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*" To the solid ground
Of nature trusts the Mind that builds for aye."*—Wordsworth.

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NATURE

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SATURDAY, JANUARY 5, 1935

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Cultural Significance of Broadcasting*

THE speed with which in a decade or so broadcasting has passed from being the interest or hobby of an expert few into the pleasure and recreation of millions has tended to concentrate attention on the purely scientific and technical developments which have made this change possible. The reactions of this rapid growth upon the listener himself, the new problems which broadcasting itself may offer, have escaped attention except by a few, and it is only slowly and with difficulty that broadcasting is emerging from the toy stage to that of laboratory and workshop for human culture.

The scientific inquiries into international aspects of broadcasting, which have been initiated by the International Committee of Intellectual Co-operation of the League of Nations, afford an example of the widening field of scientific research and the possibilities, and responsibilities, of what may be termed social research which arise out of technical advance, and are in keeping with those studies of the effect of the cinematograph on education, instruction or national life visualised by the first International Congress on Educational Cinematography in Rome last April. The first of the inquiries set on foot by the International Committee was a survey of educational broadcasting throughout the world. The substantial volume which embodies its results contains an authoritative account of experiments, results and projects in twenty-five countries, as a result of which a

* School Broadcasting. (Intellectual Co-operation Series.) Pp. 208. 7*s*. 6*d*. Broadcasting and Peace. (Intellectual Co-operation Series.) Pp. 232. 7*s*. 6*d*. (London: George Allen and Unwin, Ltd., 1934.)

statement of the leading principles of school broadcasting has been prepared which should be an invaluable guide in further experiment leading to the perfecting of this new method.

The inquiry makes it clear that school broadcasting has a place of its own in primary, secondary and higher education, but the technique of its use, the choice of subjects, methods of presentation, manner of incorporation in the general framework of classroom courses, and the full potentialities of the method, are only being evolved. Studies of this type are of great assistance in the development of an adequate technique. They throw light on the true reasons for failure, and are correctives to its indiscriminate use or rash condemnation.

The second investigation was a study of broadcasting in relation to peace, to which indeed a brief section in the first report is devoted. The dangers which broadcasting may present in regard to international peace and goodwill have been made plain abundantly by unfortunate incidents between Germany and Austria in the last two years. The dangers of the use of this method as a means of political propaganda are less obvious but none the less real, and the report which the International Committee has produced on this question will repay study by all who approach broadcasting in the spirit of scientific inquiry.

The third inquiry upon which the International Committee is now embarking relates to the possibilities, problems and methods of cultural broadcasting in its widest sense, and may prove to be the most fundamental and interesting of the three researches. The investigation deals with the organisation and contents of programmes and their national and international co-ordination, the possibility of broadcasting university extension courses, the social training of listeners, the announcement of scientific discoveries, instruction in literature and history and the teaching of foreign languages.

Studies of this order at once throw into relief the difference between the broadcast to an unseen audience and the lecturer who can see and adjust his lecture to the reaction of the audience in front of him. Beyond this there is the development of the precise technique which makes it possible to convey new vistas to a voluntary adult audience, without any suggestion of superiority or of the schoolroom. Pooling of experience and ideas on this difficult art is a first step to a scientific technique.

It is at least arguable whether the technique of broadcasting will not be ultimately more art than science. Unquestionably, however, psychology has an important contribution to make in this field, and at the International Congress of Anthropological and Ethnological Sciences in London last August, Prof. T. H. Pear pointed out several lines of research which still await the attention of psychologists and anthropologists. Prof. Pear's paper in itself indicates that the psychologist is alive to the problems which broadcasting and the film present. As an observer of human experience and behaviour, he cannot ignore the serious disturbance which they both represent in the life of the citizen, and he must attempt to find the reasons for the likes and dislikes which he observes.

Problems of this type present in fact a striking field for laboratory work, but as Prof. Pear emphasised, with certain special exceptions in regard to school broadcasting and the request for opinions on the broadcasting of drama, practically no systematic research has been carried out in Great Britain into the pyschological and other problems created by broadcasting. Little intensive or extensive research even into listeners' likes and dislikes and the reasons for them has been made, and the evidence that those responsible for the provision of radio programmes are really anxious to discover the views of the general public on the material is unconvincing.

Prof. Pear suggests that this omission is due to the fear that the results of such inquiries would necessitate either a grading up or a grading down of the programmes. If this is the correct explanation, such an attitude to research is unworthy of an industry based so fundamentally on scientific research as the broadcasting industry. Indeed, this attitude inevitably foreshadows the decay of the institutions or organisations which hold it. Change and development cannot be avoided by mere passivity, and if the broadcasting authorities are not prepared to conduct research into these fundamental problems of their art, sooner or later their power and influence will pass into the hands of those prepared to undertake the work and apply its results. Nor can society tolerate for long any organisation which does not seek to equip itself continuously to render ever more effective service based on the full, impartial and fearless exploration of the whole domain which it affects to control.

The reports and the papers to which we have referred indicate, moreover, that scientific workers themselves have special interests and responsibilities in this matter. On one hand, the possibilities which broadcasting presents as a means of diffusing scientific knowledge, and also of carrying on that educational work which is so essential if the ordinary citizen is to acquire an adequate general background for the kind of life he is called upon to live in these days, have been neither fully utilised nor explored. Evidence presented in the report on educational broadcasting already indicates a considerable volume of opinion in Belgium, France, Switzerland, Germany and the United States as to the value of broadcasting in relating scientific work to the general interests and activities of the community. Scientific workers have yet to seize the opportunities for exposition which here confront them when they have qualified themselves by acquiring the requisite technique.

On the other hand, to the true spirit of science, the fields of investigation touched upon by Prof. Pear represent an even greater attraction. There could scarcely be found a more inspiring example of the twin responsibility and challenge in respect of social research which the application of scientific discoveries throws down to the man of science himself, than these fields of investigation which now lie before us, in broadcasting and cinematography alike, demanding his close co-operation if they are to be possessed for the welfare of civilisation and not contribute to its undoing.

Reviews

Isaac Newton

Isaac Newton: a Biography. By Louis Trenchard More. Pp. xiii+675. (New York and London: Charles Scribner's Sons, 1934.) 18*s*. net.

At last we have an adequate biography of Newton. Prof. More would not wish us to say it was perfect—that would have been impossible—but he has spent seven years reading the documents and considering them, and he does not hesitate to tell his opinion, even if unfavourable. We have got into a period of biography where an unfavourable opinion has rather a preference for expression. But Prof. More is not that kind of biographer. He has a respect, almost a love for Newton, though far "this side idolatry", and deliberates a long time before he comes to an unfavourable opinion.

Newton has fallen into bad hands among his editors and biographers. Horsley was a person who did not see the difference of interest that future times would attach to works by Newton and lucubrations by Bishop Horsley. Prof. More convicts him of quite definite suppression of documents which he examined, and which would have proved Newton a 'Socinian', or as we now say, a Unitarian. Leaving Horsley aside, as too bad to mention, Brewster figures to Prof. More in much the same way. He, too, suppresses documents that he does not like. One must make allowances for him. He presented Newton as *possibly* a *very mild* Socinian, and even then, was rebuked by a bishop for it. But he must have got on Prof. More's nerves. In fact, he wipes the floor with Brewster, after the presentation of each incident. He was indeed a most unsuitable person. A biographer of someone whose greatest period of creation was at the Restoration, and who died more than two hundred years ago, ought to be imaginative, catholic, sympathetic with all and sundry, and Brewster was not that. The other biographers portray one point of view only. Edleston seems to be careful and accurate, but has done only a scrap. Rigaud's essay is the same. The separate contributions to Greenstreet's volume are of very unequal merit; some are valuable, many are by good names, but some are quite off the mark. Then there is Lieut.-Col. de Villamil, who astonished everybody by making no less than four capital discoveries; the chief of them appear to me the actual inventory of all the items which Newton's house contained, drawn up with extreme thoroughness; the actual list of Newton's books, now among the MSS. of the British Museum; and an actual statement of his money affairs at his death, including a criticism of any dealings he had in South Sea stock. Yet despite the richness of the material, the book in which he published it remains a poor affair.

Newton was little understood in his time. We cannot wonder. Scientific men are usually little understood; very few people care for pure logic, or are prepared for the surprising consequences, if it is pushed to the uttermost. But besides, Newton was habitually a silent man. He was not a ready speaker. His notion appears to have been, to say something conclusive and leave it at that, whether it was understood or not. This sort of thing does not go to the heart of the ordinary man or woman. But women had no influence in Newton's life. He began life poor and ended it rich; yet he used no corrupt practices and was generous in giving. Opposition had a very bad effect upon him—for did he not *know* it to be unreasonable? Yet most people would say that he had not more opposition than was good for him, to teach him the sort of world he was in. His life was not a pathetic life ; he had none of those amiable weaknesses that make us forgive a great deal to Goldsmith and Richard Savage. He moved among ordinary men that we can visualise, such as Pepys, Hooke and Oldenburg. But all seem to have felt that he was greater than they, and different, and that he required nothing from them. Later, this feeling seems to have congealed into a spell, which accompanied him as an unwholesome and impenetrable aura. This spell has been the greatest obstacle to acquiring a true view of Newton.

The incidents of Newton's life are indispensable, but only because his theories grew up among them. I do not think that the scientific views were much changed by the incidents, but undoubtedly their presentation was. His ideas are what matter to us now, the views that have, almost miraculously, kept their shape.

I have often wondered why Newton made no capital discoveries in chemistry, which he studied and practised so assiduously, and made absolutely revolutionary discoveries in mechanics and optics. I think I know now. The discoveries in optics were made because he was an unusually good experimenter, and knew, after he had "meditated", no man better, the immediate and ultimate inferences that his experiments required. The discoveries in mechanics, the laws of motion and the philosophical system on which they are based, are just "meditations", the object being to find something that would stand metaphysically. Metaphysics was the bane of science in those days, but since it cannot be excluded, Newton built a wall, guaranteed to stand any attack, within which his mathematics could operate undisturbed. His mathematical theorems in the "Principia", as well as his other very notable contributions to the science, are just inferences—of course *in excelsis*—from stated data. But why did he add nothing to chemistry ? Chemistry was much studied in Newton's day. Boyle was his friend, and Boyle has given us Boyle's Law. Locke, also a friend, was a chemist, even an alchemist. Van Helmont's works are in his library. Newton read the unprofitable volumes of the alchemists, I think to ascertain whether he could learn anything from them. In one of his letters, he speaks of them as "great pretenders". I think the phrase is sarcastic, meaning that you get nothing in the end.

What then was Newton seeking ? I admit that incidentally he was seeking transmutation. But he did not find it. I cannot believe that he laboured so long in vain. There is a great resource if we want to ascertain Newton's undemonstrated ideas, upon subjects on which he had "meditated"—the "Queries" which he attached to the optics. Many of the ideas which he had derived from his study of alchemy he put in the long, final query, No. 31. Prof. More quotes much of this query. Reading it through, one sees that Newton was looking for a common basis of all matter, and the mechanism of the transmission of energy and gravitation across space. From this point of view, Boyle's Law becomes a mere incident, which might be expected to become almost self-evident. But we now know that there is a very long and thorny road to go before we arrive at a common basis of matter. We are scarcely agreed upon it yet, but let that pass. Even supposing, what does not seem likely, that Newton had avoided *all* the pitfalls, and would have had nothing to do with a "phlogistic" theory, which proved such a will-o'-the-wisp to chemistry, he would have seen in face of him, beyond gross matter, the immense jungle of the carbon compounds, the molecules, the elements, the atoms of these elements, the structure of these atoms, the positive and negative element of electricity, and finally the quantum. The spectrum, even, was unknown to Newton. We can scarcely imagine the structure of the atoms being unravelled, apart from the spectrum. Except some astronomical examples, all measuring instruments were exceedingly crude. The balances are shown with rough strings to the pans, nor was the dependence of chemistry upon a balance realised. So if we read through Query 31, and say "quite possibly right", we must remember that this rightness is only possible if we think in electricity. I understate the task, but actually it was impossible ; there was no body of facts such as we have now—for example, the periodic system ; the "shoulders of giants" were wanting, from which Newton could look out over the future.

