. About the same time, the Bureau of Mines of the United States began similar experiments, using the natural gases of Texas, which are rich in helium. At the end of the War, millions of cubic feet of helium were separated by liquefaction methods, and the cost was found to be sufficiently low to use it in airships in place of hydrogen. The U.S. airships, the *Shenandoah* and the *Akron*, were both filled with helium to avoid the dangers of fire. Apart from this and other industrial uses, helium is of great importance in the liquid form for attaining temperatures not far removed from absolute zero. A number of cryogenic laboratories employing liquid helium are in active operation in Europe, Canada and the United States, for the study of the properties of matter near the absolute zero of temperatures.

Congress of Anthropological and Ethnological Sciences

A PRELIMINARY programme of the first session of the International Congress of Anthropological and Ethnological Sciences to meet in London under the presidency of the Earl of Onslow from July 30 until August 4 next is now available. The headquarters will be at University College, Gower Street, W.C.2. The inaugural meeting will take place in the Great Hall of the College on July 30 at 3 p.m., when H.R.H. the Duke of York will receive the delegates and declare the Congress open, and Lord Onslow will deliver his presidential address. On the same day at 10 p.m. H.M. Government will hold a reception of the members of the Congress at Lancaster House, St. James's, S.W. The business of the Congress will be conducted in general and sectional meetings. At the first of the general meetings, which will be held on July 31 at 8.30 p.m., Sir Aurel Stein will deliver the Huxley Memorial Lecture of the Royal Anthropological Institute and will receive the Institute's Huxley Memorial Medal for 1934. At subsequent general meetings in the evenings of the following days, the Congress will be addressed by Dr. R. R. Marett, Prof. T. C. Hodson, and Prof. J. B. S. Haldane, each of whom will deal with some one aspect of present tendencies in anthropological studies. Communications addressed to the Congress by its members will be submitted to meetings of the sections, of which there will be eight, each one dealing with a major division of the studies with which the Congress is concerned.

So far as it is possible to judge from this preliminary outline, the proceedings of the sections will be of the greatest interest. In each section topics of inquiry are suggested, although members are not thereby necessarily precluded from submitting communications on other matters. In the Anatomical and Physical Section, which will meet under Prof. Elliot Smith, for example, the central theme will be man's place among the primates. In most sections, however, the range is sufficiently wide to cover all points which members are likely to have time or desire to discuss. Joint meetings between two or more sections occupy a prominent place in the programme. The Section of Ethnography, which, naturally, is expected to have the heaviest list of communications, will meet in three divisions, General Ethnography under Dr. A. C. Haddon, African Ethnography under the Rev. E. W. Smith and American Ethnography under Capt. T. A. Joyce. The last named sub-section has been specially arranged with the view of welcoming American workers on their way to attend the International Congress of Americanists to be held later at Seville. It will take as its central theme of discussion the interrelation of pre-Spanish American culture centres and their possible connexion with extra-American influences, affording, it is hoped, a welcome opportunity for placing on record the results of the most recent developments in research. In the African Section current problems impinging on questions of administration and the future development of the African will be kept well in view. The subscription to the Congress is: members £1, associates 10*s*. Further particulars may be obtained from the Congress Secretaries, c/o the Royal Anthropological Institute, 52 Upper Bedford Place, London, W.C.2.

Japanese Trade Competition

JAPANESE competition in the world's markets is more than a new and noteworthy fact. Discussing the matter in a recent issue of the *Industrial Chemist*, Sir Harry McGowan, chairman and managing director of Imperial Chemical Industries, Ltd., shows that by no means the whole story involves the long hours of work and the low standard of living of the Japanese worker; contributory aids to Japan's advance are her realisation that, in times of depression, price is more important than quality, and her study of the needs of individual markets. "Her manufacturers . . . give each customer what he wants at the time and place that it is wanted, and patterned, designed, and packed in a manner to please his particular fancy. . . . They quote in his own language, and express units of quantity and price in the measurements of his country." Japan needs to sell goods abroad to maintain some equilibrium in her trade balance, to support her rapidly growing population, and to pay for her increasing armaments. She has the advantage of a considerably depreciated currency; a newcomer into the industrial arena, she has bought the most up-to-date machinery and adopted the most suitable methods, and she has organised her industries in large-scale units. She has evolved a system of industrial and governmental co-operation in the conduct of export campaigns. Sir Harry McGowan counsels us to take prompt and vigorous steps to put ourselves so far as possible on a competitive basis. We will not, and indeed cannot, depress the standard of living of our work-people, but we can reap the advantages of industrial organisation and the effective planning of export trade. The time has come for closer personal contact between British and Japanese industrialists, and for discussion which will lead to a tempering of healthy competition with reasonable co-operation.

Reclamation of the Pontine Marshes

IN the *Engineer* of May 11 and 18 is an illustrated account of the work being done in connexion with the reclamation of the famous Pontine Marshes in southern Italy. This work has been rendered possible by the passing by the Italian Government of the law of the 'Bonifica Integrale', commonly known as the Mussolini Law, 1928, which authorised the expenditure of 7,000 million lire (£113,000,000) for works of public utility such as irrigation and water supply schemes, roads, and reclamation projects. "Among these great works of agricultural reconstruction," says the *Engineer*, "the reclamation of the Pontine Marshes deserves particular attention, not only on account of their geographical position almost at the doors of Rome (40 miles distant), and of their history, but above all from a technical point of view, as it is the first time in history that a similar vast enterprise has successfully been carried out, and that a flourishing town—Littoria—has, magic-like, risen within thirteen months from its inception on what were the pestilential malaria-stricken and deadly Pontine Marshes." The area of the marshes, across which once ran the Via Appia, is some 60,000 acres, and its reclamation had been discussed from the days of Caesar to Napoleon. But it remained a blot on the prestige of Italy. In 1926, however, a scientific survey of the district, its rainfall and geology, was carried out and each succeeding year has seen the construction of canals for drainage or irrigation, the erection of pumping and power stations, the clearing of woods, the breaking up of the soil and the settlement of some thousands of people on the recovered land. The colonisation of the area is being carried out by the Opera Nazionale Combettenti (National Ex-Service Men's Organisation) which provides each family of colonists with a house, live-stock and fodder, implements, seeds, etc., guarantees to pay for produce at market price and arranges easy terms of purchase. By October 1935 it is considered the scheme will see the colonisation of about 5,000 families, representing a population of 50,000.

River Water Survey

THE forty-first annual report of the West Riding of Yorkshire Rivers Board for the year ended March 31 covers an extensive area, embracing, in part or in whole, the basins of the Lune, Ribble, Ure, Nidd, Wharfe, Aire, Calder, Don and Trent; therefore it naturally comprises a number of scientifically interesting, though miscellaneous, items of information, which cannot be effectively summarised within brief compass. As the twelve months in question coincided with the prevalence of the abnormally dry season which has made a shortage of water unpleasantly felt throughout Great Britain, it is not surprising to learn that "for extraordinarily lengthy periods the flow of the main rivers passing through the thickly populated manufacturing areas dwindled to about half the normal volume and a very large proportion of the water consisted of compensation water and effluents from sewage works and trade premises". The Aire and the Calder, it is stated, continue to be the worst polluted streams in the West Riding, but the sources of pollution have become more and more localised as the work of the Board has proceeded. On the subject of excessive river pollution following sudden heavy downpours after long spells of dry weather, the explanation is put forward that during dry weather the whole flow of sewage can be fully treated at sewage works, and during continuously wet weather the dilution afforded by the streams is sufficient to obliterate the effects of the discharge of storm water sewage and surface water drainage, but that a heavy shower in dry weather may carry intense pollution into a depleted river. An analysis is given of a sample of river water from the Calder at time of maximum flow after heavy rainfall, demonstrating in a striking way the intensive wave of pollution set up under such conditions.

REFERENCE is made in the report to the important matter of river gauging, and it is stated that consistent attempts have been made to persuade local authorities to take a greater interest in the work and to co-operate in extending activities over a greater number of streams. It is satisfactory to find that these efforts have been attended by some degree of success, though the report adds: "it has required the rather alarming experiences of the droughts of 1929 and 1933 to make it evident that a comprehensive scheme of stream gauging is one of the essentials in regard to a systematic survey of the country's water resources". The action of the British Association in appointing a committee to investigate the question of an inland water survey is sympathetically alluded to, and it is stated that the Board has been asked by the Institution of Civil Engineers to co-operate in the movement by allowing its records of river gaugings to be made available for inclusion in a comprehensive survey which the Institution has in contemplation (see NATURE of Nov. 11, 1933, p. 725, and April 28, 1934, p. 625).

Food Supply and Public Health

IN his Chadwick Public Lecture delivered on May 29, Dr. John Boyd Orr discussed the national food supply and public health. He stated that, if necessary, Great Britain, which at present imports about half of its foodstuffs, could increase production sufficiently to become self-supporting. Between 1913 and 1928, the world's food production increased by 16 per cent, whereas the population of the world increased by only 10 per cent. But the amount of food a person can eat is limited, and in the case of some products, notably wheat, production has outrun consumption. In 1932, the world's requirement in the international wheat market was 525 million bushels, whereas the exportable surplus of the great wheat-producing countries was 1,105 million bushels. The problem with regard to the supply of certain foodstuffs is now, not how to secure a sufficient supply, but rather how to dispose of the surplus, which is encumbering the world economic system. Governments are attempting, through international conferences, to evolve schemes to limit production.

This super-abundance of certain stable foodstuffs has led to a cheap food supply for the people—at least for certain kinds of food. Unfortunately, those foodstuffs which have a special health value are still relatively expensive. At present retail prices, 3,000 Calories, roughly the amount required by an average man, can be obtained in the form of certain foodstuffs, for example, white bread, rice, sugar, margarine, for 3*d*.–5*d*.; but the same number of Calories costs about 2*s*. in the form of milk, 3*s*.–5*s*. in the form of vegetables, 4*s*. in the form of eggs, and 1*s*.–3*s*. in the form of meat. Production of these more expensive foodstuffs is increasing in efficiency with a corresponding fall in wholesale prices. Distribution, however, is still relatively inefficient and expensive, and schemes for the marketing of agricultural produce are now being undertaken.

Suppression of Weeds

OUR knowledge in the use of artificial fertilisers has now become very extensive, and a great deal of information has also been acquired with regard to the destruction of weeds by chemical means. Further, certain fertilisers have a two-fold value in that they act as weed destroyers as well as encouraging the growth of the crop. Spraying for weed eradication was introduced in France towards the end of last century, when copper sulphate was used to kill charlock and wild radish. The practice soon became widespread and at the present time the use of sulphuric acid is rapidly becoming a recognised means of destroying various annual weeds in cereal crops, as is also the fertiliser cyanamide, while chlorates seem likely to attain a position of importance in the future for the destruction of particular weeds in certain circumstances. Mr. H. C. Long, of the Ministry of Agriculture, has just published a simple and concise account of the subject in a brochure entitled "The Suppression of Weeds by Fertilizers and Chemicals". The use of lime, calcium cyanamide, sulphuric acid, sulphates of copper and iron, chlorates and arsenical compounds are the substances chiefly dealt with, and recommendations for the destruction of many weeds that commonly occur in serious quantities are described. The booklet extends to 57 pages, and includes 17 photographic illustrations and 5 line drawings. It may be obtained from the author at "The Birkins", Orchard Road, Hook, Surbiton, price 2*s*. net (by post 2*s*. 2*d*.).

Sociological Studies

Two reports in the "Special Report Series" of the Medical Research Council, recently issued (London: H.M. Stationery Office), are of considerable, though somewhat specialised, interest. No. 190, "A Study of Growth and Development", by Miss R. M. Fleming, contains a record of observations in successive years on the same children, with continuous observation on a number of anatomical characters, and an attempt to relate to them psychological characters of the growing individuals and their reactions to the physical and psychical environments in which they lived. No. 192, "Housing Conditions and Respiratory Disease", by Dr. C. M. Smith, deals with the amount, nature and incidence of sickness occurring during one year among a population of two thousand people living in a poor quarter of Glasgow, one half being housed in a slum-type district, the other half in a rehousing scheme area. Comparison of the morbidity in the two groups does not yield conclusive results, and the value of the work lies rather in indicating the fallacies and difficulties involved in reaching reliable conclusions in investigations of this kind.

Blindness

SIR JAMES BARRETT has prepared an analysis of the causes of their blindness in applicants for admission to an Institute for the Blind (*Med. J. Australia*, 1933, December 30, p. 872). Among those over fifteen years of age, myopia (short sightedness) heads the list with 15 per cent of the total. Of all cases, venereal diseases probably cause 40–50 per cent. In another paper in the same journal (July 15, p. 69), Sir James gives an account of the development of the Braille system. Introduced in 1834, various modifications were attempted, so that at the end of last century there were several kinds of Braille in the English-speaking world. In 1905, Great Britain decided to adopt Braille uniformly; about the same time the Americans appointed examiners to inquire into the various Braille systems, and in 1913 they reported that the original Braille system came out of the test as the best, and it was adopted in America in 1918.

Crocodiles and Alligators

A NEW part of "Das Tierreich" by Dr. Franz Werner of Vienna (Pp. xiv+40. Berlin and Leipzig: Walter de Gruyter and Co. 8.75 gold marks) deals with Reptilia Loricata and contains keys and short descriptions of the distinguishing characters of gavials, crocodiles and alligators, as well as short notes on colour, habitat and distribution. The characters selected as discriminating are readily appreciated and the descriptions are helped by 33 text-figures. Old names are changing; the once familiar *Crocodilus niloticus* has become *Champse vulgaris*, and as a generic name *Crocodylus* is, paradoxically, confined to two alligators from South America, one of which is named *Crocodylus niloticus*—a native of British Guiana, Bolivia and that region! This and other points are referred to in a letter on p. 835 of this issue.

Investigations of Rudi Schneider

IN the article "From a Correspondent" on MM. Osty's investigations on Rudi Schneider in our issue of May 19, p. 747, the importance of an independent repetition of these experiments is urged. Prof. D. F. Fraser-Harris writes to direct attention to the investigations of Lord Charles Hope and others published in the *Proceedings of the Society for Psychical Research* of June 1933. These experiments, however, did not include any graphs of the rhythmic

obscuration of an infra-red ray in time with Schneider's breathing, to which our correspondent specially referred.

Tenth Satellite of Jupiter

ACCORDING to *Science Service*, Dr. H. M. Jeffers of the Lick Observatory photographed a very faint object (of the nineteenth magnitude) which appears to have the same motion in the sky as the eighth satellite of Jupiter. The new satellite has presumably a diameter even smaller than that of the eighth, which is only 25 miles. If the new object's identity as a satellite of Jupiter is established, that planet will lead the field as a satellite holder, Saturn having but nine. Jupiter is now very prominent in the evening sky, and the four brightest satellites can be seen with a modest telescope. But for the glare from the planet they should just be visible to the naked eye in a good climate. (It has been stated that certain Kalahari natives *can* distinguish Jupiter's satellites with the naked eye.) With the most powerful telescope, however, nobody will *see* the new satellite of the nineteenth magnitude. It can only be photographed by giving fairly long exposures on a large telescope.

Announcements

MAURICE, DUC DE BROGLIE, has been elected to a seat in the Académie Française, the section of the Institut de France which concerns itself with language and literature. M. de Broglie is well-known as a physicist for his work on X-ray spectra and allied subjects, for which he was awarded the Hughes Medal of the Royal Society in 1928. For the past ten years he has been *académicien libre* of the Académie des Sciences, which is the scientific section of the Institut de France.

THE second conversazione this year of the Royal Society will be held at the Society's rooms on June 20 at 9 p.m.