At the present time we are surrounded by uncertainties. We must remember that Newton was rooted in certainties—in three at least. These were, the actual words of Scripture, the "geometry of Euclid and Apollonius", and the inferences of logic. He was also endowed with a peculiar aptitude of devising and performing experiments. He "meditated" upon their consequences, by which we must understand that he saw, as none other has been able to do, all that they implied. That is the reason why, when he had arrived at a conclusion, he made no allowance whatever for those that questioned it ; and at first, when he was a young man and unknown, they were very numerous. Later, when it was enough to say "Newtono suadente", I agree with Prof. More that the deference he enjoyed reacted unfavourably upon his character. Prof. More describes the early paper in which he demonstrated his optical theories to the Royal Society as a "work of art".

This is well said. Newton was an artist, though not in paint or stone. He was, apparently, contemptuously indifferent to any work of imagination. But no one who has read the "Principia", or any of his letters, or even seen his beautiful handwriting and signature, can doubt that he was an artist. He was an artist, because he loved beauty; he thought it the direct expression of the Divine, as it is presented to us. He had moreover the artist's temperament, which showed itself, as it did in Rossetti, in rather overbearing conduct.

We have seen all these grounds of certainty fade away. Geometry went first, because it was in the hands of people who had a common ground, and were able to realise when a theorem was proved. As to the Scriptures, whatever view we attach to the Bible story, we now regard the Bible—for the most part, and subject to some delegation of authority in matters of such importance—as a book among other books, to be examined textually and in substance, confronting different statements to see whether they agree, by any method that the higher criticism may choose to apply, estimating the contents by whether we think the thing did occur or did not. Most people, nowadays, would smile if they were asked to believe in Bishop Ussher's date for the creation, or the ages of the patriarchs, and Jonah's whale.

Now logic seems to have joined the other two on the same road, and to melt away "like wracks in a dissolving dream", and prove just nothing at all. We are told that if we "prepare" an experiment, we prescribe the answer also, which is always *yes*, if the question is not nonsensical. Exit "Q.E.D.", and enter "Sez You".

Now that we can see Newton "in the round", we can form an estimate of his value, apart from what everybody knows and has known for two hundred years—that he was an incomparable genius in both theory and experiment. Roubillac was a great artist, and has caught most admirably in marble the expression which we can attach to his "meditations"—"the index of a mind forever voyaging through strange seas of thought, alone". Certainty was the note. Experiment, and inference, and experiment again—that was the indispensable key to progress; and a very good key it has proved, supposing "progress" is what we want, for it has made scientific men, where they are not leaders of the modern world, at any rate necessary authorities on all the things that other people want to answer and cannot.

But in deifying Newton, as he has been, rather grotesquely, deified up to the present, we must think of Lieut.-Col. de Villamil's "Inventory", and his list of books. Most people will read them with astonishment; it is possible some may comment "Stuffy old house. Not a single valuable piece of furniture. Crimson, a bad note. Stuffy old books. Not a single book of verse among them except those that he may have read at school. Not a single live book, except Galileo's 'De Systemate Mundi'. No Copernicus. No Kepler". They will issue from it with relief. There is no doubt that Newton appears in these authentic, if unsentimental, documents as a limited person. Nowadays we rather distrust certainty. We doubt whether we are the people to handle certainties, if someone would point one out. Besides, their field is too narrow, and we have found that we can learn all we want to know from most regions by a few well-chosen experiments, and by the general bearing of the replies. To speak of geniuses alone, Shakespeare represents much more the kind of man who might tell us something we wanted to know. You find profundities among his words, but mixed up with guffaws and sniggers and the interjections of people who just happened to be by and were certainly not profound and had no wish to be. "We are such stuff as dreams are made on, and our little life is rounded with a sleep". Would you put an automatic pistol into the hands of a dream person? He might dissipate the dream.

R. A. S.

Hamites and Semites

Semitic and Hamitic Origins, Social and Religious. By Prof. G. A. Barton. Pp. xvi+395. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1934.) 17*s.* net.

MORE than thirty years ago, Prof. Barton wrote a book on Semitic origins when he was very strongly under the influence of Robertson Smith. Owing to the strides which have been made in the study of the prehistory of Egypt and western Asia since that date, Prof. Barton now confesses, quite frankly, that there is scarcely a topic of importance in his earlier work—such, for example, as totemism, descent and marriage among the early Semites—upon which he has not had reason entirely to change his views.

Prof. Barton now attacks Hamitic and Semitic origins once more, moving on a wide front which embraces linguistics, ethnology, archæology, social anthropology and religion. In his view that the nations of western Asia were of a very mixed character, most prehistorians will concur; but they would also point out that the evidence upon which he relies is mainly linguistic and cultural, and does not necessarily imply wide differences in racial strain.

In regard to the origin of the Hamites and Semites, the view here put forward by the author is that the Semites were one branch, the early Egyptians being another, of a stock which originated in North Africa, possibly in the Sahara. They crossed to southern Arabia, and there developed their peculiarly Semitic characteristics. A later fission led to the further differentiation of the northern Semites, who are usually regarded as the purest representatives of the race. The occurrence of a strong brachycephalic element in the southern parts of the peninsula is held by Prof. Barton to be due to the fact that this territory long served as a passage-way for commerce and racial movement, so that an alien element partially submerged the older dolichocephalic strain. These are the brachycephals whom Sir Arthur Keith identifies as an intrusion of broad-headed people from the north, akin to, but not identical with, the Armenoid, holding that it is more nearly related to the broad-headed element, presumably from Central Asia, which appears in parts of India.

In his racial and cultural analysis of early Mesopotamian civilisation, Prof. Barton attaches much importance to what he characterises, somewhat vaguely, as a central Asiatic people, regarding the Sumerians as relatively late. It is to be noted, however, that Dr. Dudley Buxton, in his study of skulls from Kish, while recognising the existence of a broad-headed element in the early population, has expressed doubts as to whether the brachycephals from the Asiatic highlands penetrated the Mesopotamian area to any great extent in the earlier phases of its civilisation. In attributing the prehistoric culture of the Indus valley to his central Asiatics, Prof. Barton seems to ignore the trend of evidence which points in an increasing degree to a cultural connexion with western Asia.

In dealing with social and religious origins, Prof. Barton traces further the differentiation between the early Egyptians and the Semites. He shows how the peoples, or rather tribes, who entered the Nile valley when driven from what is now the Sahara by desiccation, brought with them animal cults and totemic beliefs, which afterwards developed into the various animal cults of the Egyptian nomes and later into the Egyptian pantheon. The Semites, on the other hand, elaborated as the characteristic expression of their beliefs a fertility cult, of which the central motive was the union of the male and female deities and its principal observance two seasonal festivals, one in spring and the other at harvest. The institution of temple prostitutes and cognate observances, once interpreted by the author as evidence of an early state of sexual promiscuity and polyandry, he now accepts as part of the fertility cult. In following Sethe's recent work on the totemic character of the cults of the Egyptian nomes, the author adopts a view which was advocated by Andrew Lang many years ago and accepted by the late Prof. A. H. Sayce, though this fact is not noted.

The interest of Prof. Barton's work in its reference to the racial problem has precluded detailed consideration of his study of questions relating to other aspects of social institutions and religious beliefs. In particular, his views on the origin and development of the Yahweh cult and the growth of monotheism among the Hebrews tempt discussion which space does not permit.

Unfortunately, it is necessary to close on a note of criticism. In dealing with the argument from physical anthropology, Prof. Barton fails to maintain the level of his scholarship in other fields. It cannot be said that he has mastered his material; nor does he appear to be acquainted with the most recent literature, such as, for example, Buxton's later work on the material from Kish and Miss Garrod's more recent results which reveal a population of mesolithic age in Palestine resembling the predynastic Egyptians. Misprints and errors in this section of the book are innumerable. "Meyers" for Myres, "Sir *Charles* Keith", "Borm" for Bornu, and "Miss Caton-Thompson" when Miss Garrod is intended, may be slips; but they suggest a lack of the familiarity with the literature, necessary for a study of this character, which would correct them almost automatically.

Standard Analytical Reagents

'Analar' Standards for Laboratory Chemicals: being Improved Standards for the Analytical Reagents formerly known as 'A.R.'. Pp. xvi+295. (London: British Drug Houses, Ltd., and Hopkin and Williams, Ltd., 1934.)

IN 1914, when chemists found themselves deprived of the usual Continental supplies of laboratory reagents, a joint committee appointed by the Institute of Chemistry and the Society of Public Analysts drew up specifications to ensure a sufficient degree of purity in eighty-eight chemicals of importance in analytical work. Reagents of this quality were distinguished by the letters "A.R.". This useful action was taken merely as a War-time emergency measure, and has not been continued by the two societies.

The letters "A.R." acquired considerable prestige in this connexion and it is unfortunate that, as is implied in Prof. J. F. Thorpe's interesting foreword to this book, they should have lost their original significance by uncontrolled extension of their application. Chemists are not entirely without a remedy for this state of things. The British Pharmacopœia 1932, and the British Pharmaceutical Codex 1934, between them provide standards for practically all the materials used in medicine. These include a large number of chemicals and it is only necessary to add the letters "B.P." or "B.P.C." to a requisition for one of these products to obtain it of the standard quality. Specifications for chemicals of industrial importance are also being gradually produced by the British Standards Institution and the few so far dealt with can be obtained of the prescribed quality by use of the letters "B.S.S.". Chemists might do worse than familiarise themselves with these three sets of authoritative standards and make use of them, where they meet their requirements.

These standards do not, however, cover the whole field, and there is still need for a modernised and extended set of specifications corresponding to the original "A.R." list. Thus, the growing importance of micro-methods of analysis and the improvements in technique, which make it possible to determine with reasonable accuracy small fractions of a milligram, are creating entirely new requirements, both in kind and quality of analytical reagents. For such work it is all-important that the operator should know the degree of purity of each reagent he has to use.

This kind of information is provided for two hundred and twenty chemicals in the book before us. The more important physical properties of each product are recorded, the methods of assay and the processes used for the determination of impurities are given, briefly, but with ample details, and the maximum limits of all likely impurities are stated. The two firms concerned are well known as makers of laboratory chemicals and have each published books of specifications for these products. They still manufacture independently, but have pooled their technical information and unified their methods of analysis and their specifications for the chemicals dealt with in this joint publication, an enterprise on which they are to be congratulated. They have also registered jointly the trade-mark "Analar" to distinguish the products they manufacture in conformity with these specifications. This action protects both the manufacturer and the consumer against the kind of deterioration which is said to have overtaken the standards implied by the letters "A.R.".

Short Notices

This Modern World and the Engineer. Pp. 140+18 plates. (Edinburgh: Royal Scottish Society of Arts, 1934.) 5*s.* net.

A GROUP of five distinguished engineers and one equally distinguished physicist has given us a concise and popular, although none the less authoritative, account of modern developments and trends in engineering. The book is essentially a presentation of the Keith lectures for 1933 of the Royal Scottish Society of Arts. With one exception, the authors are professors in the University of Edinburgh; hence the lectures "may be said to express the views of the Edinburgh School of Engineering on the tendencies in the several branches they treat". Prof. C. G. Darwin, Prof. A. R. Horne, Sir Thomas Hudson Beare, Prof. F. G. Baily, Dr. R. Lessing and Prof. H. Briggs survey the fields of physics and of mechanical, civil, electrical, chemical, and mining engineering, showing us, with apt illustration, how directly and completely life in this modern world depends for its very existence on mechanism and its human control.

This volume, however, does more than offer information; it places before us some of the world's major social problems, and leaves the layman—What more ingratiating way of evading responsibility has been discovered than this of calling one's self a layman ?—with a brainful of thoughts to weave into his economic and political creed. Prof. Briggs, in his "Extrapolation", shows that present-day engineering rests on a non-ethical basis, but he calls upon the engineer to consider questions of rights and consequences, and at a stride to identify himself professionally with his responsibilities as a civilised human being. The engineer could make war difficult by disqualifying from membership of powerful professional institutions all connected with the manufacture of arms. Organised control of industry could classify new inventions or processes as work-making or work-taking, and exploit them accordingly for the greatest good. Estimates relating to such processes should include consequences arising outside the factory walls. These and other matters which are presented for our thoughtful consideration remind us how illusory is the barrier now between technology and sociology. A. A. E.

A Soldier in Science: the Autobiography of Bailey K. Ashford. Pp. v+425+4 plates. (London: George Routledge and Sons, Ltd., 1934.) 12*s.* 6*d.* net.

COL. BAILEY KELLY ASHFORD, of the United States Army Medical Service, died on the day on which his autobiography was published. His work in scientific medicine falls into two main parts, hookworm and sprue. In 1899 he found hookworm eggs in the fæces of anæmic Porto Rican peasants, and by mass deworming lowered the island's mortality from anæmia by 85 and increased the peasant's working capacity by 60 per cent. He recognised that the worm was not the well-known Old World hookworm, but it was left to Stiles to designate it *Necator americanus*. In 1933 Ashford illuminated acute hookworm infection by his description of a small epidemic acquired during sea bathing. During the War his main charge was the command of the school at Langres for the battle training of American medical officers. He was awarded the D.S.M. and Honorary C.M.G., and the Grand Cordon of the Order of the Nile, and was appointed editor-in-chief of the United States Medical History of the War. He was instrumental in founding in Porto Rico an Institute of Tropical Medicine and Hygiene, and in arranging for its expansion into a School under the auspices of the Columbia University, New York. After experience of 4,000 cases of sprue he concluded that the essential factor in its causation was unbalanced diet, and that when to this was added infection by *Monilia*, of which he recognised only one species, there resulted sprue. He unswervingly advocated and fruitfully practised that combination of clinical observation and scientific investigation which has strikingly advanced tropical medicine.

CLAYTON LANE.

Thoughts of a Schoolmaster (*or Common Sense in Education*). By H. S. Shelton. Pp. 256. (London: Hutchinson and Co. (Publishers), Ltd., n.d.) 6*s*. net.

THE strength of this book lies in the rich variety of its author's experience. As a boy he was in four schools, and as a master in twenty-five, including public, grammar, co-educational, private, proprietary and technical schools. Not that by nature he was a 'rolling stone', but that by necessity he was transferred from place to place during the War. He deals only with secondary schools, and he touches many topics, including the 'unpopularity' of schoolmasters, the tradition of the headmaster, salaries, co-education, discipline and so on; and whether one agrees with him or not, his criticism is always practical and to the point, and it is often constructive.

On the subject of science teaching, Mr. Shelton condemns the general neglect of biology, and suggests, as a practicable reform, advanced courses in biology, with interchange between neighbouring schools, and special attention to biology in country schools. He pleads also for universal courses in general science, not, however, made up of scraps of chemistry and physics and biology and geology and astronomy merely strung together, but conceived as a single subject with many interrelated divisions. The author is not, and probably does not claim to be, free from the charge of dogmatism. But he writes with knowledge, at a time when our secondary school system is very far indeed from being above criticism.

The Principles and Practice of Surveying. By Prof. C. B. Breed and Prof. G. L. Hosmer. Vol. 2: *Higher Surveying*. Fourth edition. Pp. xix+603. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1934.) 21*s*. 6*d*. net.

ALTHOUGH this work is an American publication, it deals with its subject in such a way as to be as suitable to students as most of the well-known English books thereon. It is extremely well set out and lucid in style, and includes such modern developments as those of geology in relation to topography, and aerial photography as applied to surveying. A most useful set of problems is appended at the end of each section, but it is unfortunate that the answers to these are not given.

With the increasing use of precise levels, fuller details relating to the parts of such instruments could have been given with advantage, while the reproduction of the photographic illustrations is not up to the standard of the letter-press. It would not be usual in Great Britain to expand the portions relating to the flow of water in channels to so great an extent, these constituting a chapter generally found in large works on hydraulics.

The size and method of binding is evidently designed for field use; in its general tenor, the work can be confidently recommended to students who are preparing for engineering degrees of honours standard, and to all who are interested in the subject.

B. H. K.

Progress of Archæology. By Stanley Casson. Pp. xii+111+24 plates. (London: G. Bell and Sons, Ltd., 1934.) 6*s*. net.

MR. CASSON surveys progress in archæological discovery during the last fifteen or twenty years throughout the world, dividing it into nine main archæological provinces. His purpose is to touch upon the most significant discoveries or excavations in each and to bring out, where such consideration is appropriate, their interrelation. Mr. Casson's book is pleasantly and easily written and well illustrated; but on even the most generous interpretation of the lines upon which a book of this kind can be written for an educated but non-technical public, it is far too sketchy. The treatment of Africa, even including Egypt, and of America, for example, is quite inadequate, in view of recent work in both continents. The first chapter, on the aims and methods of archæology, is by far the best, though it shows some confusion of thought, and the definition of the field of archæology not only begs the question, but also is contradicted by the pages which immediately follow.

Practical Plant Anatomy: an Elementary Course for Students. By Comyns J. A. Berkeley. Pp. 112. (London: University of London Press, Ltd., 1934.) 3*s*.

A GOOD practical guide to elementary botany is sorely needed, and this book by Mr. Comyns Berkeley will fill part of the gap; the practical plant anatomy is dealt with, and this is done extremely well. The author is obviously conversant with the practical side of botanical study, for he not only gives clear directions as to methods of approach but he also gives hints of difficulties—sometimes slight, but irritating—that are constantly cropping up. Another problem that students and even teachers are constantly meeting is that of sources of material. Few books give the reader any idea of where to obtain their type specimen. Mr. Berkeley gives sufficient help in a series of tables. This is very useful.

It is a pity that the author did not go a little further and cover completely an intermediate science course in botany.

Immigration of Insects into the British Isles

By DR. C. B. WILLIAMS, Chief Entomologist, Rothamsted Experimental Station

ABOUT a hundred years ago, it was gradually dawning on British entomologists that many of the butterflies in this country might be immigrants from abroad. Among the species first suspected of this habit were the Clouded Yellow (*Colias croceus*) and the Pale Clouded Yellow (*C. hyale*). It is curious that about the same time a more practical controversy was commencing in the United States as to whether one of their most serious pests, the cotton worm (*Alabama argillacea*) was a permanent resident of that country, or not. To-day we know that not only these early disputed species, but also many other Lepidoptera, dragonflies, and some members of other groups of insects, regularly migrate, and that in a number of cases these movements come to an end in the British Isles, thus giving the insects in question the status of 'immigrants'.

In the study of migration it is possible to start from two points of view. We may study a single insect throughout the whole range of its migration. An example of this is seen in an account that I gave of the migration of the Painted Lady butterfly (*V. cardui*) in NATURE of April 11, 1925 (p. 535). This is, in my opinion, the most fruitful method of investigation. The alternative is to study the migration phenomena of all insects as seen within a limited area. By this method it is easier for a single investigator to take field observations, and easier to obtain the co-operation of voluntary helpers, but it must always be remembered that the results are only a group of incomplete phenomena, the basic causes of which must often be sought elsewhere.

Most insect migrations in temperate zones consist of movements in the spring from sub-tropical or warmer zones towards the cooler parts of the temperate zone with—sometimes at least—a return southward in the autumn. Since the British Isles are in the cool temperate zone, it follows that they will figure chiefly as an end point for spring migrations and perhaps, more rarely, as a starting point for autumn movements.

Among the insects which come into Great Britain in this way in the spring are to be reckoned about twelve of our sixty-six butterflies, about half our Hawk moths (Sphingidæ), quite a large number of other moths, including even some Tineidæ less than an inch across the wings; at least a dozen of our dragonflies, and an occasional errant locust. It may also be necessary to add to the list certain Coleoptera, Aphidæ and Syrphidæ (hover flies), which are occasionally washed up in great numbers on our shores after a storm, but at the moment the evidence is too fragmentary to distinguish between wilful migration and accidental distribution by wind.

Some of these species do not breed at all in Great Britain, some breed only during the summer and die out each winter, while others breed regularly and continuously here, but are reinforced at intervals from abroad. Some immigrants arrive regularly each year, while others come only at intervals of several years, or in very varying numbers. Many only invade our southern shores and the counties along the coast; others, especially in years of great abundance, may spread as far as the north of Scotland and the Orkney and Shetland Isles. Some cross the English Channel conspicuously by day in large bands, whilst others appear to cross by night or individually and have never been recorded actually during the movement.

Turning in more detail to what is known of some of the species: five of our immigrant butterflies, the Monarch (*D. plexippus*), the Camberwell Beauty (*V. antiopa*), the Bath White (*P. daplidicæ*), the Long Tailed Blue (*L. boeticus*) and the Queen of Spain Fritillary (*A. lathonia*) do not breed in Great Britain; the Clouded Yellow (*C. croceus*), the Pale Clouded Yellow (*C. hyale*), the Painted Lady (*V. cardui*) and the Red Admiral (*V. atalanta*) breed regularly during the summer but seldom, if ever, survive a winter; while the three Cabbage White butterflies (*Pieris brassicæ*, *rapæ* and *napi*) are regular residents as well as irregular immigrants.

Most of these butterflies come to us from the more southerly parts of Europe in the spring or early summer, but there are some exceptions to this rule. The swarms of Cabbage White butterflies appear to originate in the Baltic area and fly about midsummer southward through Germany and westward across the North Sea and the Netherlands. The Camberwell Beauty arrives almost exclusively in the autumn along our eastern shore, even as far north as Inverness, and probably comes from Scandinavia. The Monarch butterfly is unique in coming to us in the autumn from the west across the Atlantic. In the United States at that time of the year enormous flocks are migrating southward, and our immigrants are probably wanderers blown out of their path and helped across by the prevailing westerly winds.

Finally, the Painted Lady comes to us from the south, but there is reason to believe, as already pointed out in my earlier article in NATURE, that our immigrants may come from as far afield as North Africa, if not farther.

Among the Hawk moths, the Death's Head (*A. atropos*), the Oleander Hawk (*D. nereii*), the

Silver-Striped (*C. livornica*), the Striped Hawk (*H. celerio*), the Convolvulus Hawk (*H. convolvuli*), the Bedstraw Hawk (*C. galii*), the Spurge Hawk (*C. euphorbiæ*) and the Humming-Bird Hawk (*M. stellatarum*) are all immigrants which do not normally survive the winter in Great Britain, though most of them may breed during the summer of immigration. The status of the Privet Hawk and the Pine Hawk is not definitely settled. All the immigrants come from the south, but practically nothing is known of their origin except that some most certainly reach their maximum abundance in early spring in North Africa.

Information about the smaller moths is scattered and uncertain. Definite immigrants include the Silver Y moth (*Plusia gamma*), the Rush Veneer (*Nemophila noctuella*), the Satin moth (*L. salicis*), the Crimson Speckled (*D. pulchella*) and many others. The Diamond Back moth (*P. maculipennis*), a small but serious pest of crucifers, is believed to cross the North Sea, while one of the most widely distributed pests of cotton, the American Boll Worm (*Heliothis armigera*), is a rare immigrant in Great Britain, where it boasts of the popular name of the "Scarce bordered Straw".

The British dragonflies include a dozen immigrants, all belonging to the Anisopteridæ. Some of these are only very rare wanderers; others, such as *Sympetrum fonscolombii*, *S. flaveolum* and *S. sanguineum*, are more regular immigrants, while *Libellula depressa*, *L. quadrimaculata* and *Aeschna grandis* breed here regularly and are also immigrants at times. No member of the family Zygopteridæ has yet been considered an immigrant in Great Britain.