IT is announced in the *Times* that Sir Charles Brooke, Rajah of Sarawak, has given £20,000 towards the building scheme for the Imperial Forestry Institute at Oxford.

THE research laboratories of the Callenders Cable and Construction Co., Ltd., 38, Wood Lane, Shepherd's Bush, London, W.12, will be opened by Lord Rutherford on Friday, June 22.

THE annual general meeting of the British Science Guild will be held in the lecture theatre of the Royal Society of Arts on Tuesday, June 12, at 4 p.m. Following the meeting, a popular lecture entitled "Friction" will be delivered by Prof. E. N. da C. Andrade.

AT the anniversary meeting of the Linnean Society of London held on Thursday, May 24, the following officers were elected :—*President :* Dr. W. T. Calman ; *Treasurer :* Mr. F. Druce ; *Botanical Secretary :* Mr. John Ramsbottom ; *Zoological Secretary :* Dr. Stanley W. Kemp. The Linnean Gold Medal was presented to Sir Sidney Harmer.

THE secretary of the University Press of Liverpool, referring to the notes on the centenary of the Liverpool Medical School in NATURE of May 19, p. 753, asks us to state that "The Liverpool Medical School 1834–1934" is the production of the University Press, and is published by the Press, with Messrs. Hodder and Stoughton, Ltd.

UNDER the title of "The Silk Industry of Japan" the Imperial Council of Agricultural Research (India) has issued (1933) a comprehensive monograph by Mr. C. C. Ghosh on this subject. It is primarily based upon the results of a study made by Mr. Ghosh in Japan in 1929 and provides a useful illustrated account of the biological, technical and administrative aspects of the industry. The work can be obtained through booksellers, or through the Office of the High Commissioner for India, Aldwych, London, W.C.2, price 6*s*. 9*d*.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned :—A lecturer in physics and elementary science (including nature study) at the City of Leeds Training College—The Director of Education, Education Department, Calverley Street, Leeds (June 5). A teacher of physical chemistry at the Northern Polytechnic, Holloway, London, N.7—The Clerk (June 6). An assistant professor and a lecturer in mathematics at the Royal Naval College, Greenwich —The Adviser on Education, Admiralty, Whitehall, S.W.1 (June 11). A lecturer in mathematics at the Constantine Technical College—The Director of Education, Education Offices, Middlesbrough (June 9). A temporary assistant lecturer in agricultural botany at the University College of North Wales, Aberystwyth—Prof. R. G. Stapledon, Agricultural Buildings, Alexandra Road, Aberystwyth (June 12). A lecturer in chemistry at the Medway Technical College, Gardiner Street, Gillingham, Kent—The District Education Officer, 15, Mew Road Avenue, Chatham (June 16). A part-time assistant (biology) in the Department of History and Method of Science at University College, Gower Street, London, W.C.1—The Secretary (June 16). A lecturer in political science at the London School of Economics and Political Science, Houghton Street, Aldwych, W.C.2 —The Secretary (June 22). Examiners in various branches of science in the University of London—The External Registrar, University of London, South Kensington, S.W.7 (July 8). A professor of mining and a professor of geology in the University of the Witwatersrand, Johannesburg—The Secretary, Office of the High Commissioner, South Africa House, Trafalgar Square, London, W.C.2 (July 14). A senior lecturer in psychology, a lecturer in geology and a lecturer in mathematics (at Pietermaritzburg) and a lecturer in civil engineering, a lecturer in mathematics and chemistry and a lecturer in English and psychology (at Durban) in Natal University College—The Registrar, Natal University College, Pietermaritzburg (Aug. 1). A technical adviser on industries to the Bureau of Industry and Commerce, Ceylon—The Crown Agents for the Colonies, 4, Millbank, London, S.W.1.

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.*]

Arbitrary Character of World-Geometry

PROF. E. A. MILNE, in the important paper[1] in which he gives an account of an invariant distribution of particles forming an expanding universe in flat space-time, has stated that the geometry adopted in cosmological theories may be chosen arbitrarily, the expression of the laws of Nature being relative to the geometry assumed. A similar view has also been expressed by myself[2]. The first enunciation of the idea, however, seems to have been due to Poincaré in quite the early days of relativity. It is interesting in this connexion to observe that there is a very simple method of converting the law of motion of a particle expressed in the geometry of Einstein's theory to the corresponding law expressed in any other geometry.

In general relativity the world-line of any particle is a geodesic, a four-dimensional track satisfying the principle

$$\delta \int ds = 0, \qquad (1)$$

where

$$ds^2 = \sum_{\mu,\nu} g_{\mu\nu}\, dx_\mu\, dx_\nu.$$

The g's are here functions of $x_1 \ldots x_4$, which when given fix the geometry of the manifold; the x's, being arbitrary Gaussian co-ordinates, may be assumed to be the space and time measures of some (usually specially defined) observer. Multiplying by a dimensional constant and, top and bottom, by the element $d\sigma$ of any parameter, we can write the geodesic principle as

$$\delta \int m \sqrt{\sum g_{\mu\nu} \frac{dx_\mu}{d\sigma} \frac{dx_\nu}{d\sigma}}\, .\, d\sigma = 0. \qquad (2)$$

But in this form the equation can be interpreted in *any* geometry. Thus if $d\sigma$ is the interval of any specified fourfold, (2) becomes a principle of stationary action in that fourfold,

$$\delta \int W d\sigma = 0, \qquad (3)$$

where W, the weighting function of $d\sigma$, is, with given g's, a known function of the co-ordinates and direction-cosines of the (now curved) track at each point. Or if in (2) we write for σ the t of flat space-time, we have Hamilton's principle direct,

$$\delta \int L dt = 0,$$

with the Lagrangian L a known function of co-ordinates and components of velocity. From this the motion in ordinary space of the particle is obtainable in the usual way.

The philosophic implications of such a conversion are considerable. The motion of a particle being described generally as a track of stationary action (of a ray of light, zero action), in

$$\delta \int dA = \delta \int \frac{dA}{d\sigma}\, d\sigma = 0$$

the invariant element of action dA may be factorised in arbitrary ways into action gradient $dA/d\sigma$ and interval $d\sigma$. The latter fixes the geometry and the former is the weighting function W in (3). The physicist working on classical lines naturally adopts the simplest geometry, flat space-time, throwing the burden of accounting for non-uniform motion on the weighting function, which describes in effect a 'field of force'. The relativist, going to the other extreme, throws the whole burden on the geometry. But though these extreme ways are the simplest, the burden clearly can be distributed arbitrarily between W and $d\sigma$, these being adjustable co-factors of the more fundamental thing, action. Action itself, comprising them both, transcends the ideas of geometry.

In a paper published some years ago[3], I have shown that the electromagnetic laws also can be expressed by a principle of stationary action,

$$\delta \int dA = \delta \int \frac{dA}{dV}\, dV = 0,$$

where dV is a four dimensional volume element in the field. The electromagnetic field, therefore, like the gravitational, is obtained by a factorisation of action, but now made differently, the co-factors being action *density* and *volume* element. The former of these effectively specifies the field, for in flat space-time

$$\frac{dA}{dV} \equiv \tfrac{1}{2}\{(e^2 - h^2)^2 + 4(eh)^2\}^{\frac{1}{2}}.$$

Since dV, like $d\sigma$, can be used to define a type of geometry, the feature of arbitrariness in the geometry assumed applies to both classes of field.

S. R. MILNER.

The University,
Sheffield.
April 23.

[1] *Z. Astrophys.*, **6**, Heft 1–2; 1933.
[2] *Proc. Roy. Soc.*, A, **139**, 349; 1933.
[3] *Proc. Roy. Soc.*, A, **120**, 483; 1928.

Maximum Optical Paths

ERRORS that have once appeared in print have a way of turning up in the most unexpected places. As Dr. Karl Darrow's interesting article on quantum mechanics in *Review of Modern Physics*, **6**, 23, January 1934, is sure to be very widely read in Great Britain, it is not inopportune to refer to an old mistake that he repeats. He states that optical paths are routes sometimes of minimum and sometimes of maximum time, and that for this reason it

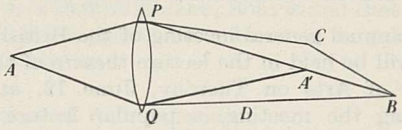

FIG. 1.

is appropriate to refer to them simply as stationary paths. His foundation is wrong though his conclusion is right. The facts are that the time happens to be a minimum when the path does not include an image of an end point of the range considered, but that if the path includes such an image, the time is neither a maximum nor a minimum—it is simply stationary. Thus in Fig. 1, if A', the image of A, is an internal point of the path interval APB, so that the optical

lengths APA' and AQA' are equal, the path $APCB$ is obviously longer and the path $AQDB$ obviously shorter than the stationary path $APA'B$. It is clearly a trivial matter to demonstrate that no given optical path is ever a maximum.

The error perhaps arose from a mistaken attempt to illustrate the alternate occurrence of maxima and minima by the various optical paths between the two foci of an elliptical mirror; and its currency is doubtless due to the fact that the coincidence in space of the object and image fields for reflection makes confusion of thought particularly easy. It

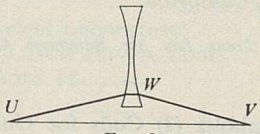

FIG. 2.

must be emphasised that the direct path, and paths including reflection at the mirror, relate to different sets of conditions, and they should no more be confused than the direct path from U to V represented in Fig. 2 should be confused with the refracted path UWV. In refraction, the distinction between the object and the image spaces is usually forced on a student's attention by the experimental conditions. In reflection the importance of maintaining a similar distinction in his mind has to be forced on a pupil's mind by his instructor.

T. SMITH.

National Physical Laboratory,
Teddington.
April 19.

Plasticity of Bismuth due to Occluded Gas

BISMUTH crystals in the form of wires are described by Georgieff and Schmid[1] as being ductile if the (111) plane makes an angle $\varphi < 55° 42'$ with the axis of the wire. If $\varphi > 55° 42'$, their crystals are brittle. The ductility is due to slip along the (111) plane, which is also the breaking plane of their crystals. Gough and Cox[2], however, do not find any ductility due to slip of bismuth crystals of any orientation. The only type of deformation of their crystals consists of twinning on planes of type (110).

The various attempts to explain this discrepancy[2] do not seem to take account of the fact that different methods are employed by the different authors to make the bismuth crystals concerned. Georgieff and Schmid apply the Czochralski method, in which the liquid metal is raised, by means of a glass capillary, out of a hole in a lid which covers the heated crucible and floats on the molten metal. The rising metal is cooled by means of a stream of gas as it comes out of the lid. Crystals of the diameter of the hole, and of any length, can thus be obtained. Gough and Cox apply the Bridgman method, in which a cylindrical mould with tapering ends, filled with molten metal and carefully evacuated, is lowered slowly through a vertical tubular furnace. Both methods have the common feature that a temperature gradient in a certain direction is achieved which makes the crystal grow in this direction.

To check these results, both methods of making metal crystals were applied. The bismuth used was "Bi, purified" supplied by Hopkin and Williams, Ltd., London. The cooling gas was nitrogen from a steel cylinder. Some of the crystals obtained by the Czochralski method were brittle and some were ductile, and the latter showed after extension clear slip lines parallel to the (111) plane. The brittle crystals showed twin formation when a tensile test was applied, giving audible 'cries', but no appreciable elongation. So far, the results are in agreement with those of Georgieff and Schmid.

None of the crystals obtained by the Bridgman method showed slipping in tensional tests, even when the (111) plane was suitably orientated for slipping. They always broke along one of the other planes of (11$\bar{1}$) type, at normal stresses ranging from 337 to 712 gm./mm.^{2}. (Accurate figures cannot yet be given owing to the lack of a suitable tensile machine.) Profuse twinning sometimes occurred before breaking, accompanied by audible sounds. (In compression tests, however, even the crystals made by the Bridgman method exhibit slip. Cylindrical rods become noticeably thicker in the direction perpendicular to the (111) plane and show clear slip lines. There is no discrepancy here with the results of Gough and Cox as they use cycles of stress and therefore cannot apply forces bigger than the breaking force.)

The explanation I suggest is that the crystals made by the Czochralski method contain a certain amount of the gas which is used for cooling. The gas is responsible for the slipping of bismuth in tensional tests.

To check this, Czochralski crystals were heated *in vacuo* to about 600° C. One could observe a large amount of gas coming out of the metal just after the melting point was passed. The amount was estimated by measuring the pressure in a part of the diffusion pump set which could be separated from the pump, and the volume of which was known. Moisture was frozen out by means of a liquid-air trap. It was thus found that the 'single crystal' contained about 3×10^{-4} molecules of nitrogen per atom of bismuth.

Although every precaution was taken—for example, the crystals were not touched by hands at all—this figure should be regarded with some reserve until further experiments check it fully. But it seems to be certain that the content of gas is responsible for the slipping of a suitably orientated bismuth crystal in tensional tests.

W. F. BERG.

Physical Laboratories,
University,
Manchester.
April 16.

[1] M. Georgieff and E. Schmid, *Z. Phys.*, **36**, 759; 1926.
[2] H. J. Gough and H. L. Cox, *J. Met. Inst.*, **48**, 227; 1932.

A Magnetic Effect on Pirani Gauges using Nickel Wires

A PAIR of sensitive Pirani gauges, set up in this laboratory for another purpose, was found to be remarkably sensitive to small magnetic fields. It seemed worth while to give a report of the phenomenon, which may be of interest to those working in the field of thermomagnetic effects. The gauges consist each of a thin nickel strip, 12 cm. long and 0·003 mm. by 0·05 mm. in cross-section. They are mounted parallel and about 2 cm. apart in a high vacuum, and are connected in two of the arms of a Wheatstone bridge, the other two arms being fixed resistances.

A relay magnet about 6 cm. away from the gauges (in the plane containing both wires) was found to produce a large deflection of the bridge galvanometer when energised. The amount of the deflection depends strongly on the voltage across the bridge (that is, on the temperature of the nickel strips). The nature of the variation is shown in Fig. 1. The abscissæ give the bridge voltages, with a rough scale of corresponding temperature; the ordinates give a quantity from which the bridge constants have been eliminated, and which represents the proportional change of resistance of one wire necessary to produce the observed deflection. Since the effects in the two gauges are opposed, the actual change must be greater. If the effect is thought of as a change in potential along the wires, the same quantity gives

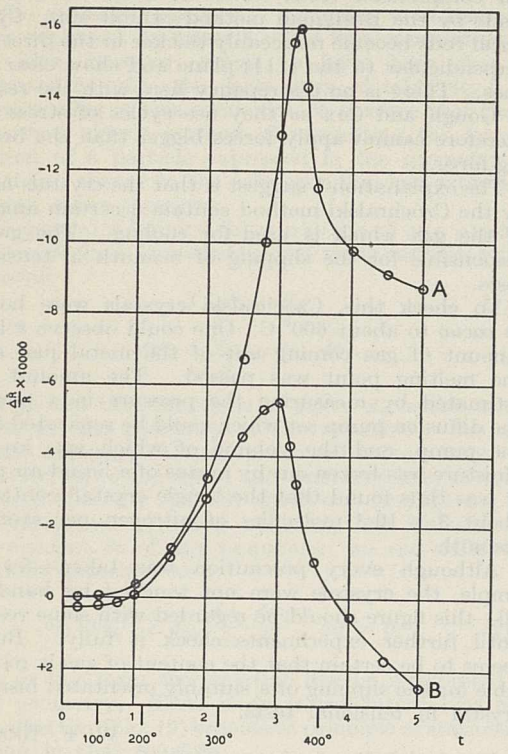

FIG. 1. Magnetic effect on Pirani gauges, plotted as equivalent relative resistance change against voltage across gauges and wire temperature. Curve *A*, magnet perpendicular to wire; curve *B*, parallel. Note that curve *B* changes sign twice. The peak in *B* may easily be caused by the superposition of some of the transverse effect.

the proportional change of potential. In the curve marked *A*, the line joining the poles of the magnet was placed perpendicular to the wires, in *B* parallel. The peak in the curves occurs at or near the magnetic transition of nickel.