Apart from the details of which insects migrate, when they migrate and where they start from, there are a number of general problems connected with this subject, chief among which is the question of a return flight or emigration in the autumn towards the south in those species which arrive from the south in the spring. Until recently, there was little evidence in support of this, and zoologists were inclined to think that insect migration was therefore fundamentally different from that of birds. However, little by little, evidence is accumulating that makes it seem that a return flight, at least of some species, does take place. Particularly is this so in the case of the Red Admiral butterfly (*V. atalanta*) for which we have now quite a number of records of small autumn movements to the south on our shores; while in the case of *V. cardui* an ornithologist has reported their arrival on several occasions on the North Egyptian coast at dawn, flying in from across the Mediterranean along with the migrating quail. It is important to recognise, in collecting evidence on this point, that a migration need not be a gregarious action, and we know of one butterfly, the Monarch of North America, which carries out a movement in one direction gregariously and in the reverse direction individually.

Other problems requiring solution, which can only be settled by long continued collection of facts, are the reasons why one or other sex (more often the male) should frequently predominate in a flight; or if there is any periodicity connected with the movements; and how the insects keep to their fixed direction. On the last point there seems to be not the slightest clue; but it might be as well to point out that the evidence in hand lends no support to the oft-quoted theory that insects fly at a definite angle to the wind. Flights, on the whole, are as often with the wind as against it, and while there are one or two cases known of a change of wind resulting in a change of flight direction, there are very many more records of flight direction remaining constant in spite of frequent changes of wind.

In the past, the collection of records on the immigration of insects into Great Britain has been entirely haphazard. Scattered through the pages of a dozen entomological and natural history journals of the past century are records of sudden abundances, unexplained absences and occasionally of clouds of butterflies crossing the English Channel or arriving on the shores of Great Britain. But the absence of records for several years means little or nothing but a period of lack of interest. However, a little more than three years ago the South-Eastern Union of Scientific Societies formed an Insect Immigration Committee under the energetic secretaryship of Capt. T. Dannreuther. This Committee has organised a widespread system of district recorders, has issued a list of insects about which information is specially needed, and has sent out some thousands of standard record cards to voluntary observers in all parts of the country. The results have so far surpassed expectations, and have thrown new light on the movements of certain butterflies, particularly the Common Whites and Red Admiral. Now also the Committee has obtained, by permission of the Trinity Brethren, the co-operation of a number of keepers of light-ships and light-houses round the coast, and the records they are sending in are adding to our knowledge of many previously known migrants, and suggesting new and unexpected insects that will require watching in the future.

The study of insect migration in Great Britain is now better organised than it has ever been before, and far more completely than anywhere else in the world; but many additional helpers are needed, and years of work and co-operation from the Continent will be necessary before a definite answer can be given to any of the outstanding problems.

Institution of Electrical Engineers' Library of Sound Films

THE Institution of Electrical Engineers is collecting a library of sound films made by eminent electricians and electrical engineers. It is hoped that they will be of interest not only to subsequent generations but also to many local centres of the Institution overseas. Sound films have already been taken of Sir J. J. Thomson, Sir Ambrose Fleming, Mr. W. M. Mordey and others. After being introduced by the president of the Institution, the speaker makes a short address giving a review of the progress made in electrical science or engineering from his earliest days and sometimes trying to foretell the trend of development in the future. We have pleasure in printing below the address given by Sir Oliver Lodge for this library.

———

I have lived from the very beginning of the electrical age that is now upon us. When I was young there was no such thing as a dynamo. If we wanted a current of any magnitude, say for instance to supply an electric arc, we had in those days to mess about with a Grove's battery, consisting of zinc, platinum and acids, and it was a troublesome business. I remember that the name 'dynamo' was invented by Lord Kelvin in a paper before Section A of the British Association, when I was a secretary to that body.

I remember seeing the original Paccinotti machine, which soon developed into the Gramme armature; and then ingeniously the Siemens firm introduced a double-winding and made the modern Siemens armature; there had been an old Siemens armature, with an iron rail wound longitudinally, which was shown at the 1862 Exhibition producing strong currents, and exciting much interest. It was no easy matter to get a really strong current in those days: covered wire was almost a novelty, while to make connexion between different things there was no notion of plugging in two terminals; we had to screw up each wire with a binding screw; a pair of binding screws were the only terminals.

I remember the first electric lamp shown to the Telegraph Engineers by Mr. (later Sir Joseph) Swann, which he said would serve well for a reading-lamp, and not require any matches for its lighting up. And a little later I remember Colonel Crompton coming for one of the conversaziones at University College, London, and bringing a number of such lamps, which he arranged in the entrance hall, festooning them as an exhibition. He came himself and superintended the erection with extraordinary energy, taking possession of Carey Foster's laboratory, and having it all rigged up in time.

I remember too the first visit of Graham Bell and his demonstration of the telephone at South Kensington, when he lectured to the Physical Society in a most beautifully articulate manner, pronouncing everything completely and accurately. He was just the right type of man to make a metal disc speak.

Then Hertz made a great advance; he discovered how to produce and detect waves in space; thus bringing the ether into practical use, harnessing it for the transmission of intelligence, in a way which has subsequently been elaborated by a number of people.

Now, this present century, which has made many undoubted discoveries in physics, seeks to discredit and deny the ether of space; and I want to conclude this talk by a few words upholding its reality. It is the ether which conveys waves in the fraction of a second to the antipodes, it is that which brings us information from the stars and the most distant nebulæ, which otherwise we should be without. The ether is the seat of all radiation energy, and indeed of all other energy, whether it be in the form of light or other waves. I remember when the nature of light was not known. Clerk Maxwell's great paper dated from the year 1864 or maybe '65, when I was just leaving school and was not awake to its magnificence. I did not know of it till the 'seventies; but in 1873 his great book on electricity appeared, and that year I attended my first meeting of the British Association, at Bradford, and heard it spoken of. This was a book worthy to be mentioned in the same breath as the "Principia".

Newton and Maxwell are among the glories of the human race; and they did for the ether something magnificent which has not been surpassed by any work of man. The ether is the vehicle of gravitation and of light. Its theory is not complete even yet. We are still groping after their great and unfinished discoveries. Einstein has shown us something more about gravitation, and has done away with action at a distance; and Planck has discovered the law regulating the interaction of ether and matter, so that radiation is only produced and destroyed in discontinuous quanta. But interference shows that radiation and the ether are continuous in free space, and that quanta only make themselves evident at the beginning and end of radiation—at the generation and absorption of light—when the ether is associated with the discontinuous thing that we call matter.

I have here indicated what will be the work of the twentieth century ; to complete the theory of the ether and to show how all things lead to an intelligible and concrete reality, very different from the abstractions and confusions under which we now, for the time, labour. Yet the present is a phase through which we had to go : it is an intermediate era in physics, through which we are guided by great men, Eddington and Jeans and Dirac, men who are contributing a great deal to physics and astronomy, work which we could not do without, and which forms a necessary avenue to the clear open space beyond.

Before the end of the twentieth century, as I think, or at any rate in the twenty-first, the ether will be recognised as the one means of communication between the atoms, and the whole of physics will become once more luminous and clear, constituting a glorious epoch for our descendants. The ether will come into its own again, not only for practical purposes as the seat of all potential energy, but with a clear understanding of it as the one substance that holds the universe together, in which all matter is embedded, without which even locomotion cannot be properly understood, and which constitutes the physical vehicle for life and mind.

OLIVER LODGE.

Scientific Centenaries in 1935

By ENG. CAPT. EDGAR C. SMITH, O.B.E., R.N.

GLANCING back once again over the history of science during the last few centuries with the object of recalling those men of science whose centenaries occur during the coming year, it is but natural to turn to the early records of the Royal Society.

In these, over and over again, is found the name of Robert Hooke, who was born on July 18, 1635, three hundred years ago. A scholar of Westminster School and a graduate of Christ Church, Oxford, he became the friend of Willis, Boyle, Wilkins, Seth Ward and others. On November 12, 1662, he was appointed curator of experiments to the Royal Society and on June 3, 1663, was elected a fellow of the Society. Two years later he was made professor of geometry in Gresham College, and it was in his apartments in Gresham's old mansion in the City of London that he passed the greater part of his life. A long list of papers and experiments testify to his ingenuity and versatility, and no doubt in due course tribute will be paid to his memory. "As to his Person," said Benjamin Martin in his "Biographia Philosophica", "he made but a mean Appearance, being very small and somewhat crooked ; but he had an active, penetrating, indefatigable Genius, sparing no Pains in Quest of the Truth in Relation to whatever came under his Consideration. . . ." Hooke died on March 3, 1703 and was buried in St. Helen's Church, Bishopgate ; a church which probably has more associations with the Royal Society than any other.

Two contemporaries of Hooke's abroad were Johann Becher (1635–1682) and Christoph Sturm (1635–1703). Becher was one of the first chemists to cast off the mystical language of the alchemists, and in his writings can be found the germ of the phlogiston theory. He wrote much, travelled widely, and only a short time before his death came to England to visit the Cornish mines. Sturm, who was also a German, was professor of physical science in the University of Altdorf, and is remembered as an advocate of the teaching of science in schools. In their day, Germany was slowly recovering from the inconceivable miseries of the Thirty Years War, during which, it is said, the population fell from 20,000,000 to 4,000,000.

It was in 1635 in the midst of that war that Wilhelm Schickard (1592–1635) and Johann Faulhaber (1580–1635) died. The latter was an able mathematician who was acquainted with Descartes, while the former was known to Kepler and to Gassendi. It was to Gassendi that Schickard sent his observations of the transit of Mercury of 1633.

The work of these scientific worthies belongs almost entirely to the seventeenth century, a period during which, says Cajori, the progress of physics was truly extraordinary. During the eighteenth century, he says, physics proper was cultivated by men of more limited powers than those of Galileo, Huygens and Newton. For all that, however, there was great activity in various branches of science, especially in mathematics and astronomy, and in England practical astronomy made wonderful advances.

To these advances a succession of clever mechanicians contributed, and of all the British men of science born two hundred years ago none has a more interesting record than Jesse Ramsden (1735–1800), who from a clothworkers' apprentice at Halifax rose to be the leading instrument maker in London. "Esteemed by the great, cherished by his friends and loved by his servants and workmen", Ramsden was called by Delambre "le plus grand de tous les artistes". From Ramsden's shop in Piccadilly came some of the finest telescopes and theodolites. He was elected a fellow of the Royal Society in 1786 and nine years later was awarded the Copley Medal for his "Various Inventions and Improvements in Philosophical Instruments". Another instrument maker of note was John Coventry of Southwark, who was born in the same year as Ramsden but outlived him by twelve years.

The year 1735 also saw the birth of Gregorio Fontana (1735–1803), for many years a professor of mathematics at Pavia and Milan; of Charles Auguste Vandermonde (1735–1796) the French mathematician and chemist who had much to do with founding the Conservatoire des Arts et Metiérs; of Hugh Williamson (1735–1819) of Philadelphia, who was one of the observers of the transit of Venus of 1769, and also of the chemists Keir and Bergmann.

James Keir (1735–1820) began life in the army, but in 1768 settled at West Bromwich and devoted himself to chemistry, geology, glass-making and the writing and translation of scientific works. He was a friend of Erasmus Darwin, Watt, Boulton and Priestley, joined in the monthly meetings of the Lunar Society, and from 1785 onwards was a fellow of the Royal Society. Tobern Olof Bergmann (1735–1784) was for a long time professor of chemistry at Uppsala. "He was," said Senier, "the first to perform chemical analysis systematically and laid the foundation of that art." At his death the Academy of Sciences of Stockholm had a medal struck to commemorate his work.

Bringing the survey a century nearer to our own time, to the year 1835, there is a considerable list of deaths and a longer list of births to be recognised. This part of the survey may well begin with Edward Troughton (1753–1835) who, like Ramsden, came from the north to achieve distinction as a London instrument maker. He also was a fellow of the Royal Society and a Copley medallist. His shop was in Fleet Street, and astronomical instruments of his making went to Greenwich, Paris, the Cape, Cracow, Brussels and elsewhere. Airy described Troughton's mode of graduating arcs of circles as "the greatest improvement ever made in the art of instrument making".

Astronomy is also represented by Dr. John Brinkley (1763–1835) sometime Bishop of Cloyne. Born in Suffolk, he was senior wrangler in 1788 and four years later became Andrews professor of astronomy in Trinity College, Dublin. He also became the director of Dunsink Observatory and was the first Royal Astronomer of Ireland.

Another Copley medallist who died in 1835 was Capt. Henry Kater, one of the earliest workers on the trigonometrical survey of India. Ill-health brought him back to England and after further service in the Army, in 1814 he was placed on half-pay, from which time he devoted himself to science. He was well known for his accurate pendulum experiments and his study of standard weights and measures, and, had his life been prolonged, his services would undoubtedly have been used in connexion with the replacement of the British standards destroyed in the burning of the Houses of Parliament in October 1834.

Physics is also represented by Leopoldo Nobili (1784–1835) of Florence, who invented the thermopile afterwards used with great skill by J. D. Forbes and Melloni.

To this record of men of science who passed away a century ago may be added the Irish geologist, John MacCulloch (1773–1835), who abandoned medicine for the study of the rocks and became geologist to the Trigonometrical Survey; Gilbert Thomas Burnett (1800–1835), the short-lived professor of botany in King's College, London; the great French surgeon Baron Guillaume Dupuytren (1777–1835), who from the humblest ranks raised himself to the position of the foremost surgeon in Europe, but, falling sick, refused to permit an operation upon himself, preferring as he said rather to die at the hand of God than of man; Thomas Charles Auguste Dallery (1754–1835), a French pioneer of steam navigation and screw propulsion, and lastly Sir Edward Banks (1769–1835), who with his partner, William John Jolliffe (1774–1835), built Waterloo, Southwark and London Bridges, and was the principal contractor of his day.

As the frontiers of science are extended, and its territories enlarged, so does the number of explorers ever increase. Of those who have made notable contribution to science and have passed away in recent times, the columns of NATURE, since its foundation in 1869, contain biographical sketches of many hundreds, and by the aid of these it is possible to recall briefly some of the outstanding men of genius and talent who were born a century ago. Foremost among these, perhaps, must be placed the distinguished American astronomer, Simon Newcomb, who was born on March 12, 1835, and died on July 11, 1909. Loewy, writing in NATURE of May 4, 1899, said: "Newcomb must be considered without contradiction as one of the most celebrated astronomers of our time, both on account of the immensity of his work and the unity of view which marks the choice of the subjects treated by him".

Two days after Newcomb was born in Nova Scotia, Giovanni Virginio Schiaparelli, the Italian astronomer, was born in Piedmont. Schiaparelli died just a year after Newcomb, on July 4, 1910. The English astronomer, Sir William Huggins, had only recently passed away and on July 5, 1910, the *Times* wrote, "As Huggins stood at the head of English-speaking astronomers, so Schiaparelli stood at the head of the astronomers on the Continent".

Another astronomer who was born a century ago was Friedrich August Theodor Winnecke (1835–1897), whom Sir David Gill called "the greatest teacher of practical astronomy since the days of Bessel"; and another, Jean Charles Rudolphe Radau (1835–1911), who though German by birth spent most of his life in France and at the time of his death was a member of the Paris Academy of Sciences and the Bureau des Longitudes.

Chemical science of the nineteenth century is represented by Adolph von Baeyer (1835–1917), August Dupre (1835–1907), Rudolph Fittig (1835–1910) and Johann Wislicenus (1835–1902). All were of German birth, but Dupre became a naturalised Englishman and as such held important Government posts. Fittig, von Baeyer and Wislicenus all received the Davy Medal of the Royal Society. One of Fittig's earliest appointments was to the University of Tübingen, and it was in 1871 that Sir William Ramsay, then a youth of nineteen wrote home: "I go regularly to Fittig's lecture at 8. He lectures very distinctly and clearly. It is really very beautiful to see the way the organic compounds are arranged". Of the career of Wislicenus, and of the charm of his character, much is contained in the memorial lecture delivered in 1905 to the Chemical Society by W. H. Perkin, Jr.

The progress of science is furthered by many means, and this is illustrated by comparing the careers of the three physicists Joseph Stefan of Austria, Elisha Gray of the United States and George Carey Foster of University College, London, who were all born in 1835. Stefan by his researches furthered our knowledge of liquids and gases, light and sound and electricity, and his name is now recalled by the Stefan-Boltzmann law of radiation. Gray was a practical electrician with more than sixty patents to his credit, and though originally a professor he was afterwards connected with manufacturing. It will be remembered that on February 14, 1876, he lodged a caveat for a telephone with the American Patent Office only a few hours after Alexander Graham Bell had visited the office on a similar errand. Carey Foster, on the other hand, although a contributor to scientific literature, was known for the part he played in furthering the best interests of University College, in supporting the claims of women to university privileges and in extending the use of physical laboratories in the teaching of science.

It need scarcely be said that this list of men of science born in 1835 who were devoted to physical subjects could be made longer, but it is perhaps unnecessary to do so. Finally, therefore, attention is directed to the names of one or two distinguished naturalists whose centenaries occur this year. Of these, Alexander Agassiz (1835–1910), the son of Louis Agassiz, was for a time superintendent of the well-known Calumet and Hecla Copper Mines, Lake Superior; but was best known for his work as a zoologist and oceanographer. Born at Neuchâtel, Switzerland, he accompanied his father to the United States in 1846, and there he passed the remainder of his life, holding important positions and taking part in many scientific expeditions. Another naturalist connected with North America was Joseph Frederick Whiteaves (1835–1909), who was born at Oxford and worked there under John Phillips. A visit to Canada in 1861, however, led to his studying the geology of Quebec, and he became palæontologist, zoologist and assistant director of the Geological Survey of Canada. In 1907 he was awarded the Lyell Medal of the Geological Society of London. Of Sir Archibald Geikie (1835–1924) it is but necessary to recall that he was in turn director of the Geological Survey of Scotland, Murchison professor of geology and mineralogy in the University of Edinburgh and director of the Geological Survey of the United Kingdom. He was born on December 28, 1835 and died on November 10, 1924.

Obituary

Prof. B. H. Buxton

BERTRAM HENRY BUXTON was the eldest son of Mr. Charles Buxton, M.P., of Fox Warren, Cobham, Surrey. He was born in 1852 and was educated at Eton. He entered the business with which his family was associated, but did not find it congenial. Preferring travel, he was a frequent visitor to the United States; on one of his visits, medicine attracted him. Having voluntarily undertaken duty on board a passenger vessel in quarantine because of cholera, he followed up his observations through the Health Officer of the Port of New York, who introduced Buxton to bacteriology. At Cornell he studied in the Post Graduate Laboratory and rapidly became proficient. His keen mind quickly appreciated medicinal science. The University gave him a doctor's degree, and finally he occupied the chair of bacteriology.

Buxton's work was outstanding, his technique brilliant; no detail was too small for his scrutiny or attention. He was among the first to recognise the differing strains of typhoid bacillus in culture; he made notable contributions to the study of erysipelas and typhoid fever, and at the Memorial Cancer

Hospital developed Dr. Coley's vaccine of erysipelas for the treatment of inoperable sarcoma. He made fine histological preparations and developed a remarkable skill in microscopic pathology and photomicrography. He pursued these morphological studies until his voluntary retirement in 1912.

Returning to Surrey, Buxton lived at the Manor House, West Byfleet, at the foot of the hill on which is situated his parental home. From 1922 he worked as a guest in the laboratory of the Royal Horticultural Society. With the late Dr. F. V. Darbishire he studied the effect of varying hydrogen ion concentrations on the colour pigments of plants. It was always a great pleasure to watch Buxton at work—so neat and precise in his methods, so keen was his observation of every colour change. His work with Darbishire was reported in the Royal Horticultural Society's *Journal* and in the *Journal of Genetics*. Buxton was also keenly interested in genetics and he raised a cross between *Digitalis purpurea*, the purple foxglove, and *Digitalis ambigua*. As the result of doubling of the chromosome complement, this hybrid became fertile and has now been recognised as a new species, *D. mertonensis*. He collaborated with the cytologists at Merton in these investigations, particularly with Dr. C. D. Darlington and the late Dr. Newton. Other genetical work concerned the Wisley blue primrose and *Primula acaulis*.

Buxton keenly felt the loss of his colleague Darbishire, who died in 1932, and his visits to the laboratory became more infrequent. A year or so ago he visited Devonshire and decided to live there. He survived his brother Earl Buxton, who was a year younger, by two months. Like him, he was also keenly interested in birds, and on his walks over the Surrey commons and in the woods he derived much pleasure from observing the pheasants and the antics of jays and activities of green woodpeckers. His charm of manner and courtesy was shown to all, his modesty even prevented his colleagues from learning much of his earlier work, but his wide and varied research has established his reputation in two continents.

M. A. H. T.

WE regret to announce the following deaths:

Prof. Arthur Brožek, professor of genetics in the University of Prague, known for his work on plant breeding, on November 8, aged fifty-two years.

Dr. Otto Folin, professor of biological chemistry in the Harvard Medical School, an authority on the technique of urine analysis, on October 26, aged sixty-seven years.

Prof. R. Kövesligethy, professor of cosmography and geophysics in the University of Budapest, an authority on seismology, on October 12, aged seventy-two years.

Miss Rosalie B. J. Lulham, lecturer in natural history at the Froebel Educational Institute, and author of "An Introduction to Zoology through Nature Study", on December 28.

News and Views

New Year Honours

THE following names of scientific workers and others associated with scientific interests appear in the New Year Honours List: *Baronet:* Sir Holburt Waring, president of the Royal College of Surgeons. *G.C.B.:* Sir Josiah Stamp. *K.C.M.G.:* Lieut.-Gen. Sir William Furse, director of the Imperial Institute; Dr. A. C. D. Rivett, deputy chairman and chief executive officer of the Council of Scientific and Industrial Research, Commonwealth of Australia. *Knights:* Dr. C. V. Boys, for services to physics; Prof. W. Langdon-Brown, regius professor of physic, University of Cambridge; Dr. E. Deller, principal of the University of London; Dr. Cyril Fox, director of the National Museum of Wales; Dr. J. B. Orr, director of the Rowett Institute for Research in Animal Nutrition, Aberdeen; Prof. E. B. Poulton, honorary life president of the Royal Entomological Society of London, and emeritus professor of zoology in the University of Oxford; Dr. J. D. Sutherland, lately assistant forestry commissioner for Scotland, member of the Forestry Commission. *C.B.:* Col. H. St. J. L. Winterbotham, Director-General of Ordnance Survey, Ministry of Agriculture and Fisheries. *C.M.G.:* Lieut.-Col. C. L. Carbutt, Chief Native Commissioner, Southern Rhodesia; Prof. F. L. Engledow, professor of agriculture, University of Cambridge, and member of the Colonial Advisory Council of Agriculture and Animal Health; Lieut.-Col. S. P. James, medical officer and adviser on tropical diseases, Ministry of Health, and member of the Colonial Advisory Medical Committee. *C.I.E.:* Rai Bahadur Daya Ram Sahni, Director-General of Archæology in India. *C.B.E.:* Dr. E. J. Allen, secretary of the Marine Biological Association of the United Kingdom and director of the Plymouth Laboratory; Mr. C. C. Hawkins, lately superintendent of the Department of Technology, City and Guilds of London Institute; Dr. J. S. Plaskett, director of the Astrophysical Observatory, Dominion of Canada. *O.B.E.:* Mr. G. W. Austin, principal scientific officer, R.N. Torpedo Factory, Greenock; Mr. R. W. Harris, secretary of the London School of Hygiene and Tropical Medicine. *M.B.E.:* Dr. Alice E. Wilson, assistant invertebrate palæontologist, Department of Mines, Dominion of Canada.