The effect is complicated by the presence of the residual field from a large electromagnet near the gauges. This means that the field of the relay magnet must be considered as only a small change in an already existing field. The geometrical relations are also too complicated for these results to be more than a rough picture of the phenomenon.

The behaviour of the deflection on reversing the magnet current, reversing the bridge current, or putting the magnet near the other of the pair of wires, was just as would be expected if the effect were a simple change of resistance. But the magnitude and the variation with temperature are widely different from the results of Knott[1] on nickel. It is more likely that the effect is connected with the existence of a temperature gradient between the centre and the ends of the wires, being perhaps a change of the Thomson coefficient produced by the magnetic field. Such a change is known to exist, but has apparently not been studied as a function of temperature.

EDWIN MCMILLAN.

Department of Physics,
University of California,
Berkeley, California.

[1] L. E. Knott, *Trans. Roy. Soc. Edinburgh*, **41**, 39; 1903. *ibid.*, **45**, 547; 1907.

Gaugain-Helmholtz (?) Coils for Uniform Magnetic Fields

THE use of two equal and co-axial circular coils of wire, separated by a distance equal to their common radius and traversed by the same electric current in the same sense, has long been the standard practice for producing a nearly uniform magnetic field throughout an appreciable volume. The question which seems unsettled is whether Helmholtz improved upon a device invented by Gaugain or invented the whole device by himself at an earlier date.

In favour of the latter point of view is the statement by Wiedemann in 1883 (in a footnote to p. 250 of the third volume of his "Lehrbuch der Elektrizität"): "Helmholtz hat das Princip dieser Bussole schon in der Sitzung der physikalischen Gesellschaft zu Berlin am 16. März 1849 mitgetheilt und zu derselben Zeit einen Apparat nach diesem Principe construirt und benutzt." I have not been able to find any other report of this session except the title of the lecture: "Princip bei der Construction der Tangentenbussolen". This, with the date, is given in *Fortschritte der Physik im Jahre 1849* (p. vii).

In favour of the former point of view is the absence of any reference to Helmholtz either in the papers of Gaugain (*Comptes rendus*, **36**, 191–193. *Ann. d. Physik*, [2], **88**, 442–446; 1853. *Ann. de chim. et de phys.*, [3], **41**, 66–71; 1854) or in the supporting note by Bravais (*Comptes rendus*, **36**, 193–197. *Ann d. Physik*, [2], **88**, 446–451; 1853). Furthermore, we have the much-quoted statement by Clerk Maxwell: "Helmholtz converted Gaugain's galvanometer into a trustworthy instrument by placing a second coil, equal to the first, at an equal distance on the other side of the magnet." ("Treatise on Electricity and Magnetism", vol. 2, p. 318, 1873; 2nd ed., vol. 2, p. 327, 1881; 3rd ed., vol. 2, p. 356, 1892.) This, it will be observed, considerably antedates Wiedemann's note on the subject. Helmholtz, so far as I can find, made no claim on his own account at any time.

A less direct but even more convincing argument in favour of Gaugain's priority is furnished by the following facts. F. E. Neumann, a great authority on Ampère's discovery and its applications, was at Königsberg when Helmholtz went there in 1849, so that they were colleagues during the period when, if ever, Helmholtz anticipated Gaugain. We learn from a paper by H. Wild (*Vierteljahrsschr. d. naturf. Ges. in Zürich*, 2, 239; 1857) that Neumann lectured on two-coil and four-coil combinations at least as early as 1856. In a transcript of Neumann's

"Vorlesungen über elektrische Ströme", as given in 1864–65, published with his permission in 1884 by K. Vondermühl, we find on p. 197 a careful reference to Gaugain (the only reference in a 36-page chapter) and no mention of Helmholtz.

This letter is written in the hope that some reader of NATURE may have additional evidence to offer. If none is forthcoming, I think we should call the two-coil combination Gaugain-Helmholtz coils. If the whole truth were known, it seems probable that the proper designation would be Gaugain-Neumann.

L. W. McKEEHAN.

Sloane Physical Laboratory,
Yale University, New Haven, Conn.
April 11.

The Apparent Thermionic Constant A of Clean Metals

THERE seems to be little room for doubt that the apparent thermionic A (the A derived from a Richardson line) of at least some clean metals is genuinely less than the upper theoretical limit for this quantity, A_0, the value of which is 120 amp. cm.$^{-2}$ deg.$^{-2}$. Thus, for tungsten, tantalum and molybdenum, which are among the metals for which the most reliable data are available, values of 60–100, 60 and 55 amp. cm.$^{-2}$ deg.$^{-2}$ respectively have been obtained, and, if surface roughness had been taken into account, somewhat smaller values still must have been found. It would, of course, be quite possible to attribute these results to an imperfect transmission of the electrons through the emitting surfaces, assuming the apparent A to be the true A. There is, however, a known effect which, unless compensated for by other effects, must make the apparent A less than the true A by a factor of at least 2 or 3, and which would, therefore, account for the order of magnitude of the observed data on the assumption of practically perfect transmission.

It is well known that the apparent A will differ from the true A if the work function χ varies with the temperature. According to Sommerfeld's theory of metals, this quantity is given by the equation

$$\chi = C - \frac{h^2}{8m}\left(\frac{3n}{\pi}\right)^{2/3},$$

where C, h, m and n are the product of the inner potential and the electronic charge, Planck's quantum of action, the electronic mass, and the number of effectively free electrons per unit volume of the metal respectively. Strictly speaking, there should be a further term in the expression for χ, but with ordinary free electron concentrations this is small and its temperature dependence makes the apparent A differ from the true A by only something like 2 per cent. Apart from this, χ might vary with the temperature, as Fowler[1] has pointed out, owing to a temperature variation either of C or of n. Concerning what variation of C with temperature is to be expected, little, unfortunately, seems to be known. There must, however, be a temperature variation of n associated with the thermal expansion of the metal, if, as is probable, the number of free electrons *per atom* remains constant. It appears worth while, then, to see whether the experimental data might be accounted for by assuming that C is sufficiently nearly constant for the temperature variation of χ to be determined in direction and order of magnitude by that of n alone.

Let the coefficient of linear expansion be denoted by α. Then from the formula for χ we find that the corresponding factor, f, by which the apparent A must be less than the true A is given by

$$f = \exp.\left\{\frac{h^2\alpha}{4mk}\left(\frac{3n}{\pi}\right)^{2/3}\right\}.$$

In the temperature regions where thermionic measurements are usually made, α has the value $6{\cdot}3\times10^{-6}$ deg.$^{-1}$ for tungsten and $8{\cdot}0\times10^{-6}$ deg.$^{-1}$ for both tantalum and molybdenum. On the assumption of one free electron per atom the values of n for the three metals in the order named would be $6{\cdot}2\times10^{22}$, $5{\cdot}6\times10^{22}$ and $6{\cdot}3\times10^{22}$ per cm.^{3} respectively. Hence for the corresponding values of f we should have 2·3, 2·7 and 2·9 respectively. For two free electrons per atom we should have, instead, 3·7, 4·3 and 4·6 respectively. These are of the order of magnitude of the factors by which the apparent A-values fall short of A_0.

A. L. REIMANN.

Research Laboratories of the
General Electric Company, Ltd.,
Wembley.
April 30.

[1] R. H. Fowler, *Proc. Roy. Soc.*, A, **122**, 36; 1929.

Isomeric Nuclei?

As I have shown elsewhere[1], the introduction of negative protons into nuclear structure leads to the possibility of the existence of isomeric nuclei, that is, nuclei with the same atomic number and atomic weight but different internal structure (a pair of positive and negative protons instead of a pair of neutrons). As an example, the nucleus of uranium-Z was given, which seems to be isomeric with uranium-X_2.

A further indication is furnished by recent measurements of Aston[2], who has found in the mass-spectra of ordinary lead the line 210. This isotope of lead has the same atomic number and atomic weight as radium-D but, since it exists to the extent of 0·08 per cent, it cannot be, of course, the usual radioactive radium-D. Therefore, if the ascription of the observed line to lead is not erroneous, we must conclude that the nucleus with atomic number 82 and atomic weight 210 may exist in two modifications (isomers) of which one is stable and the other is subject to β-decay.

G. GAMOW.

Institute for Theoretical Physics,
Copenhagen.
April 25.

[1] G. Gamow, *Phys. Rev.* (in print).
[2] F. W. Aston, *Proc. Roy. Soc.*, A, **140**, 535; 1933.

Ground State of C_2 and O_2 and the Theory of Valency

ACCORDING to the quantum mechanical theory of the chemical bond in its original form, the lowest state of a diatomic molecule should be a singlet term. The ground states of C_2 ($^3\Pi_u$) and O_2 ($^3\Sigma_g^-$) found experimentally seem to be in contradiction with this theory while other considerations (Hund, Mulliken, Lennard-Jones) lead to the right result.

But it can be seen that the above mentioned theory also easily explains the experimental facts. One has only to take into account that the binding

energy of the molecule is not only due to the interaction of the ground states of the atoms, but is also effected by slightly excited atomic states. For C_2 and O_2 one has to consider besides the ground states (^3P) the ^5S state of C and ^1D of O.

It is well known that two potential curves with the same symmetry interact strongly if their separation is not too large. In this case they repel each other so that one of the curves is strongly depressed and becomes very low.

For C_2, the configuration $^3P - {}^3P$ (both atoms in the ground state) gives rise to singlets and triplets; one should expect the lowest to be a singlet. But from the configuration $^3P - {}^5S$ (one atom excited) only triplets result. Therefore, because of the above mentioned interaction, just the triplet-terms will be depressed. By Slater and Pauling's method concerning the overlapping of eigen-functions it can be seen that the strongest interaction exists between the two $^3\Pi_u$-terms. So, one of them becomes very low and a rough calculation shows that it probably lies still lower than the $^1\Sigma_g^+$, the lowest of the $^3P - {}^3P$ configurations, so as to become the ground state of the molecule in agreement with experiment.

The same considerations can also be applied to O_2. From the configuration $^3P - {}^1D$ only triplet terms result. The $^3\Sigma_g^-$ terms have the strongest interaction giving the fundamental state of the molecule[1].

W. HEITLER.
G. PÖSCHL.

H. H. Wills Physical Laboratory,
University of Bristol.
May 7.

[1] Similar considerations for the explanation of the BeH molecule have already been applied by C. Ireland, *Phys. Rev.*, **43**, 329; 1933.

Pupation of Flies initiated by a Hormone

DR. V. B. WIGGLESWORTH reported in NATURE of May 12 on the detection of a hormone which initiates moulting and pupation in a tropical bug. In the pupation of flies a very similar principle is acting, according to experiments carried out by me during the past few months. Prepupæ of the blow fly, *Calliphora erythrocephala*, were ligatured securely into two parts. If the ligature was laid down not more than about 12 hours before pupation, both parts pupated, the anterior part preceding the posterior part usually by 1 to 3 hours. But if the prepupæ were ligatured more than 12 hours before pupation, then either the anterior pupated alone, within 12 to 48 hours, or both parts failed to pupate.

In the fly larvæ all the ganglia are concentrated in a single mass in the anterior part of the body; so that by ligaturing, the posterior part is disconnected from the nervous centres. It is, therefore, shown that the separation of the nervous centres does not prevent the posterior part from pupating, if the separation took place only a short time before pupation. From these experiments it can be concluded that something in the anterior part initiates or induces the pupation. The isolated posterior part is able to pupate only if the induction by the anterior part was already accomplished before the ligature was laid down.

This induction may consist of a nervous stimulus, brought to the skin by the nervous system, or it may be accomplished by a special hormone, secreted in the anterior part and carried about in the body by the blood. The following experiments show that the latter alternative is the true one:

(1) Prepupæ are securely ligatured more than 12 hours before pupation and the ligature is taken away after about 15 min. In these specimens the nervous conduction between the two parts of the body is interrupted, but the blood circulates through the whole body. When pupation takes place, it occurs in the whole body simultaneously.

(2) The blood of prepupæ which are about to pupate is injected into posterior parts of younger prepupæ the anterior part of which was ligatured off about 24 hours before. These posterior parts would never have pupated without the injection. Of the injected posterior parts about 50 per cent pupated. In certain cases they pupated only when a second injection was given 24 hours after the first.

The localisation and identity of the organ which produces the hormone are being investigated.

GOTTFRIED FRAENKEL.

Department of Zoology,
University College,
London, W.C.1.
May 16.

Crossing-over in the Land Snail *Cepæa nemoralis*, L.

A GENETIC situation of particular interest from the point of view of the evolutionary modification of genetic phenomena occurs, not only among fishes (*Lebistes*, and other genera), but also among insects (Orthoptera), and land snails (*Cepœa*), in all of which a number of variant genes, completely dominant to their recessive allelomorph, are found to be closely linked in the same linkage groups. In the grouse locusts, the linkage was so close as to be equivalent to a single allelomorphic series. The occurrence of an outlier of the main group showing only moderate linkage with it was demonstrated by Haldane in the extensive data published by Nabours. Nabours has since shown that in one American species of grouse locust (*Acrydium arenosum*) a similar series of pattern factors occurs, showing high frequencies of crossing-over.

In the course of experiments at the Galton Laboratory, designed to test quite other consequences of natural selection, a brood of *Cepœa nemoralis* has been obtained recently showing apparently 20–25 per cent recombination between the factor for a pink (*v.* yellow), and that for bandless. The brood of about sixty young appeared in the summer of 1933, the parents having been taken in Nature about 15 and 28 months previously. The pink bandless double heterozygote was evidently in coupling phase, for there survived to be classified in April of this year 17 bandless pink, 18 banded yellow or 35 of the parental combinations, together with 4 banded pink and 5 bandless yellow, making 9 recombinations, evidently due to crossing-over.

The occurrence of close linkage between a number of genes in natural populations of *Cepœa* has long been recognised[1] though the actual data have not yet been published. The unpublished genetic results of A. W. Stelfox, kindly placed at the disposal of one of us (C. D.), include a similar back-cross between pink bandless and yellow banded, which gave 13 pink bandless and 11 yellow banded, followed by a second generation from bandless pinks of 16 pink bandless and 10 yellow banded. Neither of these progenies show recombination, and they are inconsistent with the occurrence of so much as 20 per cent. It seems

likely that the pinks used in the two sets of experiments were genetically different, and that one is more closely linked with bandless while the other shows appreciable recombination. The alternative that the same genes may show variable linkage in different strains is, however, not excluded.

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C. DIVER.

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May 9.

[1] Diver, C., *Proc. Sixth International Cong. Gen.*, **2**, 236; 1933.

Crystalline Œstrus-producing Hormone from Horse (Stallion) Urine

PROF. B. ZONDEK[1] has published results on the high quantities of œstrus-producing hormone present in horse (stallion) urine. By application of the method employed in this Institute for the preparation of crystalline œstrogenic hormones from the urine of pregnant mares, a few milligrams of crystals of high œstrogenic activity were obtained from 5 litres of horse urine.

They were rhomboid plates, melting after recrystallisation from alcohol at 254°–255°, and when mixed with a sample of α-folliculin (α-œstrone) melting at 257°–259°, the melting point of 254°–256° was obtained.