Heavy Water in Chemistry

THE lecture by Prof. Polanyi which is published as a Supplement to this issue of NATURE directs attention to some of the applications which may be made of heavy water in elucidating the mechanism of chemical reactions. The heavy water may be either the variety containing heavy hydrogen in place of ordinary hydrogen, or that containing heavy oxygen in place of ordinary oxygen, and the distribution of the heavy atoms among the products of reactions will indicate the part played by water in them. The striking difference in chemical properties between heavy hydrogen and ordinary hydrogen is due very largely to the differences in zero-point energy, which Prof. Polanyi calls permanent energy, the existence of which is predicted by the new quantum theory. It is possible to calculate this energy, and the results of the calculations may be checked by measurements of equilibria in which the two sorts of hydrogen participate. These experiments are in agreement with the theory. Exchange of heavy hydrogen from heavy water may occur with other compounds, such as benzene, and the mechanism of hydrogenation in ordinary reactions can also be followed in such experiments. The use of nitrogen and carbon isotopes is likely to prove important in the future.

Future of the Sulphur Industry

A PAPER by M. P. Applebey, published in *Chemistry and Industry* of December 28, on recent developments in the chemistry of sulphur, foreshadows important advances and perhaps far-reaching changes in those industries which are concerned with sulphur and its oxide. Researches extending over some years in the laboratories of Imperial Chemical Industries, Ltd., at Billingham have solved the problem of concentrating sulphur dioxide from metallurgical gases containing from three to seven per cent, by the ingenious method of using a sulphite-bisulphite system which can be regulated to have a moderately high *p*H in the cold and a much lower one when hot by the addition of a substance such as aluminium chloride, the hydrolysis of which is much increased by rise of temperature. It has been further discovered how to reduce the practically pure sulphur dioxide so obtained by coke:

$$SO_2 + C = CO_2 + S.$$

The reduction takes place very rapidly and almost completely at 1100° C. and is exothermic. It is considered possible to convert economically the sulphur dioxide in dilute furnace gas on the large scale into sulphur, and since this can be transported at about a tenth of the cost of sulphur dioxide and a fifth of the cost of sulphuric acid, the process may be expected to alter radically the economic aspect of sulphur dioxide disposal.

THE metallurgical industries are at present forced to make sulphuric acid to get rid of the sulphur dioxide they produce, and the disposal of this acid locally causes great difficulty, and limits the size of the smelting plants. All these troubles will largely disappear if sulphur is produced instead at one centre. Dr. Applebey visualises a new rationalisation of the metallurgical industries based on pyrites which will enable the sulphur, the non-ferrous metals and the iron to be separated at or near the port of arrival. With the new process, the manufacture of sulphur from anhydrite or gypsum becomes practicable, and lastly, the process reopens in a much more favourable manner the perennial question of the possibility of recovering the sulphur from coal. The discoveries outlined are probably the most important which have been made in the heavy chemical industries for some considerable time.

The Christmas Day Empire Broadcast

FOR the third year in succession, the British broadcasting programmes on Christmas Day included a special hour during which greetings were exchanged with various parts of the world. This year the major portion of the programme came from the countries of the Empire; the Dominions, India and Southern Rhodesia each contributed one or more scenes representing different phases of their national lives. Twenty-five different scenes were presented, and the programme was notable for the accuracy of the timing and the rapidity with which the various connexions were made in succession. It was not a steady tour round the world as was the case on a former occasion; rather had it the air of a random selection of individuals in such places as Australia, Ireland, South Africa, Canada and so on. A broad outline of the technical arrangements by which the programme was carried out was given in the issue of *World Radio* of December 21. In order that so many different programme sources may be blended together to form a homogeneous whole, rapid and silent switching arrangements must be provided by means of which each item may be faded into the next without a break. This is made possible by the dramatic control panel, which was originally designed by the B.B.C. to provide silent and speedy switching between a number of studios in a production of a radio play. It is a simple step to adapt the use of such a panel to the switching of long distance telephone circuits, whether these be land-line or radio.

FOR the purpose of the Christmas Day programme, control of fifteen channels was required, and for this purpose a recently developed dramatic control panel was brought into action at Broadcasting House. The panel is so long that it has been necessary to provide a sliding seat for the producer to keep all the controls within reach. The collection of the individual items of the programme was made along circuits connecting Broadcasting House with the Post Office International Telephone Exchange at Faraday Buildings. This exchange is connected with the radio telephone transmitting and receiving stations at Rugby and Baldock respectively, which daily handle the normal commercial radio-telephone traffic with all parts of the world. The whole programme as thus assembled at Broadcasting House was radiated through all the B.B.C. transmitting stations, including three Empire shortwave stations, while various relays were made over the local networks in different portions of the Empire. This broadcast provided simultaneously a tribute both to the very high standard of modern communication technique, and to the excellence of the organisation and international co-operation which are so necessary for its success.

Radio-telephone Link from Scotland to Ireland

THE experiments of the Post Office engineers with ultra-short wave radio-telephony links across the Bristol Channel have already been mentioned in these columns. During December, transmitting and receiving stations were installed in Scotland and Ireland with the view of providing in the New Year six radio telephone channels in the wave-length range 4–5 metres. The *Times* reports that shortly before Christmas, however, the ordinary submarine telephone cables broke down, and three of the new radio links were brought into operation by the postal authorities in order to maintain the telephone traffic between the two countries. The positions of the wireless stations are at Enoch Hill, near Portpatrick, on the Scottish side, and Ballywater, near Belfast, on the Irish side. The sites were specially chosen on account of their height and freedom from obstruction, and at both places there are ample facilities for extension. This wireless link has already dealt successfully with a number of telephone calls from all parts of Great Britain to Ireland, and the callers have, without knowing it, been taking part in an important experiment in wireless telephony. An antenna array is used at each station to concentrate the radiation into a beam in the desired direction, and the telephone communication may thus be regarded as secret for most practical purposes. The development is of particular interest to Scotland, because of the possibility of applying the system to link up many districts in the Western Isles that are at present isolated so far as telephone communication is concerned. The laying of submarine cables is very expensive, and it is likely that the radio link will provide the means of linking up many districts on the west coast at very much lower cost.

A Radio Beacon at Southampton

THE coasts of the British Isles are already equipped with a number of fixed radio beacons, which frequently and automatically emit characteristic signals for the use of ships fitted with radio direction-finders. Such beacons are found to be of great assistance to marine navigation, particularly during foggy or stormy weather. According to the Southampton correspondent of the *Times*, an agreement has now been reached between Trinity House, the Cunard White Star line and the Southampton Harbour Board, as a result of which a radio beacon will be installed on the Nab Tower for the benefit of ships using Southampton Harbour. This tripartite agreement provides for the sharing of the cost of installation and maintenance of the beacon, which, however, will be owned and operated by Trinity House, the authority to which all similar fixed beacons in Great Britain belong. The decision to carry out this new installation is particularly opportune, as the Compagnie Générale Transatlantique has just decided that, in future, all its westbound steamers from France to America will call at Southampton.

British Empire Air Mails

SIR PHILIP SASSOON, speaking in the House of Commons recently, outlined fresh proposals for the development of Empire air communications. These, he stated, represent His Majesty's Government's considered scheme, but are necessarily provisional until the other Empire Governments concerned have examined them. There are three main features: an improvement on present time schedules, an increase of frequency of service, and the automatic transfer of all first-class mail to air transport. The new proposals envisage a time of seven days to Australia and four days to the Cape, with proportionate times for intermediate places. This will be made possible by progressive development of ground organisation to enable night flying to operate over the whole of the routes. There will be possibly five services a week to India, three to Singapore and East Africa, and two to Australia and South Africa respectively. It is hoped to keep the charge the same as the present Empire rate of 1½*d*. by reducing the permissible weight to half an ounce. It is suggested that correspondence covering eight sides of a special light paper can be sent within that limit. The new services will cater for passengers as well as mail. The completion of the negotiations, provision of the necessary fleet, ground organisation, etc., will take at least two years, and the Postmaster-General has stated that there is little possibility of the introduction of the new postal rate before 1937.

150th Anniversary of *The Times*

ON January 1, 1785, *The Daily Universal Register* began publication as a modest news sheet at the price of 2½*d*. The journal was intended, in the first place, as much to advertise the Logographic Press, set up by John Walter near Printing House Court or Yard, Blackfriars, as to function as a newspaper. The title of the paper soon became *The Times*, which now celebrates its one hundred and fiftieth anniversary by the publication of a supplement of thirty pages, in which the history and activities of the paper are surveyed. During the past century and a half, both the technique of printing and the art of news gathering and presentation have been revolutionised, largely through the progress of scientific developments. *The Times* was printed at first on hand-presses, which turned out about 250 copies an hour. On November 29, 1814, the steam printing machine developed by Friedrich Koenig (1774–1833), was used, which immediately increased the output to more than a thousand copies an hour. Since then progress has been rapid and speeds of 40,000 copies an hour are now in use. On the side of news gathering, progress has been even more spectacular. In the early days, foreign news came mostly from foreign journals. Nowadays, all the channels for rapid communication opened up by science are utilised to the utmost. Correspondents are appointed in the principal cities throughout the world or sent specially to places of interest, from which the latest news and reports are transmitted, by telegraph and radio, in word and picture. By demonstrating the practical utility of modern methods of rapid conveyance of news and equally by recording scientific developments wherever they occur, *The Times* has played a noteworthy part in the rapid progress of the past century.

Rural Conditions in Roman Britain

A NOTABLE addition to our knowledge of the conditions of farm life in Roman Britain is made by the account of an excavation of farm buildings in Carnarvonshire carried out by Mr. B. H. St. J. O'Neil on behalf of the Office of Works, which is described in the *Times* of December 29. The site is on Caerau farm, north of Pant Glas station, in an area which has already afforded evidence of similar cultivation sites, evidently parts of a rural group or community centring on the Roman fort of Segontium, at Carnarvon, and in which the ancient field system of terrace cultivation can still be readily discerned. Of a succession of four ancient farms along the hill-side, facing the west, one is practically intact. Within what is described as an excellent system of ancient fields, rising one above another, are two separate courtyard houses, of which the first is an oval about 100 ft. long, bounded by a stone-faced wall of earth or turf. It was approached by a cobbled road 8 ft. wide, which passed through an opening in the wall into the courtyard. On this yard two rooms now open, but originally there were four. These rooms are circular, the larger having a diameter of 25 ft. Their structure is interesting. The walls are now 4 ft. high and may never have been higher. The roof was supported by six posts, for which the holes remain, mid-way between the wall and the centre of the building, where there may also have been a post. The room was provided with a stone bench on the west side, drains and a trench which may have been a slot to receive a wooden partition, dividing the room into two. The smaller hut, which also had a system of drains and gulleys, apparently was used for industrial purposes ; the find of a crucible and two hearths suggests the reduction of metals. The second house on the edge of the field system has a polygonal boundary wall with a well-defined entrance and at least five rooms around the courtyard. One room appears to have had a ridge roof. The numerous pottery fragments are typical Romano-British of the second and third centuries A.D.

The Vertebrate Evolutionary Tree

FOR long we have accepted as well-established and equivalent the five classes of vertebrate animals, but recent zoological research, particularly on the palæontological side, has modified many old conceptions of relationship and suggests that there may be need for readjustment in the major groups. An attempt at a new classification which will give due weight to recent discoveries has been made by G. Säve-Söderbergh (*Arkiv. zoologi*, 26, No. 17 ; 1934). Its main suggestions are that the present class Pisces is a medley of two of the three main stocks of Gnathostomes and parts of a third one. This third stock (Choanata) gave rise to the higher vertebrates, but probably by two routes, the ancestors of the Dipnoi leading to the Urodela, of the Crossopterygii to the Anura by a devious route. The Amphibia also must be looked upon as a mixed assemblage, which includes the two stocks just mentioned, but also an offshoot of the reptilian Reptiliomorpha, the Anthracosauria. Finally, birds and mammals belong to a richly branching part of the vertebrate phylogenetic tree, most of the branches being grouped as reptiles, while two equivalent branches are given unequal status as the independent classes Aves and Mammalia. The author regards it as absurd that equal systematic value should be given to these classes as to the fundamental group Pisces composed of two entire stocks of Gnathostome vertebrates, and half of the third stock. The writer's first reaction to this interesting and revolutionary view of vertebrate phylogeny, in which birds and mammals are grouped with reptiles and Anthracosauria as equal divisions of the Reptiliomorpha, is the thought that systematic classification is not entirely a matter of equivalents, and that even when phylogeny is known, weight must be given to outstanding novelties in evolution which have originated decisive lines of development. Thus the 'invention' of warm-bloodedness, which by adding to the adaptability of vertebrates has enabled them to conquer land surfaces far beyond the reptilian range, seems worthy, in association with the structures which made it possible, of a distinctive classificatory label.