As predicted by Zondek by the comparison of the physiological properties, the isolated substance seems to be identical with the hormone of the urine of pregnant women. Greater quantities of horse urine are now being worked in order to identify the hormone with certainty.

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April 30.

[1] NATURE, **133**, 209, Feb. 10; 494, March 31, 1934.

Crocodiles or Alligators?

THERE has recently been published the part of "Das Tierreich" dealing with Reptilia Loricata, and since this great work is bound to be widely used by zoologists in the naming of species, it becomes of considerable importance in the stabilising of zoological nomenclature. One therefore examines with more than usual interest the generic and specific names adopted by Dr. Franz Werner for crocodiles and alligators. Again the strict application of the laws of priority in nomenclature gives rise to some confusion. The generic name *Crocodilus*, as applied to Old World crocodiles (Crocodilidæ) by Cuvier in 1807, is replaced by *Champse* of Merrem (1820), the reason being that in 1768 Laurenti had used the name *Crocodylus* with another significance.

Following Laurenti's usage the name *Crocodylus* is accordingly applied to two South American species of alligators, so that, in the first place, confusion arises between the old-established distinctions between crocodiles and alligators, and, in the second place, the family name Crocodilidæ (although still retained) loses its significance, since it no longer includes the genus *Crocodilus*.

More unfortunate still, the specific name of the tropical South American alligator, widely known as *trigonatus*, has, following Laurenti, become *Crocodylus niloticus*, so obvious a misnomer that its meaning can only lead to confusion.

My impression is that the laws of priority provide against the perpetuation of obvious mistakes; in any case, if Laurenti, more than a century and a half ago, made the blunder of naming a South American form under the impression that he was naming a specimen from the Nile, there seems to be no good reason why the blunder should be stabilised in a scientific system. It is on a par with, though more confusing than, the retention of the name *Certhia familiaris brittanica* for the British tree-creeper, because Ridgway forgot for a moment how to spell Britain.

"*Sine systemate chaos*" is the motto printed on the cover of "Das Tierreich"; but confusion may arise under the cloak of systematics.

JAMES RITCHIE.

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May 8.

Air-Pockets in Shore Sands and Winter Packing of the Sea-Bottom

WHILST crossing the Lancaster sands last summer from the village of Flookborough, my attention was attracted by a succession of curious sounds all around me, resembling either profound sighs or the strong flat expirations made through pursed lips by a sleeping person. These sounds were first heard in daylight; but they may have been heard at night in the past by others and given rise to tales of legendary monsters. On searching for the cause I was at once shown it by my companion, Mr. Thomas Wilson; the sounds were due to the escape of air from small pockets below the surface of the wet sand, and could be produced by perforating with one's finger the drying and slightly elevated areas of sand overlying the pockets. The vibration produced in the ground by a pedestrian or a passing cockle-cart appears to increase the air pressure sufficiently to blow off the sandy caps of the pockets.

It occurred to me that the holes and cavities formed in the sand might be of interest to geologists, since similar ones might have become 'fossilised' in past ages and remain to perplex the palæontologist.

These air-pockets have been observed near high-water mark when crossing the sands soon after the recession of the tide; the following explanation is suggested for their formation. At this level the sand dries and drains to a great extent in summer, and especially during the neap tide period. When the spring tide floods set in, water flows very rapidly over the area of dry sand, imprisoning air below the wetted surface. During high and the following ebb tide water gradually percolates below the surface into the underlying sand, driving the imprisoned air into the looser aggregations of sand where it collects and forms a pocket, which may be 'blown' by a gradual accumulation of the encircling water pressure or by a sudden increase due to vibration of the ground.

These miniature air-volcanoes were noticed frequently during the summer, but not during monthly visits in the winter. In April this year they have again appeared. This apparent periodicity is interesting in connexion with the prevailing view held by British inshore fishermen that the sea-bottom on the fishing grounds becomes hard or 'closes up' in winter

and loosens or 'opens up' again in the spring: confirmation of this observation—important in quantitative studies on fish and fish food—offers a difficult problem for the biologist. The Flookborough sands appear 'harder' in winter, but this may be due to lack of drought and drainage, factors which would not, however, operate below sea-level. Whether the fisherman's hardening of the sea-bottom might be due to biological phenomena, such as a relative quiescence of the in-fauna, or to physical causes, remains to be sought.

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May 11.

Strange Sounds from Inland Ice, Greenland

DURING the month of August 1932, when setting up the French Expedition of the International Polar Year in Scoresby Sound, on the East Greenland coast, some of my colleagues and I heard four times the mysterious sound called by the late Prof. A. Wegener the "Ton der Dove-Bai"[1]. The sound was heard in the morning, generally at 11 a.m. (G.M.T.), and also during the afternoon. It was a powerful and deep musical note coming far from the south, lasting a few seconds. It resembled the roaring of a fog-horn. After that it was not heard during the course of the Polar Year.

A. Wegener and five of his companions heard it eight times in five different neighbouring places, both during the day and the polar night. It lasted sometimes a few minutes and Wegener ascribed it to the movements of inland ice. In fact, it seemed, in Scoresby Sound, to come from beyond Cape Brewster, precisely from the part of the coast where the inland ice flows into the sea from the large glaciers.

Is this vibrating sound really caused by the detachment of icebergs or is it similar to the 'desert song', that strange musical note produced by the sand? In fact, there is a close analogy between the fields of powdery dry snow of the inland ice and the fields of sand of the Arabian desert.

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[1] J. P. Koch und A. Wegener: Meddelelser om Grønland, Bd. 75, 314; 1930 (Dove Bay: 76½° N., 20° W.).

Spearman's General Factor without the Indeterminate Part

IT is well-known that Spearman's two-factor theory of intelligence leads to an expression for the general factor g containing an indeterminate part[1]. Considerable discussion has taken place on the inconvenience so caused. I have proved that if we adhere strictly to the conditions laid down by Spearman, namely, that the general factor and the specific factors are all mutually uncorrelated, we cannot dispense with the indeterminate part[2].

However, the problem can be stated in another way, which seems likely to prove much more convenient in practice. Let us define the *approximate* general factor g^1 as the determinate part of the formula obtained for g (with a slightly different multiplier so as to keep the standard deviation unity), with a similar definition for the approximate specific factors. Then I have proved that these approximate specific factors are all approximately uncorrelated with each other and *exactly* uncorrelated with the approximate general factor. For Brown and Stephenson's results no coefficient of correlation of these approximate specific factors is numerically greater than about 0·1.

A detailed proof will be offered for publication elsewhere.

H. T. H. PIAGGIO.

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April 25.

[1] *Brit. J. Psychol.*, 24, 88; 1933.
[2] Lecture to Manchester Mathematical Society, Feb. 14, 1934 (unpublished).

The Reaction between Oxygen and the Heavier Isotope of Hydrogen

WE have made a preliminary survey of the principal respects in which the reaction of deuterium with oxygen differs from that of ordinary hydrogen. The deuterium was prepared by the nearly quantitative decomposition of 97 per cent deuterium oxide by repeated passage over pure iron. The reaction with oxygen was studied by methods which have been used in this laboratory in a number of previous investigations of the normal hydrogen–oxygen reaction. All experiments with deuterium were made in alternation with blank experiments carried out sometimes with cylinder hydrogen and sometimes with hydrogen made from water in the apparatus used for preparing the deuterium. No differences between these different specimens of normal hydrogen were found.

The results may be summarised as follows:—

(*a*) With deuterium the chain reaction occurring in the gas phase at 560° and pressures greater than the upper explosion limit has a speed 64 per cent of that shown by hydrogen.

(*b*) For the surface reaction occurring in a packed vessel at 525°, the ratio of the rates for deuterium and for hydrogen is approximately 0·65–0·70.

(*c*) The upper explosion limit is higher with deuterium than with hydrogen. Our results here correspond to those of Frost and Alyea[1], which appeared during the course of the present work. The shifting of the limit is almost exactly what would be predicted from the theory of deactivation by ternary collisions. Deuterium, on account of its smaller speed, is a less efficient deactivating agent. Using the formulæ given by Grant and Hinshelwood[2], we find that to account for the observed shift of the limit at 550°, 525° and 500° respectively, the values required for the relative collision frequencies of deuterium and hydrogen are 0·67, 0·76 and 0·76, the mean being 0·73. The value calculated from the respective molecular weights, assuming equal collision areas, is 0·74. This is, indeed, a good confirmation of the ternary collision hypothesis itself.

For the energy of activation of the branching process we find 26,500 calories, which does not differ significantly from the values 25,500 and 26,500 found for hydrogen.

From the fact that the effect of the deuterium can be calculated from its speed as above, we must conclude that there is little difference in the actual probability of chain branching with the two isotopes. If, as has been suggested[3], the branching depends upon whether at a certain stage of the chain H_2+HO_2 gives $H+H_2O_2$ or $H+2OH$, it will be determined by the breakdown of H–O–O–H into 2OH. Then,

since no link involving H or D is broken, the different zero point energies of the two isotopes will have only a second order effect, or none, as found. In the surface reaction, and the steady chain reaction, the rates depend, not upon simple branching, but upon initiation and propagation mechanisms, one or other of which must involve the activation or dissociation of H_2 or D_2. The different zero point energies will then give rise to different activation energies, and hence to different rates, in accordance with observation.

It appears, therefore, that the study of the behaviour of the heavy isotope brings, from a somewhat unexpected angle, an interesting confirmation of several matters connected with the mechanism of the reaction.

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May 24.

[1] *J. Amer. Chem. Soc.*, **56**, 1251; 1934.
[2] *Proc. Roy. Soc.*, A, **141**, 29; 1933.
[3] See Hinshelwood and Williamson, "The Reaction of Hydrogen with Oxygen" (Clarendon Press, 1934).

Photochemistry and Absorption Spectrum of Acetone

IN a recent letter[1] we noted that the ultra-violet absorption band of acetone, which earlier workers[2] (with the apparent exception of Herzberg[3]) had regarded as continuous, has a fine structure. This occurs in the long wave side of the band; Bowen and Thomson[4] now record a resolution of the remainder of the band into "about four groups each containing about 25 diffuse bands" but conclude that "the diffuseness of the bands can be attributed to an unresolved close packing of the rotation lines without calling on the additional hypothesis of predissociation". In citing the fluorescence of acetone as evidence of the absence of dissociation, they make no reference to the fact that it is confined to the longer wave-lengths of the absorption band[5]. Actually the fluorescence disappears near the wave-length at which the line-structure noted by us becomes diffuse, and while this abrupt change can be readily explained by the onset of dissociation, it is not accounted for by the assumption that the diffuse region consists of close packed rotational lines.

For the photochemical decomposition of acetone Bowen and Thompson adopt the mechanism which we suggested for the decomposition of aldehydes[6], namely, a unimolecular elimination of carbon monoxide according to the equation $R \cdot CHO \rightarrow RH + CO$. They make no reference, however, to the different behaviour of methyl ethyl ketone[7], which gives a mixture of ethane, propane and butane in comparable quantities, instead of only propane. This crucial fact is not explained by the hypothesis which they have adopted, but is readily understood if the hydrocarbon chains are liberated as 'free radicals'.

The photodecomposition of methyl butyl ketone[5]:

$$CH_3CH_2CH_2CH_2 \cdot CO \cdot CH_3 \longrightarrow CH_3CH : CH_2 + CH_3CO \cdot CH_3$$

is in complete contrast with that of acetone and was quite unforeseen by us; it would be of interest to know on what grounds these authors are able to regard it as "not unexpected". The initial electronic excitation of the chromophoric group will undoubtedly be associated with various vibrations of the molecule, including the 'deformation' vibration mentioned by Bowen and Thompson, but in our opinion the energy associated with these vibrations is much too small to account for the decomposition of the butyl chain, which in the analogous case of butane requires an activation of 65 k. cal.[7]

It may now be suggested that the energy of excitation passes from the chromophoric group to another group within the polyatomic system by a process akin to the radiationless transfer in a collision of the second kind. This process, which we shall describe as 'inner sensitisation', need not give rise to a quantum yield of unity. In a complicated molecule there is likely to be a finite probability that the energy transfer may lead to thermal degradation instead.

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University, Cambridge.
April 23.

[1] Crone and Norrish, NATURE, **132**, 241, Aug. 12, 1933.
[2] See footnote in paper by Scheibe, Povenz and Lindström, *Z. phys. Chem.*, B, **20**, 297; 1933.
[3] Scheibe and Lindström, *Z. phys. Chem.*, B, **12**, 387; 1931. Damon and Daniels, *J. Amer. Chem. Soc.*, **55**, 2363; 1933.
[4] Bowen and Thompson, NATURE, **133**, 571, April 14, 1934.
[5] Norrish and Appleyard, *Trans. Faraday Soc.*, **30**, 103; 1934.
[6] Norrish and Kirkbride, *J. Chem. Soc.*, 1518; 1932.
[7] Pease and Durgan, *J. Amer. Chem. Soc.*, **52**, 1262; 1930.

Chemistry of the Red and Brown Algæ

SOME experiments of ours confirm the results of Dr. Russell-Wells on the presence of true cellulose in algæ[1]. From Laminariæ we obtained cellulose from which we made viscose and which we converted into sugar by the method of Ost. This sugar gave phenylglucosazone, but no trace of insoluble phenylhydrazone (indicating mannose) was found.

We were led to these experiments by the well-known occurrence of mannitol in seaweeds and by the demonstration by Nelson and Cretcher[2] that algin is a polymerised uronic acid. Evidently, whatever uronic acid occurs in the plant, the unit of the cell wall material remains the same.

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May 10.

[1] NATURE, **133**, 651, April 28, 1934.
[2] *J. Amer. Chem. Soc.*, **51**, 1914; 1929.

Phosphorescent Beryllium Nitride

ALUMINIUM nitride activated by silicon[1], and boron nitride activated by carbon[2], are the only known phosphorescent nitrides.

Phosphorescent beryllium nitride has been obtained by me by passing ammonia gas at 1,000° C. for four hours over a mixture of beryllium metal containing ten per cent alumina. The product thus obtained shows blue luminescence after exposure to a mercury arc lamp.

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Tokyo.
April 17.

[1] E. Tiede, Max Themann and K. Sensse, *Ber.*, **61**B, 1568; 1928.
[2] E. Tiede and F. Buecher, *Ber.*, **53**B, 2206; 1920. E. Tiede and H. Tomaschek, *Z. Elektrochem.*, **29**, 303; 1923. E. Tiede and Heuriette, *Z. anorg. Allgem. Chem.*, **147**, 111; 1925.

Research Items

Irradiated Yeast and Rickets. Although a number of questions relating to the action of vitamin D still remain unsettled, the fact that irradiated ergosterol determines the fixation of calcium in the animal organism and hence induces good ossification has been indisputably demonstrated. In almost all countries this particular form of prophylaxis is practised by administering definite doses of the irradiated ergosterol dissolved in olive, arachis, sesame, or other oil. In discussing this subject before the Royal Lombardy Institute of Science and Letters (*Rendiconti*, **66**), Prof. Ernesto Bertarelli points out that these ergosterol-containing oils readily become rancid and have other properties which make them unsuitable as products to be applied extensively as prophylactics. He emphasises the advantages of replacing these oily liquids by irradiated dry brewers' yeast, which is rich in ergosterol and easy to take, and remains unchanged over long periods. The powdered yeast can easily be mixed with, for example, bread and milk in daily amounts of 0·5–0·75 gm., and the doses are simpler to handle and regulate than are small quantities of oils.

Fauna of the Dutch East Indies. The latest additions to the faunal studies in the Dutch East Indies ("Résultats Scientifiques du Voyage aux Indes Orientales Néerlandaises de LL. AA. RR. Prince et la Princesse Léopold de Belgique." *Mem. Mus. Royal d'Histoire Naturelle de Belgique*, Hors Série, 1933) are on the Sipunculidæ by J. M. A. ten Brocke and Brachiopoda and Amphineura by E. Leloup (vol. 2, fasc. 3); on Holothuria by H. Engel and "Crustacés décapodes d'Eau douce" by Jean Roux (vol. 3, fasc. 13 and 14) and "Poissons" by Louis Giltray (vol. 5, fasc. 3). Of these the most important is the last, occupying 129 pages and describing a large collection of specimens (850) many of which were caught at the surface by night or found among the corals. There are 205 species, 6 of which are new to science. A knowledge of the general distribution is much extended, most of the species having a very wide range from the Red Sea to Polynesia. It is very interesting to note that the fishes of this Indo-Pacific zone seldom pass the Hawaiian Islands or Paumotu. On the Pacific coasts of Central America one meets with a totally different fish fauna. That part of the Pacific between these islands and the American continent seems to constitute an almost complete barrier to colonisation from the west. The reason for this appears to be the surface temperature of the sea, as the American coast is bathed by two cold currents, one from the north and one from the south (the north and south equatorial drifts), both taking cold water towards Polynesia, the salinity being very much lower than in the Indo-Pacific zone and thus a natural barrier is formed for eggs and the young stages of fishes. The separation between America and Indo-Australia is very ancient, but the Indo-Pacific zone has undergone a series of successive continental formations and possesses physical characters suitable for a somewhat homogeneous fauna throughout its whole area, the main centre of dispersal apparently being the Indo-Australian archipelago.

Gill Movements in the May-fly Nymph. An interesting addition to our knowledge of propulsion mechanisms in animals comes from Prof. L. E. S. Eastham (*Proc. Roy. Soc.*, B, **115**, 30), who has analysed the gill movements in the nymph of the may-fly, *Cœnis horaria*. In this insect the four pairs of gills beat in a normal (longitudinal) direction, but work in such a manner as to produce a current that is transverse. The direction is reversible, and no permanent functional asymmetry is involved. The gills on one side are found always to be out of phase with those of the other, but, though of some importance, this phenomenon proves to be not the only factor concerned in the production of the transverse current. Indeed, analysis revealed that several factors were conspiring to that end, involving at least three different mechanical principles. The up-and-down movement of the gill in an elliptical path, with the convex side above, and the gill fringe closing on the downward stroke, recalls the action of a bird's wing; the change of angle of the gill to the direction of flow brings about what is essentially a screw action; while the alternate suction and compression between both successive gills and members of each pair, caused by the metachronal rhythm, has an effect comparable with that of the limb-movements in the filter-feeding *Cheirocephalus*.

A Foliar Endodermis and the Function of the Endodermis. Almost throughout the vascular plants, the vascular system of the young absorbing root is enclosed within an endodermis, and the fact that this means that the stelar sap is enclosed within a cylinder of living protoplasts embedded in the peculiar network formed by the Casparian strip has been interpreted as the mechanism determining the osmotic entry of water into the stele. Further experimental examination of the passage of solutes across the endodermis has therefore considerable significance, and George Trapp has recently used the foliar endodermis of the Plantaginaceæ, having made a thorough study of its structure and distribution, for a re-examination of its behaviour in retaining solutes. Using relatively high concentration of non-toxic dyes, which were absorbed by cut shoots of *P. arborescens*, very definite results could be obtained in comparatively short periods of time. Dyes the diffusion of which is confined to the cell membranes were prevented from outward diffusion from the veins wherever the endodermis was present. Trapp's experiments are described and discussed, after a discussion of the structure and distribution of the foliar endodermis in this family, in the *Transactions of the Royal Society of Edinburgh*, **57**, part 2, No. 18, 1933.

Preservation of New Potatoes. The popularity of the new potato has led to investigations being carried out as to the possibility of devising some method of storage so that the characteristic flavour will be retained. Interesting results of experiments on these lines are described by A. M. Smith in the *Scottish Journal of Agriculture*, **17**, 202. Since the thin skin is one of the most highly valued properties of the new potato, immaturity at the time of lifting is essential. This is preferably achieved by anticipating the ordinary harvest by about a fortnight, as late planting (the other alternative) is liable to expose the crop to bad climatic conditions. Storage of such

immature potatoes clearly requires special treatment, as they are more liable to mechanical injury and show a greater respiratory activity than mature tubers. The greatest measure of success was achieved by the following method, attention to conditions of temperature and humidity proving of the first importance. The tubers were packed in ordinary fruit barrels of 2–2½ cu. ft. capacity and stored in a cellar at a temperature of about 40° F. The barrels held 40–50 lb. of potatoes placed in six or seven layers interspersed with a packing mixture of approximately equal volumes of granulated peat and sand, the moisture content averaging between 10 and 12 per cent. The peat helps to retain the moisture while the sand aids aeration. The presence of 1 per cent calcium carbonate appeared to reduce the tendency to sprout in some cases, but both this method and the addition of apples (also claimed as a deterrent to sprout development) need further study before conclusive evidence is obtained. As regards the best variety to use, King Edward appears to fulfil the necessary conditions most nearly, but it is probable that further trial will show that many other varieties are equally suitable.

Grassland and Grazing. An interesting résumé of the experiments on grassland management carried out at Jeallott's Hill by Mr. Martin Jones is given in the 1933 issue of the *Journal of the Royal Agricultural Society*, vol. 94. Provided a pasture lies on an adequately drained and limed soil and maintained at a satisfactory level of fertility, the character of the sward can largely be controlled by the grazing methods adopted. In the case of grassland newly sown with a simple mixture of grasses and clover, the latter could be obtained as the dominant if close grazing were carried on from March until May, competition with the earlier growing grasses being thereby avoided. On the other hand, if heavy stocking was always avoided and no grazing at all allowed before mid-April, grasses could be secured as the dominant feature. An intermediate result was brought about by resting the field up to April and then alternating close grazing with intervals of a month's rest. Overstocking in the winter and understocking in the summer induced the poor weedy condition which is of only too common occurrence on farms in general. Similar differential results were obtained with an old established pasture, where equilibrium had apparently been reached for a number of years, the rapid increase in rye grass and clover and the reduction of weeds being specially noticeable. Individual species of grass could also be encouraged at will, the predominance of rye grass or cocksfoot, for example, depending chiefly on the time of year at which the field was rested.

Gemstones. The latest of the series of handbooks on "The Mineral Industry of the British Empire and Foreign Countries" published by the Imperial Institute is one on "Gemstones" (137 pp. 2*s*. 6*d*.) which summarises in a handy form the economic and statistical information available on this subject. The introduction deals, in a popular style, with the physical characters on which the beauty of the stones depends and mentions the methods used for identifying different species. A description of the various minerals and their modes of occurrence is followed by an account of the methods adopted for cutting and polishing the stones. The main part of the book deals with each producing country, describing the stones obtained, the location, type and extent of the deposits and the method of working. Technical data for the expert and interesting information for the gem-lover are also provided. A useful list gives the London prices for cut gemstones of various qualities and weights. About five-sixths of the world's annual output of diamonds is produced in the British Empire, which is also well furnished with supplies of other important stones. Australia contributes opal; India, Burma and Ceylon provide jade, sapphire, ruby, spinel, agate, garnet, tourmaline, chrysoberyl, zircon, moonstone and the various forms of quartz; South-West Africa yields tourmaline and beryl and South Africa has deposits of beryl and emerald. The volume should be read by all interested in gemstones and in the gem industry.

Saxton's Maps of England and Wales. The county maps of England and Wales by Christopher Saxton published between 1574 and 1579 provided material for English maps for a long period, but very little is known of the method Saxton used in compiling his sheets. In many of the sheets there are certainly striking omissions of physical features large enough to be shown on the scale used. Mr. G. Manley has studied the problem in certain of the Pennine sheets and makes some interesting suggestions in a paper in the *Geographical Journal* of April ("Saxton's Survey of Northern England"). Mr. Manley finds that Saxton's choice of hills to be marked was dictated by several reasons: historic names, sources of streams, beacon hills, boundary hills and lastly a category of hills that are characterised if anything by the extent of the view which they offered from the summit but not necessarily by great height. These would appear to be hills which Saxton or his assistant climbed. He may have gone up other hills but it is unlikely. Certainly his river valleys are often incomplete at their heads. From the hill-tops he reached, Saxton seems to have estimated distances along single bearings. He was careful about detail in well-inhabited lands, but worked rapidly in uninhabited country, where his maps are weakest, especially when he surveyed by this method a rugged land like the northern Pennines and Lake District, where much detail at lower altitudes was hidden from his elevated viewpoints.

A New Objective for X-Ray Cinematography. A new objective specially computed for X-ray cinematography has been produced by Messrs. Carl Zeiss and is described in the *Zeiss Nachrichten* of April 1934. This lens has several unusual features which are of interest. For the cinematography of the fluorescent screens used in X-ray work, a very fast lens is required on account of the small amount of light available. The new lens, the *R*-Biotar, has an aperture of $f0{\cdot}85$, which is larger than that of any satisfactorily corrected lens previously available. In computing it, special attention has been given to the reduction of spherical aberration, which judging by the details given has been very successfully done. The lens has, however, no depth of focus, and a very narrow field, neither of which defects is important for the purpose for which the lens is to be used. With such a large aperture the dependence of the correction on object distance is very large, so that in its normal form the lens can only be used when the distance of

the object is large compared with the focal length. A special lens has been designed for use in sound-film work where closer objects are used. On account of its unusual proportions, the lens, which is made for both standard and substandard cinematography, can only be used in existing cameras after alterations have been made to the latter. Moreover, no iris diaphragm is provided as this would still further increase the difficulty of using it in existing cameras. With such critical focusing as is required, it is necessary to ensure that the film lies perfectly flat and that successive frames come into exactly the same place. The light emitted from the fluorescent screens used lies almost entirely within the visible region, and the transmission of the lens in this region is very good although 30 per cent of the incident light is lost by reflection at the glass-air surfaces. This lens in combination with modern high speed photographic emulsions makes possible X-ray cinematography at a picture frequency approaching that normally used.

Trichromatic Reproduction in Television. In a paper read before the Royal Society of Arts on May 2, Mr. J. C. Wilson gave an account of some experiments that have been conducted in the Baird television laboratories in an attempt to develop a television system in which the transmitted scene is reproduced at the receiver in colours. The scanning at the transmitter and receiver was accomplished by the use of a scanning disc with three spiral segments, each segment containing 15 holes. The three segments were responsible for the red, green and blue components of the picture respectively, and by rotating the disc at 600 r.p.m., the image was scanned 30 times per second in all, 10 times per second in each colour. The system is thus a trichromatic system in which the three colours are presented successively and fused owing to the persistence of vision; only one channel between transmitter and receiver is therefore required. The holes in the scanning disc were covered with the appropriate coloured gelatine filters, and the photoelectric cells at the transmitter were selected to give a satisfactory balance between the three sets of signals. The light sources at the receiver comprised a neon lamp and a mercury vapour lamp. While the colour quality of the reproduced image was apparently quite good, the definition with only 15 lines was very crude and any extension of the method is limited by the limitations inherent in mechanical scanning devices. The work was, however, mainly intended to investigate the nature of the problem and the difficulties that have to be overcome.

Removal of Sulphur Dioxide from Library Air. It is well known that books and papers stored in cities where atmospheric pollution is high are in a uniformly poorer state of preservation than similar books and papers stored in country or suburban localities where the air is purer. Experiments have shown that papers exposed to an atmosphere containing sulphur dioxide in an amount varying from 2 to 9 parts of sulphur dioxide per million parts of air for 10 days underwent pronounced physical and chemical deterioration, manifested by a large increase both in brittleness and acidity. A valuable study of a method of removing sulphur dioxide from the air entering a library has recently been published by the Bureau of Standards, Washington (Misc. Publications, No. 142. 5 cents). Tests were made in the Folger Shakespeare Library, Washington. They show that the sulphur dioxide is not completely removed from the air by washing it with untreated water in an air-conditioning system. Effective elimination was obtained on washing the air with water that had been treated with alkaline material at a rate sufficient to maintain the hydrogen ion concentration of the wash water within the range 8·5 to 9. It was proved that the sulphur dioxide content of the washed air was entirely dependent upon the hydrogen ion concentration of the wash water. The composition of a specific mixture of chemicals commercially available was found to be very satisfactory. An air washer of the commercial type using untreated water does not remove enough of the sulphur dioxide from library air. The hydrogen ion concentration should not be allowed to rise above *p*H 9·0 owing to the danger of removing zinc from brass fittings.

Nessler's Reagent. An alkaline solution of mercuric iodide and potassium iodide, probably containing the compound HgI_2, 2KI, is Nessler's reagent and gives a brown colour or precipitate with ammonia. The composition of the brown compound has been variously given since its discovery by Nessler in 1856, but in a recent study (Nichols and Willits, *J. Amer. Chem. Soc.*, April 1934) it is shown to have the composition represented by the empirical formula $NH_2Hg_2I_3$. The compound is very insoluble and tends to form in very minute particles, which are negatively charged and form a colloidal solution. These particles can be separated by ultra-filtration. They are formed instantaneously in the reaction. When ammonia solutions of higher concentrations are nesslerised, the yellow colour changes to red owing to agglomeration of the particles. This may be prevented and the colour made permanent over a wider range of concentration of ammonia by adding a protective colloid, for example, by adding to 50 ml. of Nessler solution 1 ml. of a 0·5 per cent alkaline ash-free gelatin solution containing 1 per cent of perhydrol. The colour is of as great or a greater intensity than that produced in the standard method.

Stellar Spectra of Type *B*. A detailed study of the wave-lengths, origins and behaviour of lines in *B*-type spectra was made in 1931 by Dr. Struve (noted in NATURE, 129, 442; 1932). Much work still remains to be done on these lines, and an important contribution has now been made by R. K. Marshall (*Pub. Obs. Univ. Michigan*, 5, No. 12). The spectra of 11 stars (the same as those discussed by Struve, with one exception) were measured over the range 3587–5047 A., with special attention to the near ultra-violet. They were all taken with the single-prism spectrograph of the 37½-in. Ann Arbor reflector. Intensities of all measurable lines are given as found in each of the 11 stars (which range in spectral type from *O*9 to *B*8), together with the atomic symbol, when identified, and the laboratory wave-lengths and intensities. Of the 534 lines finally tabulated as genuine, only half have been even provisionally identified, and only about two fifths of these are considered as satisfactory identifications. An interesting set of spectrophotometer tracings shows the differences between individual spectra as well as the main general features, and the variations of intensity with spectral type of the more important lines are also well marked.

The Hawke's Bay Earthquake of February 3, 1931

THOUGH not in the front rank among the seismic regions of the world, New Zealand has been visited by several earthquakes with great crustal changes, such as those of 1823, 1848, 1855 and 1929. All these occurred in sparsely inhabited regions, and the death-roll of New Zealand earthquakes has hitherto been small, the greatest loss of life before 1931 being that of 17 persons during the Murchison or Buller earthquake of 1929. For the first time in its history, New Zealand, on February 3, 1931, experienced an earthquake in the neighbourhood of important towns, the population of Napier being 16,025, and that of Hastings 10,850.