Starlings in London

FOR some years, enormous numbers of starlings have taken to roosting on the ledges of buildings in central London, where they spend the winter nights in safety on such buildings as the National Gallery, Somerset House, St. Paul's and Covent Garden. In Edinburgh, similar hordes frequent the roof-ledges of the General Post Office and other buildings in the neighbourhood. The winter population of starlings in large towns must be unbelievably large, yet it appears still to be increasing. In the report for 1933 of the Committee on Bird Sanctuaries in Royal Parks (England), C. S. Bayne states that in 1933 (for the first time) starlings roosted on Duck Island in St. James's Park without an interval. In the first week of May, when winter roosts are usually deserted, he counted there eight thousand of them ; but the numbers were greatest in autumn before the usual contingents moved in November to take up their winter quarters in Trafalgar Square. It is a matter of some interest to know whence come the starlings that flock to London at night, and R. W. Hale has discovered one of the sources. He has watched the birds feeding on and near Hendon Sewage Farm, and has seen them leave there in flocks about two hours before sunset. The flight of the flocks he has tapped at Cricklewood Lane, Finchley Road Station, Lord's and Baker Street Station. A line drawn through these points and extended passes through Trafalgar Square, so the slightest deviation from this would bring them over St. James's Park, and some of the largest flocks which settle in St. James's Park come from that quarter.

(*Continued on p.* 27.)

Supplement to NATURE

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Heavy Water in Chemistry*

By Prof. M. Polanyi, University of Manchester

Conflicting Definitions of Isotopy

ONE gram is the weight of one cubic centimetre of water at 4° C. One cubic centimetre of heavy water weighs about 10 per cent more, that is, 1·1 grams. The molecule of heavy water is composed of hydrogen and oxygen, in the same proportion as that of ordinary water ; two hydrogen atoms being united with one oxygen atom. Nor is there anything unusual about the oxygen atom in this heavy water molecule. But the hydrogen is different from ordinary hydrogen. Its atomic weight is 2 instead of 1, and to this new sort of hydrogen all the heaviness of heavy water is due.

It is this heavy hydrogen, discovered by Prof. H. C. Urey in New York, which interests chemists in heavy water. At first sight, this interest may well seem unjustified. Heavy hydrogen is not a representative of a new class of substances. It is to be considered as an isotope of hydrogen, which is accompanied by it in the same way as almost every element is accompanied by one or more of its isotopes. Lead, for example, which is mainly constituted of atoms weighing 208 units, contains in addition atoms of weights 203, 204, 205, 206, 207, 209 and 210. In chlorine there is, beside the main part consisting of atoms of weight 35, another kind of atom weighing 37 which forms as much as one third of the element.

The discovery by Soddy, more than twenty years ago, of the existence of isotopes, and the disclosure by Aston, with his mass-spectrograph, of the isotopic composition of the elements, were great discoveries. But in the years that have followed, new isotopes have ceased to arouse general interest, and even when, more recently, the three basic elements of organic chemistry and of living matter, carbon, oxygen and nitrogen, were found to contain a fair amount of heavier isotopes, namely, a carbon of weight 13 beside that of weight 12, nitrogen of weight 15 beside that of weight 14, oxygen of weight 18 beside that of weight 16, these discoveries did not arouse much interest among chemists. Indeed, many excellent chemists of my acquaintance have taken no notice of these new isotopes.

Why, then, is the new isotope of hydrogen viewed so differently from other isotopes that some chemists consider its discovery to be possibly the greatest advance in chemistry made in this century ? The answer is, because it does not behave as an isotope at all. So much so, that Prof. Soddy, the discoverer of isotopy, has, in contradiction to the general view, actually repudiated its claim to be regarded as a true isotope. Prof. Soddy upholds the original definition of isotopy, according to which two elements should be called isotopes if they cannot be separated from one another by any chemical means. By this standard, the two different hydrogens should certainly not be considered as isotopes. Heavy hydrogen is easily separable from ordinary hydrogen. Water containing 95 per cent of heavy water is available, not as a natural product, but manufactured, by Imperial Chemical Industries Ltd. in England, from ordinary water which contains only 1/4,000 of heavy water. Evidently, a very effective separation of the heavy hydrogen from the ordinary one has been carried out in this case. Also there is no doubt that the process used for the separation is a chemical one.

The preparation consists in a process of electrolysis. The first indications of the separability of the two hydrogens by electrolysis was discovered by the late Dr. E. W. Washburn and Prof. Urey, who found that when water is decomposed by electrolysis, the undecomposed residue has a somewhat greater density than ordinary water. The purification of heavy water on this basis is due to Prof.

* Friday evening discourse at the Royal Institution, delivered on November 23.

G. N. Lewis of California, who has shown that by decomposing very large quantities of water until only a small residue remains, almost pure heavy water is obtained.

There is plenty of other evidence for chemical differences between ordinary and heavy water. Generally, the compounds of heavy hydrogen react more slowly than the corresponding ordinary hydrogen compounds. The greatest difference has been described by Prof. Urey in the reaction between water and aluminium carbide, which leads to the formation of methane. Heavy water reacts twenty times more slowly than ordinary water.

Why, then, if the two hydrogens are so different, do chemists generally agree to consider them as isotopes ? The answer is, because the two hydrogens, although chemically different, are true isotopes with regard to the structure of their atoms.

The amplification of the original definition of isotopes implied in this opinion is the natural outcome of the theory of Rutherford and Bohr on atomic structure. We can illustrate this structural

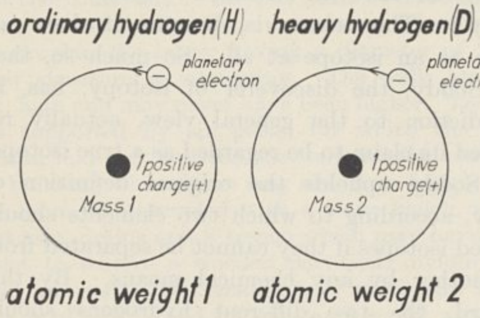


FIG. 1. The isotopes of hydrogen.

view of isotopy by comparing the atomic models of the two sorts of hydrogen atoms. These are shown in Fig. 1 according to Bohr's theory. The two atoms are equal in every respect, apart from the difference in the masses of their nuclei. Two atoms thus related to one another are considered to be isotopes from the structural point of view.

Until the discovery of heavy hydrogen, atoms which have the same structure, and differ from one another only in the mass of the nucleus, have always been found to possess identical chemical properties.

It is easy enough to show reasons why this should be so. The forces originating from an atom are due to the electric field of the charges contained in it. Two atoms with identical electric charges, identically distributed in space, will therefore originate identical forces. It is therefore to be expected that such a pair of atoms should have equal chemical properties.

The astonishing thing is that this should not hold for the two sorts of hydrogen atoms, that these two, although giving rise to identical forces, should have different chemical properties. How can the mere difference in nuclear mass cause such marked chemical differences as shown by the two hydrogens ? If mass differences can cause such disparities, why have they never become apparent in other known pairs of isotopes—why has this mass effect remained undisclosed up to the discovery of heavy hydrogen ?

Only when we can answer these questions fully, shall we be quite justified in considering heavy hydrogen as an isotope of ordinary hydrogen.

Now there is a certain difference in chemical properties caused by mass differences, well known for a long time, which we must expect to find more accentuated between the two sorts of hydrogen atoms than between any other pair of isotopes known hitherto. This difference has its origin in the motion in which all particles around us are kept by the *heat* contained in matter. The thermal velocity of a lighter particle is greater than that of a heavier one. A particle moving faster will reach a molecule with which it might react faster than its slower competitor ; it will therefore be found to react more quickly, just as light hydrogen reacts more quickly than heavy hydrogen.

The chemical differences which arise from thermal velocities will depend on the *ratio* of the atomic masses. This ratio is certainly more marked in the case of the two hydrogens than in any other element. It is 1 : 2 for the hydrogens, while in the element coming next to these, namely, the pair of lithium atoms of mass 6 and 7, there is a ratio of only 1 : 1·2. There is thus a good *prima facie* case for attributing the chemical differences between the hydrogen isotopes to their different thermal velocities.

However, this explanation, although it looks so promising at first sight, turns out on closer examination to be an incorrect one. First, calculation shows that the differences in thermal velocities are quite insufficient to account for the differences which have been actually found between the reaction velocities of the two hydrogen isotopes. Secondly, there are some dissimilarities to be described presently between the compounds of the two hydrogens, which prove that these compounds differ in their *energy content*. Consideration of thermal velocities cannot account for such energy differences.

We must, therefore, postulate a cause apart from the differences in thermal velocities, for the explanation of the actual dissimilarities of the two sorts of hydrogen. We shall see that this cause is to be found by applying to our problem one of the more recently discovered principles of Nature, namely, the uncertainty relation of Heisenberg.

The Law of Uncertainty

The uncertainty principle states that no information can be obtained about the velocity of a particle the position of which is known with absolute accuracy. *Certain* information about the velocity can be arrived at, if we admit a *certain inaccuracy* of position. Thus, the two inaccuracies remain tragically linked together in the formula:

$$\text{Inaccuracy of position} \times \text{inaccuracy of velocity} = \text{constant.}$$

Our information on position and velocity has in it a compound inaccuracy which is irreducible.

From this uncertainty, however, we can derive a dynamical principle latent in all matter, which acts against a force holding a particle, and in doing so modifies the effects of the force. It will also appear that the effect of this dynamical principle depends on the mass of the particle, and is, therefore, different for two atoms giving rise to identical forces, but differing in mass. We shall then see that this is the true reason why the two hydrogen atoms are so different.

A fictitious experiment will enable us to recognise the dynamical principle in question. Suppose we attempt to defeat the uncertainty principle by sheer force. We take an atom and hold it at rest in some fixed position. If we succeed in doing this, we would obviously overthrow the law of uncertainty. The position of our atom would be exactly known and, since we suppose it to be held at rest, its velocity would also be known to be exactly equal to zero.

The law of uncertainty predicts that our experiment will fail. Any force trying to keep an atom in a fixed position would be defeated by a power given to the particle to defend its uncertainty. It will defend it by starting to vibrate. The tighter we try to hold the atom to stop this vibration, the more violent would the vibration become. No force would be strong enough to keep the particle in place, motionless.

The uncertainty law thus leads to the following postulate: Any particle restricted to a definite range of positions is necessarily in motion; the range of velocities contained in this motion will be the wider, the narrower the restriction of positions; that is:

$$\text{Range of positions} \times \text{range of velocities} = \text{constant.}$$

In Nature, atoms are restricted in their position when linked up to chemical compounds. Such restrictions, we must conclude, will give rise to an uncertainty motion of the atoms. All molecules will hence contain a certain amount of uncertainty motion, and also, since this motion has kinetic energy attached to it, a certain amount of corresponding energy. We might also postulate that the more restricted the positions of the atoms in the molecule are, that is, the stronger the bonds that hold the atoms in position, the more violent will be the uncertainty motion, and hence the greater will be the energy content of the molecule, due to uncertainty.

Next to bond strength, atomic mass will influence the uncertainty motion. This influence of mass is contained in the constant of the uncertainty formula, which can be written:

$$\text{Range of positions} \times \text{range of velocities} = \frac{\text{universal constant}}{\text{mass}}.$$

Thus the composite uncertainty on the left hand side of the equation is smaller the larger the mass of the particle. Hydrogen of mass 1 will have a compound uncertainty twice as large as hydrogen of mass 2. Under equal conditions, therefore, the uncertainty motion and the energy of this motion will be larger for light hydrogen than for heavy hydrogen; in corresponding molecules containing the two sorts of hydrogen, there will be more 'uncertainty energy' present when the molecule contains ordinary hydrogen than when it contains the heavy isotope.