The official report on the earthquake has recently been issued*. It is the joint work of several writers. The general account of the earthquake is given by Mr. F. R. Callaghan, its geological aspects are described by Mr. J. Henderson, the director of the New Zealand Geological Survey, and the seismological phenomena by Dr. C. E. Adams, Mr. M. A. F. Barnett and Mr. R. C. Hayes. Mr. P. Marshall studies the effects of the earthquake on the coast-line near Napier, and Mr. S. W. S. Strong the uplift in Sponge Bay. In the concluding section, Messrs. A. Brodie and A. G. Harris report on the damage to buildings. The whole volume is a notable contribution to our knowledge of an interesting earthquake.

The east coast of the North Island, from Cape Palliser to East Cape, a distance of about 300 miles, is practically straight, except for the deep indentation of Hawke's Bay, 50 miles across. Napier lies on the south-west coast of the bay, Hastings about 12 miles to the south.

The first known earthquake in the district since its settlement seventy-five years ago occurred on February 23, 1863. Several houses in Napier were then destroyed. On May 7, 1890, and again on August 9, 1904, the district was severely shaken by earthquakes with centres 180–200 miles south-east of Napier. On July 21, 1921, there was a strong local earthquake with its centre about twenty miles inland. During the next ten years, a number of slight or moderate shocks occurred either along an inland band or some distance out to sea, but the epicentral region of 1931 remained inactive.

Suddenly, without any warning shocks, the great earthquake began at 10.17 a.m. on February 3 (February 2, 10.47 p.m., G.M.T.). The shock was in two parts. The first part became rapidly stronger and was an uplifting movement combined with violent and confused swaying. Then, after a pause of about 30 seconds, followed the second part with a motion resembling a sharp bump downwards. The total duration was timed as 2½ minutes. The number of known deaths was 256—161 in Napier, 93 in Hastings and 2 in Wairoa.

The isoseismal lines, depending on the Rossi-Forel scale of intensity, are reproduced in Fig. 1. They show that the intensity decreased rather regularly with increasing distance from the epicentre, except towards the south-west. In this direction, the disturbed area reached so far as Timaru, 460 miles from the epicentre, while the shock was not felt at Auckland, only 200 miles to the north-west. The area of destruction, bounded by the isoseismal 9, is elongated, being about 100 miles long and 30 miles wide. Within it is a smaller area of similar form, in which the intensity reached the highest degree, 10, of the scale.

From the seismographic records at three stations (Arapuni, Wellington and Takaba), it was ascertained that the epicentre lay in lat. 39° 20′ S., long. 177° 0′ E. This point, represented by the black spot in Fig. 2, lies close to the west coast-line of Hawke's Bay, about 12 miles north of Napier. The same records give a focal depth of about 13 miles, which is approximately

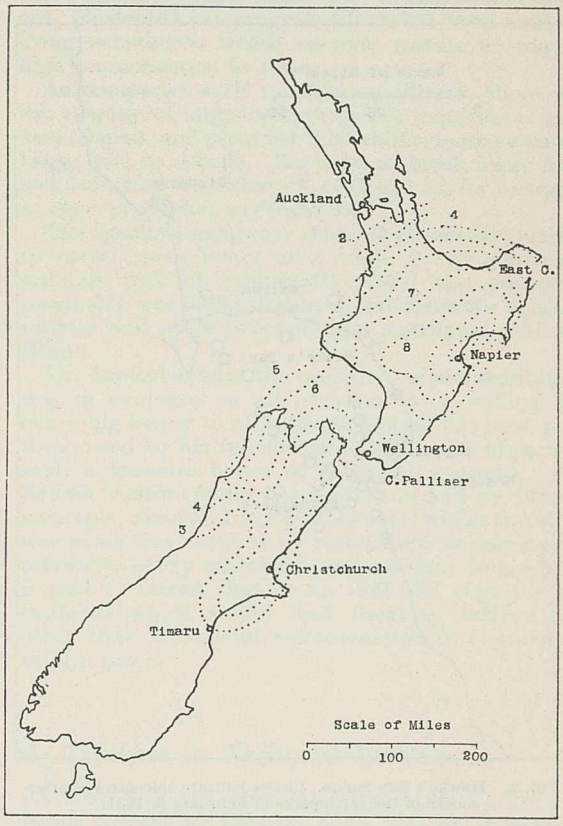

FIG. 1. Isoseismal lines of the Hawke's Bay earthquake of February 3, 1931.

the same as that of several of the stronger after-shocks.

The changes in the surface features form one of the most interesting sections of the report. About 22 miles south-west of Napier begins a series of ridges, rents and cracks extending in a general north-easterly direction for about 6 miles from Lake Poukawa. The ridges were due to the shortening of the surface, as is shown by the absence of gaping cracks farther up the slope. Their usual height is 3–4 ft., but in places they rise 6–8 ft. above the general surface. They indicate that, as a rule, the country on the west side of the ridges moved relatively eastwards, and by an amount that, judging from the effect on the wire fences, must be measured in feet rather than in inches. At one point, indeed, a road is displaced horizontally between 6 ft. and 7 ft. Still farther to

* N.Z. Department of Scientific and Industrial Research, Bulletin No. 43: Report on the Hawke's Bay Earthquake (3rd February, 1931). Pp. 116. (Wellington, N.Z.: Government Printer, 1933.) 2s.

the north are two other similar series of ridges. The persistence of these ridges, along courses several miles in length, clearly points to movements along deep-seated fractures.

After the earthquake, the uplift of the land was at once noticed at Napier and along the coast to the north. Inland, however, it could only be traced by the rise of the bench-marks. Three lines of levelling were carried across the low-lying plain to the south of Napier. They revealed the existence of a line or narrow zone of no change, running south-west from a point on the coast about a mile south of Napier, and parallel to the ridges near Poukawa, etc., described above. The country north-west of this neutral line was elevated as a whole, and that to the south-east of it depressed, the greatest

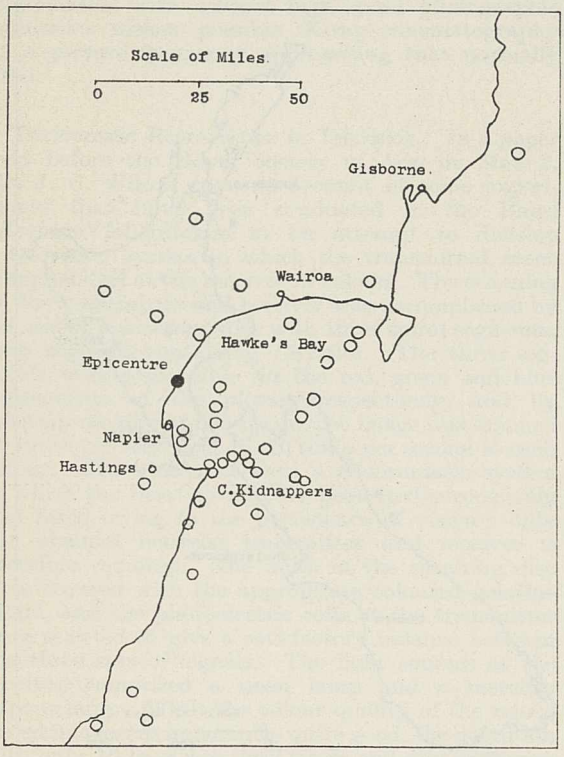

FIG. 2. Hawke's Bay region. Circles indicate epicentres of after-shocks of the earthquake of February 3, 1931.

amounts shown on the sections being about 5 ft. upwards and nearly 3 ft. downwards. The first series of levels was made between June and October 1931. In March and April 1932, the levellings were repeated, and these showed that, in the interval, the upraised mass had sunk as a whole and fairly regularly, the subsidence being most marked (a little more than a foot) at points where the previous uplift was greatest. The re-triangulation of the district revealed displacements of three points by 13 in., 13 in. and 49 in.

The disturbances of the beach first become notable at a point 7 miles south of Napier. At the north-east corner of the Scinde Peninsula, on which Napier stands, the tide-gauge indicated a rise of 6 ft. Between this point and the entrance to Port Ahuriri, to the west of the city, the uplift was manifest from the bleached remains of calcareous Algæ. The Ahuriri Lagoon is shallow and its floor flat. The outer margin was raised 6 ft. and the inner 3 ft. 9 in. As a result of this movement, wide areas of the lagoon-floor have been laid bare at all states of the tide. The total area of new land is estimated at about 5 sq. miles. Farther north, the uplift gradually increased from about 6 ft. 6 in. at a point 10 miles north of Napier to 9 ft. at one 10 miles beyond. Two miles to the north of the latter point, however, it seemed, though obscured, to decrease rapidly, until at and beyond a point 24 miles north of Napier, the uplift was too small to be discerned, with the exception of a small area to the west of the Wairoa River, in which there was a rise of about 2 ft.

The floor of Hawke's Bay is regular, the depth of water increasing slowly outwards to about 8 fathoms at a distance of one mile. After the earthquake, soundings were made in the bay. These showed a rise of about 6 ft., as on the adjoining coast. Later in February, and again a year afterwards, further lines of soundings were carried out, but, beyond the reduction in depth by about 6 ft., it was clear that there had been no marked distortion of the sea-bed.

Assuming that the fracture traced on land crosses the floor of Hawke's Bay to the uplifted coast beyond, it follows that the total length of the dislocation is not less than 40 miles, a length comparable with that of the fissures formed with the earthquakes of 1848 and 1855. Mr. Henderson thus concludes that, at the time of the earthquake, an earth-block, about 60 miles long in a north-east direction and at least 10 miles wide at one place, was uplifted, and that its central portion—and probably the whole block—was tilted gently and uniformly to the north-west.

One more phenomenon—and it is a most unusual one—may be noticed. On February 17, or a fortnight after the earthquake, some men were working on the beach of Tuamotu Island near Gisborne, when they witnessed the rapid uplift of a bank, formerly covered by a foot or two at low water, to an average height of 7 ft. They state that the reef "just rose out of the sea without warning". The new reef is in Sponge Bay, 2¼ miles from Gisborne, and has an area of about 2 acres. Its surface is slightly dome-shaped and is covered with large boulders. At the same time, the adjoining land was depressed a few feet, and broken into segments by numerous fissures. No earthquake was felt with the movement, nor was any recorded in the adjoining district.

The after-shocks were registered at Wellington, Hastings and elsewhere. At the former station, 175 miles from the epicentre, the numbers of shocks recorded were 151 on February 3, and, on successive days, 55, 50, 29, 24, 21, 12, and so on, until February 13, when there was a renewal of activity with 81 shocks, including one severe earthquake of intensity 8, with its epicentre 34 miles east of Napier. From February 3 until March 3, the total number recorded was 612. During February, 590 shocks were registered at Hastings, the total number until the end of the year being 938. The epicentres of 40 after-shocks from February 3 until the end of June 1932 were determined from the records. These are indicated by the small circles in Fig. 2. It will be seen that most of the after-shocks originated beneath Hawke's Bay, especially in its southern portion. Many of them are grouped along two bands, one running north from Cape Kidnappers, and the other in the east-north-east direction from the same cape for 10–15 miles, and then striking north-east right across the mouth of the bay.

C. DAVISON.

Exhibition of Technical and Scientific Chemical Apparatus at Cologne

THE Seventh Achema (Exhibition of Technical and Scientific Chemical Apparatus) was duly held at Cologne in the spacious and centrally situated permanent exhibition buildings on May 18–27. It is a testimony both to the importance of the exhibition itself and to the newer national development of the chemical industry in all countries that it was very largely visited by foreigners. More than 2,000 were expected, including a considerable and influential party of British chemical and chemical-plant manufacturers, who spent several days in studying it and who are reported individually to have found the time well spent.

With past traditions to encourage her, Germany is striving to retain the lead which she formerly gained in this field, and although there was nothing particularly outstanding or novel on display, there was much among the exhibits of the three hundred firms to interest the serious. The method of display of the exhibits on small open stands of uniform character has much to commend it, and was thought by many to be preferable to the closed stands adopted at the British Industries Fair. Needless to say, the representatives at the stands were well versed in the technicalities of their wares and able usually to deal with technical points raised by the visitor, who frequently also found a willingness to discuss the special problems he brought forward at further private meetings or at the exhibitors' own works. The problems of the industry are so variable that standard apparatus has frequently to be modified to meet the particular requirements, and the Germans are known to be particularly adaptable in this respect.

The exhibits covered a wide field and were perhaps the more valuable in consequence, whereas the last exhibition of British chemical plant held in London, at the time of the jubilee of the Society of Chemical Industry, was restricted almost entirely to plant. Such collective displays as those made by the publishers of the many technical and scientific books were a feature that should be copied, as also the exhibit covering safety regulations and precautions in the industry. It is proper that chemists should be as meticulous in the treatment of the health and safety of their work people as they are of their reactions, and indeed it is well known that the industry is one of the safest in spite of the potentialities for danger in it.

The tendency, if there were one, was towards the exhibit of apparatus for copying large-scale working in the laboratory. The development of chemical processes at high pressures and elevated temperatures had its influence on the apparatus exhibited, whilst the ceramic section, which was a particularly good one, illustrated the progress which has been made in using substances which corrode metals or require high temperatures to react.

As compared with the last exhibition, there was less display of large-scale processes requiring a good deal of space and plant for the exhibit, more attention being paid to details. The urge to break away from tradition was sometimes in evidence as, for example, in the vest-pocket microscopes.

The spacious gangways made it physically possible to spend some hours at a time at the somewhat arduous task of examination, and the important social side was facilitated by a club room for overseas visitors and other concomitants associated with the Rhine.

Dr. Bretschneider, the organiser of the exhibition, was in evidence on all occasions as a willing and charming helper to all visitors, and all felt how much they owed to his indefatigable energy in organising such a treasure house of chemical weapons. The British visitors found the Rhineland and the Moselle as simple, clean and convivial as ever, whilst travelling was in no way fettered by restrictions of currency or otherwise—they received a real welcome from all. It is well to record that at no time did they see any evidence which would lead them to believe that other than a peaceful reconstruction of Germany is taking place.

Annual Conference of the Association of Teachers in Technical Institutions

AT the recent (twenty-fifth) annual Conference of the Association of Teachers in Technical Institutions, held at Middlesbrough, Mr. H. J. Cull, of the Central Technical College, Birmingham, took over the presidency of the Association from Mr. F. H. Reid, of the Technical Institute, Paddington.

Mr. Cull opened his presidential address with a survey of the results of the application of science to industrial processes, and stressed specially the growth of 'technological unemployment'. "These are the days," he said, "of the second industrial revolution—the coming into full use of electricity and the internal combustion engine. The difficulties are greater than those which marked the passage into full use of steam power, mainly on account of the speed of the development." He instanced the following as illustrations of his point: the rise in production of several nations between 1925 and 1929 was 38 per cent in Poland, 54 per cent in Canada, 30 per cent in France, 22 per cent in Germany, 14 per cent in the United States and 13 per cent in Great Britain. More important, perhaps, was the physical output per worker: in Great Britain in 1924–29 there was an increase of 11 per cent. The figure for the United States rose by 50 per cent in a quarter of a century. In 35 typical American factories the output per man-hour between 1919 and 1927 rose 74 per cent. "It is futile," said Mr. Cull, "to think of retarding these scientific applications, and of 'scientific holidays', and so the consequences remain to be faced . . . it is now apparent that this machine age will demand that, if employment is to be continuous, skill will be judged by adaptability. It is for future consideration to show the precise form of the demands of this changing industrial condition on the technical teacher." Mr. Cull then linked with his general picture of these industrial changes their implications of the work of junior technical schools, juvenile instruction centres, continuation classes, regional co-ordination of technical education, etc., and the need for educational research. He also directed special attention to the course for laboratory assistants promoted by the

Institute of Physics in order to remove from some of these appointments the suggestion of blind-alley employment.

At the Association's annual dinner, the question of industrial changes and the need for adaptability was deftly sketched by Dr. R. E. Slade (Imperial Chemical Industries, Ltd.) who responded to the toast of "Education and Industry". Since world markets are changing, he said, industry must keep pace with the changes. On the north-east coast, industry has one of the finest positions in a free-trade world, but since the free-trade world no longer exists, industry is compelled to adjust itself. At the Imperial Chemical Industries works at Billingham they set out to send nitrogenous fertilisers all over the world. The plant was completed in 1929. But the world now requires only a portion of these fertilisers, and the firm had to turn its attention to other products for home and export purposes. The factory is now working hard on other things, and is being extended. Dr. Slade insisted that changes in industry can be achieved only by full confidence in technical and research staffs. Only the association of commercial minds with scientific and technical possibilities will lead to success. Workers on Tees-side, he declared, are wonderfully adaptable, and this is due to technical training.

A resolution passed during the Conference urged the necessity of grace periods up to one year in order that technical teachers could undertake research or gain further industrial experience. Other resolutions pressed for an extension of part-time day classes which would be attended by students during the normal working hours of industry, and for closer co-operation between the Board of Education and the Ministry of Labour in connexion with juvenile instruction centres.

University and Educational Intelligence

CAMBRIDGE.—Dr. O. M. B. Bulman, of Sidney Sussex College, has been appointed University lecturer in geology. M. Black, of Trinity College, has been appointed University demonstrator in geology, Dr. G. N. Myers, of Sidney Sussex College, University demonstrator in pharmacology and Dr. H. A. Krebs University demonstrator in biochemistry.

An election to the Isaac Newton studentships will be held early in the Michaelmas Term 1934. These studentships are for the furtherance of advanced study and research in astronomy (especially gravitational astronomy) and physical optics. Candidates are invited to send in their applications to the Vice-Chancellor between October 9 and October 15.

LIVERPOOL.—Dr. Henry Cohen, lecturer in medicine in the University and honorary physician to Liverpool Royal Infirmary, has been appointed to the chair of medicine in the University in succession to Prof. John Hay, who retires at the end of the present session.

PROF. L. M. MILNE-THOMSON, assistant professor of mathematics at the Royal Naval College, Greenwich, has been appointed professor as from September 30 next.

AN International University Conference has been arranged by the Association of University Teachers to be held at Oxford on June 29–July 2. This Conference will be the first attempt to form an organ of direct co-operation between universities of all countries. Among the subjects to be discussed at the Conference are: university organisation, vocational instruction, interchange of teachers, opportunities for research by foreign students, academic freedom. Further information can be obtained from Prof. R. C. McLean, University College, Cardiff.

THE first Register of the London School of Economics and Political Science (Houghton Street, Aldwych. 3*s*. 6*d*.) which has just been published contains, in addition to short biographies of former students and a list of lecturers since 1895, an interesting introduction contributed by Sir William Beveridge, the director of the School, describing its growth. At first the School did not prepare students specifically for examinations. In 1895 there was no teaching University of London, no internal degree, no university professoriate and no faculty of economics. There was an examination authority and there were individual colleges such as University, King's or Bedford, but these had no organic relation to each other or to the examining authority. The teaching University as it has grown since 1900 out of the London colleges is a new thing altogether. Since the War, there has been a rapid growth in the number of regular students of normal university type attending the School, and this has been accompanied by a decline in those listed as occasional. The number of regular students is now about 1,300, that of occasional students about 1,100, while the regular teaching staff numbers 89.

THE report of the president of Columbia University, New York, Dr. Nicholas Murray Butler, for 1933 includes a discussion of some fundamental questions relating to the organisation and development of universities in the United States. Dr. Butler admits the confusion which results from the lack of an official definition of a university in the United States and of authority for its creation and recognition. "Nothing is easier than for a college in this country to call itself a university, even though it has not the first characteristic of university organisation, method or ideal". There is no such thing as a private university, he says. Some may be supported by taxes and others not, but all are public institutions. The American college covers the field which on the Continent is occupied by the upper years of the *lycée* or *gymnasium* and the first year of the university. Hence there are but 11 universities in England, 4 in Scotland, 1 in Wales, 5 in Belgium and 8 in Holland, 17 in France and 23 in Germany, 3 in Austria, 4 in Hungary, 25 in Italy and 11 in Spain. But in the United States there are 263 universities, colleges and technological institutions approved by the Association of American Universities. Of these, 36 are institutions having a more or less complete university organisation. The *World Almanac* lists 579 universities and colleges in the United States. The tendency in the United States appears to be to regard the graduate student only as doing 'university' work. "The university student", says Dr. Butler, "has a quite different outlook and a quite different method of approach to his field of intellectual interest." The teaching staff at Columbia in 1932–33 was 3,064 (comparing with 3,255 for the previous session) and 5,609 degrees, certificates and diplomas were granted, the total number of resident students being 30,588, of whom 13,144 were graduate and professional students.

Science News a Century Ago

Entomological Society: Prizes for Essays

At a general meeting of the Entomological Society, held on June 2, 1834, the Rev. William Kirby, F.R.S., honorary president, in the chair, a scheme for the establishment of prize essays to be awarded by the Council, on the subject of noxious insects and remedies was adopted, one of the principal objects of the Society being to make its labours practically useful. Accordingly, an annual sum of five guineas, or a gold medal of the like value, would be made available for the writer of the best essay (drawn up from personal observation) upon the natural history, economy, and proceedings of such species of insects as are obnoxious to agricultural productions, to be illustrated by figures of the insects in their different states; together with the result of actual experiments made for the prevention of their attacks or the destruction of the insects themselves. It was decided that the subject of the essay for the year 1835 should be the turnip fly (Entomol. Soc. *Journal of Proceedings*, 1834).

Public Education in Great Britain

Early in 1834, Parliament had granted £40,000 for assisting the National Society for Educating the Poor and the British and Foreign School Society in erecting schools, this being the first grant of its kind. On June 3, 1834, Mr. J. A. Roebuck, M.P. for Bath, moved for the appointment of a select committee to inquire into the means of establishing a system of education. Nobody, he said, would contest that the legislature considered the moral and intellectual improvement of the people so important as to justify an inquiry, in order to ascertain how far their moral and mental culture could be affected, influenced, or promoted by the Government. The motion was seconded by Sir W. Molesworth, who considered that the education of the lower classes was as deficient in quantity as it was in its quality, and it left the minds of the people in a state of indifference which could not but be condemned by every well-thinking individual. Lord Morpeth supported the motion, remarking that the grants already made could only be looked upon as experimental, as they were quite inadequate for the purpose of general education. After considerable discussion, on the suggestion of Lord Althorp, Chancellor of the Exchequer, the motion was altered to read "that a select committee be appointed to inquire into the state of education of the people of England and Wales and into the application and effect of the grant made last session for the erection of school houses and to consider the expediency of further grants in aid of education".

The Royal Society

On June 5, 1834, ten additional candidates were elected into the fellowship, following nineteen elected previously in April. Their names were: John, Marquess of Breadalbane, Charles John, Lord Teignmouth, the Hon. George Elliot, the Rev. Frederick William Hope, Joseph Jekyll, the Rev. Robert Murphy, Sir George Rose, Richard Twining, William Robert Whatton, Dr. George Witt.

Among the newly elected in the above list, only a few can be said to have achieved distinction in science, social and family connexions in the main seeming to serve as claims to recognition. The Rev. F. W. Hope, entomologist, is held in universal esteem for his contributions to entomology, and as founder of the chair of zoology in the University of Oxford. Hope took an active part in the formation of the Zoological Society in 1826, and of the Entomological Society in 1833. Robert Murphy, mathematician, was one of the seven children of a shoemaker. He early evinced mathematical qualities of mind, and ultimately graduated at Cambridge as third wrangler. William R. Whatton, surgeon and antiquary, was not long a fellow. He died on December 5, 1835, in his forty-sixth year.

Steam to India

In the *Mechanics Magazine* of June 7, 1834, it was stated that "The House of Commons, has on the motion of Mr. Chas. Grant, appointed a select committee to inquire into the best means of promoting steam communication with India. The Messrs. Seaward, of the Canal Works, Millwall, in a pamphlet which they have recently published on the subject, recommend that vessels of very large capacity should be employed—of 1,600 tons, for example, with engines of 246 horse power. Such a vessel, they say, would allow of 900 tons being appropriated to merchandise, 100 to provisions and water and 460 to coals—which last would suffice with occasional assistance from the wind to carry her to the Cape, where a further supply of coal could be obtained. The time occupied on the voyage is calculated not to exceed eleven weeks." In 1825, the steam vessel *Enterprise* had made the voyage from Falmouth to Calcutta via the Cape, but she had taken nearly four months for the passage. Five years later, the Admiralty started a steam packet service from Falmouth to various Mediterranean ports, and through this came the proposal to send mails by sea to Alexandria, whence they would be taken overland to Suez where a steam vessel would be waiting to convey them to Bombay. By an agreement between the British Government and the East India Co., this scheme came into force in 1837, thus reducing the time for letters to reach India by a half.

Wellington as Chancellor of the University of Oxford

On Monday, June 9, 1834, the Duke of Wellington arrived at Oxford for his installation as Chancellor of the University, alighting at the gate of University College, of which the vice-chancellor was the master. His election had been received with much enthusiasm, and the proceedings of June 10–13 were marked by many brilliant gatherings. On Tuesday forenoon, he proceeded to the Theatre accompanied by Lords Londonderry, Montague, Apsley and Hill, and on opening the Convocation declared that it had been convened for the purpose of conferring the degree of doctor of civil law on several distinguished individuals including the Dutch Minister, the late Russian Minister, the Dukes of Buccleugh and Newcastle, the Marquises of Salisbury and Bute, the Earls of Warwick and Winchelsea and others. Next morning, another gathering took place in the Theatre, of which the galleries, as before, were crowded with undergraduates who cheered the names of Wellington, Nelson, Canning and Pitt and the mention of the House of Lords and the University of Oxford, but showed their disapproval of references to the University of London, the "Gower Street Company" and the admission of Dissenters.

Societies and Academies

LONDON

Mineralogical Society, March 15. ARTHUR RUSSELL: Baryte crystals from the Manvers Main Colliery, Wath-upon-Dearne, near Rotherham, Yorkshire. A cavity containing exceedingly beautiful colourless crystals of baryte was discovered in the roof of the Parkgate Seam of this colliery in 1930, and the occurrence was briefly described by C. P. Finn in the same year. Two distinct habits of crystals occurred, prismatic and tabular. The crystals are attached to cream-coloured rhombohedra of dolomite which form a coating on the grey sandstone, both baryte and dolomite being for the most part more or less thickly sprinkled with small bright twinned crystals of chalcopyrite. The crystal forms present are listed and drawings of the crystals are given. W. Q. KENNEDY: The conditions for the crystallisation of hornblende in igneous rocks. By means of a statistical study of the MgO-CaO-FeO ratios of igneous hornblendes it is shown that the latter occupy an intermediate position between the diopsidic pyroxenes and the magnesia-rich, lime-poor monoclinic and orthorhombic pyroxenes. It is concluded, therefore, that (1) pressure and the concentration of the volatile constituents are not the sole determining factors in the crystallisation of pyroxene and hornblende from a magma, but that the original proportions of the constituent oxides play an equally important part; (2) a magma which will produce hornblende as its ferromagnesian constituent under physical conditions tending towards the retention of the volatile constituents will, under effusive conditions, produce diopsidic pyroxene + hypersthene or enstatite-augite (pigeonite). ARTHUR RUSSELL: An account of British mineral collectors and dealers in the seventeenth, eighteenth and nineteenth centuries (contd.). John Williams of Scorrier House, Cornwall, mine agent and adventurer, copper and tin smelter and banker, born September 23, 1753, died April 17, 1841. The collection of Cornish minerals which he had formed at Scorrier in conjunction with his son John (born August 3, 1777, died August 11, 1849) was greatly added to by the latter. The collection, which contained about 10,000 specimens, was one of the three finest in Cornwall. In 1893 Mr. John Charles Williams disposed of the collection by presentation between the British Museum, the Royal Institution of Cornwall, Truro Museum and the Robert Hunt Memorial Museum, Redruth. In addition to a memoir of both the Williams, a general account of the collection and its outstanding specimens is given. M. H. HEY: (1) On the advantages of the face-adjustment for two-circle goniometry. The statement often made that an accurate projection cannot be so quickly prepared from two-circle measurements made with the face-adjustment as from measurements made with the zone-adjustment is shown to be incorrect, and a construction for the preparation of a projection is described. The face adjustment has several decided advantages over the zone-adjustment. (2) An improved method of crystallographic computations. A system for the computation of the elements of a crystal from two-circle goniometric measurements is described in which due weight is given to each measured angle in accordance with its estimated probable accuracy. (3) On face- and zone-symbols referred to hexagonal axes: a correction. The system of four-index hexagonal zone-symbols described by L. Weber is correct, and that formerly described by the author is abandoned. The derivation of Weber's symbols from a gnomonic or linear projection is described, and their relation to the 'three-index' symbols noted.

Physical Society, April 20. LORD RAYLEIGH: Further experiments in illustration of the green flash at sunset. An artificial source of light and a prism, the dispersion of which is equal to the atmospheric dispersion, was used. A straight edge parallel to the base of the prism plays the part of the horizon. The observer was 74 metres from the prism. On moving the eye into the shadow of the straight edge, the bluish-green flash was well seen. By means of substantially the same arrangement with large dispersion and short distances, the simultaneous-contrast effect of a red or orange background was studied, but it was not found possible to obtain a green as opposed to a blue flash in this way. With a liquid containing small particles in suitable concentration in front of the source, the disappearing flash is of a brilliant green colour. It is concluded that when the flash is bright green, atmospheric filtration is acting to remove the blue light. D. H. FOLLETT: An ultra-violet photoelectric spectrophotometer. The transmission of the sample is found by comparison with a rotating sector of cylindrical type. Two photocells are employed and fluctuations in the intensity of the source are compensated for. A. S. RAO and S. GOPALAKRISHNAMURTY: The spectrum of trebly-ionised bromine. Vacuum spark and discharge-tube spectra of bromine have been investigated over a wide range. Many of the triplets and singlets involving the terms due to $4p$, $5s$, $4d$, sp^3 and $5p$ configurations have been identified. From the present work the classifications made by S. C. Deb appear to be incorrect. The deepest term $4p^3P_0 = 404{,}892$ cm.$^{-1}$ yields an ionisation potential of about 50 v. for the trebly-ionised atom of bromine. T. C. SUTTON and H. L. HARDEN: The purity required for surface tension measurements. The extent to which impurities affect the measured value of the surface tension of a liquid depends on the method of measurement employed. This effect is applied to test whether the purity of a sample is adequate for the measurement of the surface tension of the pure liquid. E. E. WRIGHT: Velocity modulation in television. The motion of a spot of light of constant intensity, necessary to produce the effect of a sinusoidal linear distribution of light-intensity on a television viewing screen, is determined and the effect of the finite size of the scanning spot is compared with the analogous effect in the more usual type of television system in which the scanning spot moves with constant speed and is modulated in intensity.

Society of Public Analysts, May 2. A. SHAW: Determination of free silica in coal measure rocks. Whilst the method of rational analyses for the determination of free silica in coal measure rock tends to give results too low by about 2 per cent, it is far more accurate than calculations from the ultimate analysis, micrometric measurements of shale sections, or X-ray analysis. S. A. ASHMORE: A new apparatus for determining the temperature of crystallisation of cocoa butter. The temperature at which separation of solid fat occurs is a constant for each fat, and an

apparatus has been devised whereby this temperature can be determined with rapidity and precision on as little as 2 gm. of fat. The Tyndall effect has been utilised by projecting a beam of light through a small tube containing the melted fat suitably enclosed in a darkened chamber; as soon as any separation of solid particles occurs, a scattering of light takes place, and the tube appears luminous against the darkened background. S. A. COASE: Determination of small quantities of germanium in the presence of arsenic. The electrolytic reduction of germanium dioxide to monogermane has been investigated. A suitable apparatus is described and it is shown that the yield of gas is greatest when (i) the cathode is of nickel, (ii) the alkalinity of the solution is low, (iii) the current density is high. By using the electrolytic March test with a standardised apparatus, 0·027 mgm. of germanium dioxide can be detected. S. UENO and H. IKUTA: Saturated fatty acids of chrysalis oil. Palmitic acid is the main constituent of Japanese chrysalis oil; stearic acid and a saturated fatty acid of the C_{20} or C_{22} series have also been isolated.

PARIS

Academy of Sciences, April 4 (*C.R.*, 198, 1281–1328). EMM. DE MARGERIE: Notice on William Morris Davis, *Correspondant* for the Section of Geography and Navigation. L. LECORNU: The lighting of roads. Mathematical discussion of the most advantageous form for the mirrors of street lamps. EMILE COTTON: Local study of a surface and of certain integrals. RENÉ LAGRANGE: Congruences of circles which have two focal diameters. A. DELGLEIZE: The transformations of surfaces. M. GHERMANESCO: A system of equations with an infinity of unknowns. N. LUSIN: Some difficult problems of the theory of functions. S. P. LIAU: The light curve of the star *G*0 Cygni and the elements of the double system. The curve given is based on 200 observations, and from this, together with the spectroscopic data of J. A. Pearce, the constants for the double star are deduced. PIERRE VERNOTTE: The calculation of the heat losses of the walls of motors, and more generally, on various non-adiabatic phenomena. MICHEL LOÈVE: The means of Dirac's theory. P. L. CASSOU and J. CAYREL: Remarks on the true capacity of coils. T. NANTY and M. VALET: The specific inductive power of colloidal solutions. EMILE SEVIN: The reciprocal action of waves and particles in a constant field. L. NÉEL: The interpretation of the paramagnetic properties of alloys. P. JACQUET: A method of measuring the adherence of electrolytic deposits. A. ANDANT, P. LAMBERT and J. LECOMTE: The application of diffusion spectra (Raman effect) and absorption in the infra-red to distinguish between the five isomeric hexanes. By the simultaneous use of both methods, the purity of each hydrocarbon and freedom from other isomers can be ascertained. DANIEL CHALONGE and ETIENNE VASSY: The absorption spectrum of oxygen in the extreme ultra-violet. GÉRARD PETIAU: The radioactive series and the classification of the light elements. MAMAN: The preparation and some physicochemical properties of hexane and its isomers. Full details of the preparation and properties of normal hexane, isohexane, methyldiethylmethane, trimethylethylmethane, diisopropyl. JEAN ESCHER-DESRIVIÈRES, ROBERT FAILLIE and RAYMOND JONNARD: Psychomotive visual reactions resulting from an intense illumination of the eye.

GENEVA

Society of Physics and Natural History, February 1. P. ROSSIER: The relation between the abscissæ of the extremities of spectrograms of *F*0 stars. The coefficients of this relation (which is linear) differ notably from those relating to the *A*0 stars. This variation is explained, at least qualitatively, by the application of the laws of radiation and those of the spectral sensibility of the plates. P. ROSSIER: The total width of the three lines H_γ, H_δ and $H_\epsilon + H$ in spectrograms of the *A*0 and *F*0 stars. On normally exposed spectrograms, this width is a sensibly linear function of the length of the spectrogram. Its variation is more rapid for the *A*0 stars than for the *F*0 stars. The use of over-exposed spectrograms may lead to mistakes. J. WEIGLE and H. SAINI: The thermal expansion of calcite measured with the X-rays. The authors have determined the coefficients of thermal expansion of calcite measured by means of the X-rays. They have found for the mean coefficients between 20° C. and 100° C. the following values: $\alpha_{11} = 21 \times 10^{-6}$, $\alpha_1 = -4 \times 10^{-6}$, values sensibly different from those obtained by Benoit by means of macroscopic measurements, namely, $\alpha_{11} = 25 \times 10^{-6}$, $\alpha_1 = -5 \times 10^{-6}$.

ROME

Royal National Academy of the Lincei, November 5. U. CISOTTI: Differential deductions from the definition of reciprocal vectors: successive derivations (2). G. A. MAGGI: Reflection and refraction of harmonic electromagnetic waves of any form whatever at a plane surface. G. ARMELLINI: Investigations on the form of the nuclei of extra-galactic nebulæ, and on cosmic repulsion. Q. MAJORANA: Metallic photo-resistance experiments in a current of water. In order to distinguish the new purely photoelectric effect recently examined from any thermal effect occurring, the influence of a stream of water on the metal sheet struck by the light has been investigated. From the results obtained, the existence, in part at least, of the photoelectric characteristic of the phenomenon of metallic photo-resistance is assumed. G. LEVI and HERTHA MEYER: Mitotic division of nerve cells in cultures *in vitro*. A technique is described which renders it possible to observe such division. B. MANIÀ: Mayer's problem. In some cases, at least, it is possible, from the conditions sufficient for the semi-continuity of the integrals and for the existence of the solution in problems relative to the extreme limits, to deduce conditions sufficient for the semi-continuity and for the existence of the solution in Mayer's problem. MARIA CIBRARIO: Properties of the generalised numbers and polynomials of Bernouilli and of Euler. P. DIENES: A theorem of Fermi. T. WAZEWSKI: The unicity and limitation of the integrals of equations to partial derivatives of the first order. L. CAMPEDELLI: The algebraic surfaces on which curves of genus π and degree n equal to or greater than $2\pi - 2$ exist. B. SEGRE: Geometric-functional determination of groups of covariant points relative to a net of curves on an algebraic surface. A. COLACEVICH: The orbit of the visual double 831. A. SIGNORINI: Finite deformations of systems with reversible transformations. G. R. LEVI and D. GHIRON: Boron arsenate and its mixed crystals with boron phosphate. Boron arsenate, which has not previously been prepared, forms tetragonal crystals, $a = 4{\cdot}46$ A., $c : a = 1{\cdot}524$. It

gives mixed crystals in all proportions with boron phosphate, which also forms tetragonal crystals, $a = 4{\cdot}33$ A., $c : a = 1{\cdot}532$. G. AMANTEA: Determination of the beriberi quotient, Q_b; notes on technique. V. ZAGAMI: Further considerations on the food value of seeds of *Cicer arietinum L.* These seeds contain proteins sufficient to supply the needs of adult rats over a protracted period, but they are deficient in saline matter and also in other factors, probably the fat-soluble vitamins A and D. Vitamins B and E are apparently present in suitable proportions.

VIENNA

Academy of Sciences, February 15. L. PORTHEIM, H. STEIDL and F. KÖCK: Orienting investigations on the influence of ultra-short waves on flowers. Flowers and inflorescences of 47 different plant species were exposed in test-tubes in a condenser field to waves of 3·4 metres. Very high temperatures were quickly developed in the tubes, these reaching 80°–90° C. in 27 per cent of the total number within 30 seconds. Substances contained in the plant cells are evidently capable of transforming the applied energy rapidly into heat. E. TSCHERMAK: Cultivation of a native oil-fruit not sufficiently valued. Crossing of a pumpkin with huskless seeds with a husked edible pumpkin having no tendrils yields a fruit rich in comestible oil. ARNULF KNAFFL: Applicability of similarity considerations to the flow of electricity in gases ionised by X- and gamma-rays.

February 22. ERNST BEUTEL and ARTUR KUTZELNIGG: Coloured bromine sorbates. Bromine vapour is absorbed by a number of substances, including various oxides and salts, marble, and vegetable fibres, with development of more or less intense coloration. In general, substances which readily take up iodine are also good sorbents for bromine, although certain striking exceptions occur.

Forthcoming Events

Monday, June 4

ROYAL GEOGRAPHICAL SOCIETY, at 5.30.—Bosworth Goldman: "Through Afghanistan to India".

Tuesday, June 5

RESEARCH DEFENCE SOCIETY, at 3.—(at the London School of Hygiene and Tropical Medicine, Keppel Street, W.C.1).—Prof. J. Barcroft: "Experiments on Man" (Stephen Paget Memorial Lecture).

Thursday, June 7

CHEMICAL SOCIETY, at 3.—(at the Chemical Research Laboratory, Department of Scientific and Industrial Research, Teddington).—Discussion on "Chemical Syntheses under Pressure". Speakers: R. Taylor, Dr. D. V. N. Hardy and Dr. D. D. Pratt.

ROYAL SOCIETY, at 4.30.—Prof. G. I. Taylor: "The Mechanism of Plastic Deformation of Crystals".

Prof. G. I. Taylor: "The Strength of Rock Salt".

C. A. Beevers and H. Lipson: "The Crystal Structure of Copper Sulphate Pentahydrate, $CuSO_4$ 5 H_2O".

ASSOCIATION OF APPLIED BIOLOGISTS, June 8. Annual summer meeting to be held at the Wellcome Physiological Research Laboratories, Langley Court, Beckenham, Kent.

Official Publications Received

GREAT BRITAIN AND IRELAND

Amgueddfa Genedlaethol Cymru: National Museum of Wales. The Life-History of Birds: a Handbook to a Temporary Exhibition, November 1933–February 1934. By Colin Matheson. Pp. 22. (Cardiff: National Museum of Wales.) 3*d*.

The Liverpool Medical School, 1834–1934: a Brief Record. By Arthur A. Gemmell. Pp. 23+5 plates. (Liverpool: University Press of Liverpool; London: Hodder and Stoughton, Ltd.) 1*s*.

Department of Scientific and Industrial Research. Second Report of the Steel Structures Research Committee. Pp. xviii+369+25 plates. (London: H.M. Stationery Office.) 7*s*. 6*d*. net.

The Institution of Professional Civil Servants. Annual Report of Council for the Year 1933. Pp. xiv+72. (London.)

The West Riding of Yorkshire Rivers Board. Forty-first Annual Report. Pp. 70. (Wakefield.)

Ministry of Health. Report of Conference between Representatives of the Advisory Committee on Nutrition and Representatives of a Committee appointed by the British Medical Association. Pp. 7. (London: H.M. Stationery Office.) 2*d*. net.

OTHER COUNTRIES

Smithsonian Miscellaneous Collections. Vol. 89, No. 6: The Classification of the Free-living Nematodes and their relation to the Parasitic Nematodes. By I. N. Filipjev. (Publication 3216.) Pp. 63+8 plates. (Washington, D.C.: Smithsonian Institution.)

Report of the Kodaikanal Observatory for the Year 1933. Pp. 3. (Delhi: Manager of Publications.) 1 anna; 1½*d*.

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 105: Motion of Flying Boats during Take-off and Landing Run. By Taitiro Ogawa and Yosiro Murata. Pp. 291–334. (Tôkyô: Koseikai Publishing House.) 35 sen.

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 21, No. 14: Formicidæ of the Templeton Crocker Expedition, 1933. By Prof. William Morton Wheeler. Pp. 173–181. (San Francisco: California Academy of Sciences.)

Proceedings of the Academy of Natural Sciences of Philadelphia, Vol. 86. Zoological Results of the Third De Schauensee Siamese Expedition, Part 1: Fishes. By Henry W. Fowler. Pp. 67–163. (Philadelphia: Academy of Natural Sciences.)

Colony of Mauritius. Annual Report of the Royal Alfred Observatory for the Year 1932. Pp. 9. Miscellaneous Publications of the Royal Alfred Observatory. No. 14: The Cyclone Season, 1931–1932, at Mauritius. By N. R. McCurdy. Pp. 7+41 plates. (Port Louis: Government Printer.)

Journal of the Indian Institute of Science. Vol. 16A, Part 14: The Solubility of Silver Chloride. By P. C. Dave and K. R. Krishnaswami. Pp. 153–165. 1 rupee. Vol. 16A, Part 15: Contributions to the Physiology of Sandal (*Santalum album*, Linn.), Part 1: Nature and Extent of Parasitism; Part 2: Influence of Host on the Nitrogen Metabolism of Sandal. By Y. V. Sreenivasa Rao. Pp. 167–184. 1 rupee. Vol. 16A, Part 16: Indian Coal Tar. By S. K. Ganguly, B. Sanjiva Rao and P. C. Guha. Pp. 185–192. 8 annas. Vol. 17A, Part 3: The Gas from Indian Oil Wells. By G. P. Kane, K. R. Krishnaswami and H. E. Watson. Pp. 33–40. 12 annas. Vol. 17A, Part 4: Reactivity of Dimethyldihydroresorcin, Part 3: Azo-dyes and Diazo-oxy Compounds. By B. H. Iyer and G. C. Chakravarti. Pp. 41–47. 12 annas. (Bangalore.)

Conseil Permanent International pour l'Exploration de la Mer. Temperature and Salinity at the Surface of the North Sea and the English Channel. By J. P. Jacobsen. Pp. 20. (Copenhague: Andr. Fred. Høst et fils.) 2.00 kr.

Ministry of the Interior, Egypt: Department of Public Health: Research Institute and Endemic Diseases Hospital. Second Annual Report, 1932. Pp. viii+38+2 plates. (Cairo: Government Press.) 12 P.T.

U.S. Department of the Interior: Geological Survey. Water-Supply Paper 737: Surface Water Supply of the United States, 1932. Part 12: North Pacific Slope Basins. A: Pacific Slope Basins in Washington and Upper Columbia River Basin. Pp. vi+184. (Washington, D.C.: Government Printing Office.) 15 cents.

Carnegie Institution of Washington. Supplementary Publications, No. 7: Racing Capacity in the Thoroughbred Horse. Part 1: The Measure of Racing Capacity; Part 2: The Inheritance of Racing Capacity. By Dr. Harry H. Laughlin. Pp. 26. (Washington, D.C.: Carnegie Institution.)

American Psychical Institute. Bulletin 1: History of the A.P.I., an Instrumental Test of the Independence of a "Spirit Control". Pp. iii+95. (New York: American Psychical Institute.) 2 dollars.

CATALOGUES

Australia, New Zealand and the Islands of the Pacific. (Catalogue N.S. No. 12.) Pp. 70. Periodica. (Catalogue No. 13.) Pp. 12. (London: Wm. Dawson and Sons, Ltd.)

Geographie, Ethnographie, Prähistorik, mit einer grossen Anzahl von alten geographischen Werken. (Antiquariats-Katalog 218.) Pp. 42. (Leipzig: Max Weg.)

Livogen (Liver Extract with Vitamin B and Hæmoglobin.) Pp. 4. (London: The British Drug Houses, Ltd.)

B. T. L. Monthly Bulletin. No. 18, May. Pp. 4. (London: Baird and Tatlock (London), Ltd.)

Catalogue of Botanical Books from the Library of the late C. C., Lacaita. (Catalogue No. 222.) Pp. 32. (London: Dulau and Co., Ltd.)

Catalogue of Books on all Technical Subjects and Applied Science. Pp. 110. (London: W. and G. Foyle, Ltd.)

Object Glasses, Mirrors, etc., for Astronomical Instruments. (Pamphlet No. 105.) Pp. 8. (Newcastle-upon-Tyne: Sir Howard Grubb, Parsons and Co.)