Compare, for example, ordinary water with heavy water. For ordinary water, the 'uncertainty energy' amounts to 13,097 cal.; for heavy water it is only 9,527 cal. Since the uncertainty energy is only present in molecules, and vanishes when the atoms are set free, it follows that less work is needed to break up an ordinary water molecule into free atoms than to separate the atoms of heavy water. This is illustrated graphically by Fig. 2. From such differences in the energy contents of the corresponding molecules, all the differences in the chemical properties of the two hydrogens arise. I will show this in the remaining part of my lecture, but before turning to this, I wish to emphasise two points. First, that the attribution of the exceptional dissimilarity of the two hydrogen isotopes to the exceptionally high ratio of their masses is not correct. Suppose a lead isotope should be discovered having double the mass of ordinary lead. Such an isotope would be chemically indistinguishable from ordinary lead, because the 'uncertainty' attached to a particle of the mass of a lead atom is imperceptible, and hence no variation of this uncertainty can be detected. Secondly, the permanent character of the atomic motion, which is required to keep up the uncertainty of velocities, should be clearly realised. Atoms and molecules are ordinarily kept in, what may seem to us, perpetual motion by heat. But heat can be passed on to a cooler body, or be lost altogether by radiation. In the distant future, all heat may become lost by radiation, and all thermal motion may die out. But beyond

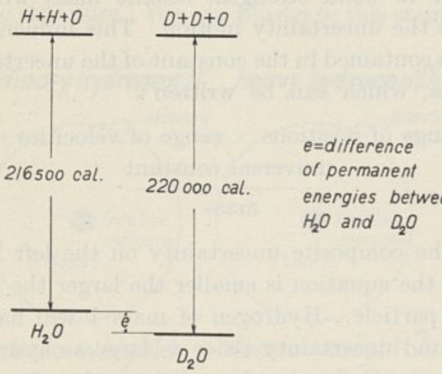


Fig. 2.

that death, the uncertainty motion will persist for ever. No atom bound in a molecule can ever find rest from this motion, nor lose the energy arising from it. We might well call this the *permanent motion*, and the energy corresponding to it the *permanent energy* of the molecule.

Permanent Energy and Chemical Properties of the Hydrogen Isotopes

We have now to show in what way the differences in permanent energies cause the dissimilarities in the properties of the ordinary and the heavy hydrogen.

The curves in Fig. 3 show the permanent energies of both the ordinary and the heavy hydrogen halides. Since the bond strength of the hydrogen halide molecules decreases in the sequence → Cl → Br → I, we might expect—remembering that the permanent energy is greater the tighter the bond which holds the atoms in position—that the permanent energy will decrease in the sequence of falling bond strength. This is well borne out by both curves, which show consistently a decrease in the sequence HF → HCl → HBr → HI, and likewise in the corresponding sequence DF → DCl → DBr → DI.

The reduction of permanent energy which has been deduced from the uncertainty principle for the case of H being replaced by D is also clearly shown. The D-curve lies everywhere below the H-curve. The relative depression of the permanent energy is very nearly equal for all four compounds. Consequently, the absolute value of the difference in permanent energies is the greater the higher the permanent energy of the original compound. This relation when connected with the above-

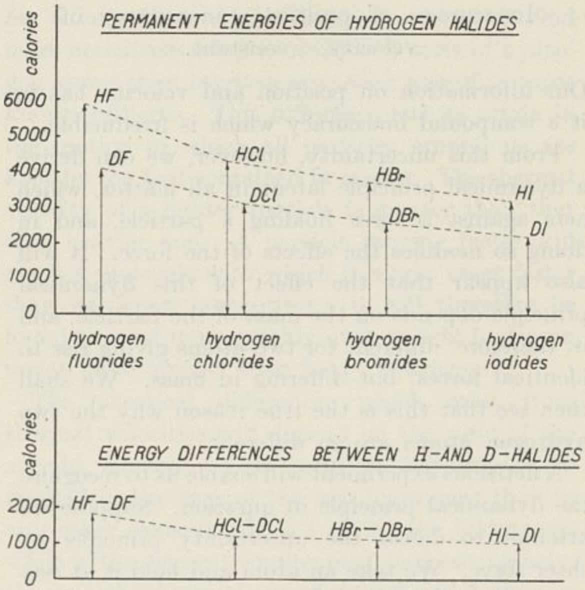


Fig. 3.

mentioned rule governing the sequence of the permanent energies leads to the important conclusion, illustrated by the lower part of Fig. 3, that the differences in the permanent energies of corresponding H and D compounds fall off in the sequence of decreasing bond strength. Or, putting it in a more general way: the contrast between two corresponding ordinary and heavy hydrogen compounds will differ from compound to compound and will be the more marked the firmer the bond by which the hydrogen is linked in the compound.

The energies in Fig. 3 are not measured data, but values calculated from molecular theory. A little further discussion leads us to a very sensitive method of checking these theoretical results. The diagram shows us that if we replace H by D in hydrogen fluoride, the energy will fall by about 1,600 cal., that is, this amount of energy will be gained. Similarly, if we replace H by D in hydrogen iodide, we gain about 900 cal. We can express this in the following chemical equations:

$$D + HF = DF + H + 1{,}600 \text{ cal.} \quad (1)$$
$$D + HI = DI + H + 900 \text{ cal.} \quad (2)$$

By subtracting equation (2) from equation (1) we obtain, after a slight rearrangement:

$$HF + DI = HI + DF + 700 \text{ cal.}$$

Hence an interchange of H and D between HF and DI is a reaction in which energy is set free. Since reactions always tend to go in the direction in which they produce energy, we might expect that in a mixture of hydrogen fluoride and hydrogen iodide which have between them a certain amount of heavy hydrogen, the heavy hydrogen will have the tendency to unite with fluorine rather than with iodine.

An experiment to test this conclusion could be carried out in the following way. A quantity of heavy hydrogen could be prepared by decomposing heavy water, for example, by electrolysis. We might use one gram of water, containing 1 per cent of pure heavy water, and by completely decomposing it, produce about one litre of hydrogen containing 1 per cent heavy hydrogen. From one half of this we could make, with fluorine, one litre of hydrogen fluoride containing 1 per cent of DF. The other half would go to form 1 litre of hydrogen iodide containing 1 per cent DI. We could now let the two gases mix together in a two litre vessel, and add a trace of water to catalyse the interchange of hydrogen atoms between the two gases. On separating the gases and estimating how much heavy hydrogen is contained in each of them, we should find that heavy hydrogen accumulates in the hydrogen fluoride, which will contain about 1·3 per cent of D as against 0·7 per cent of D in the hydrogen iodide.

By carrying out the experiment at a low temperature, for example, − 150° (supposing that an efficient catalyst could be found), the distribution of D would become even more unequal, namely, 1·8 per cent D in hydrogen fluoride as against 0·2 per cent D in the hydrogen iodide.

Interchange Reactions of Hydrogen Atoms

Such interchanges of H and D between two hydrogen compounds have been the object of numerous studies, especially at the Universities of Manchester and Cambridge; in Manchester the work was mainly done by Dr. J. Horiuti; the work in Cambridge is due to Dr. A. Farkas, Dr. L. Farkas and Prof. E. K. Rideal. Indeed, the principal part played by heavy hydrogen in chemistry is in some way or another connected with such interchange processes.

Suppose that we bring together the two gases, hydrogen and hydrogen iodide, and add to these the three liquids, water, benzene and ethyl alcohol, and suppose also that we have appropriate catalysts present to bring about the interchange of the hydrogen atoms between all these compounds, then, after separating the substances, we shall find that each contains a certain part of the heavy hydrogen present in the mixture. This characteristic quota of each compound will specify the relative preference which it gives to D over H.

Distribution of D between different hydrogen compounds

Hydrogen compound*	Specific quota	Reference
HI	0·17	Calculated from known equilibria.
H_2	0·33	A. Farkas and L. Farkas (*Trans. Far. Soc.*, **30**, 1071; 1934).
H_2O	1·00	(Arbitrary unit.)
C_6H_6	0·95	J. Horiuti and M. Polanyi (NATURE, **134**, 377; 1934).
C_2H_5OH (hydroxyl group only)	1·5	C. E. H. Bawn (unpublished).

* The symbol H used here includes both kinds of hydrogen.

A list of these quota figures for the five compounds mentioned above is given in the accompanying table, in which the units are, of course, arbitrary. From what has been said above, we know that these figures depend on the differences of permanent energy between the ordinary and the heavy compounds. We obtain from these figures a rather intimate knowledge about the permanent energy of different compounds which otherwise would not be easily accessible to measurement.

The capacity of some substances to accumulate a comparatively high quota of the heavy hydrogen present in a mixture can be utilised in the following way. Suppose we bring hydrogen iodide containing some D into contact with alcohol, then we shall find on separating the two substances a concentration of heavy hydrogen about ten times greater in the alcohol than in the hydrogen iodide. If we carry out the process at low temperatures, for example, at $-80°$ C., the ratio of the two concentrations will be as high as 30 to 1.

Processes of this kind may promise to be of use for the manufacture of heavy hydrogen. Ordinary hydrogen contains, as I have said, about 1/4,000 of heavy hydrogen. To concentrate it from this dilution at a reasonable cost is as yet an unsolved problem.

Suppose we convert the hydrogen gained by decomposing ordinary water into hydrogen iodide, and then pass this hydrogen iodide through alcohol at $-80°$ C., we should get an alcohol containing almost 1 per cent of heavy hydrogen in its hydroxylic hydrogen. By decomposing the hydroxyl group of the alcohol, for example, by metallic sodium, a hydrogen containing almost 1 per cent of heavy hydrogen would be set free, and it would be easy to arrive at highly concentrated heavy hydrogen by repeating the process once or twice. In practice, this process would probably fail on account of the unavoidable losses of iodine and of alcohol, which would make it fairly expensive.

Similar processes based on the unequal distribution of heavy hydrogen between different substances will probably be found practicable sooner or later, and might then bring down the price of heavy hydrogen to the point where it could be used in the manufacture of the more valuable chemical products, such as drugs and dyestuffs.

Another interest attached to the interchange of hydrogen atoms between different hydrogen compounds lies in the possibility which they offer for the preparation of the more complicated compounds of heavy hydrogen. It is, of course, not impossible to build up all sorts of heavy hydrogen compounds by synthesising them from their elements, using heavy hydrogen instead of ordinary hydrogen. But this procedure might prove rather awkward with many very common substances usually not prepared by synthetic processes, such as benzene, naphthalene, anthracene. However, it seems easy to prepare the heavy hydrogen compounds corresponding to benzene, naphthalene, etc., by taking the ordinary substances and replacing in them the H atoms by D atoms.

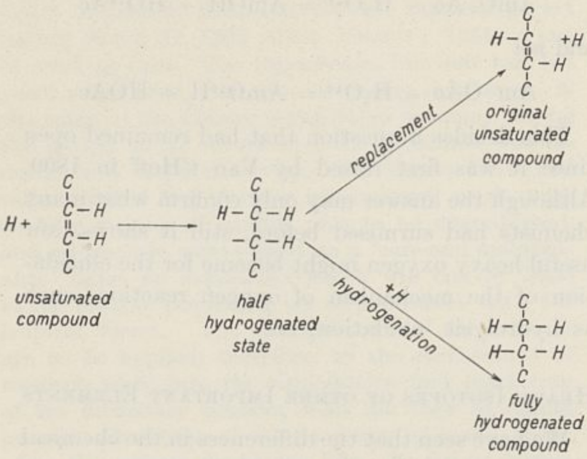
Suppose we want to make benzene with the hydrogen atoms substituted by heavy hydrogen atoms, that is, C_6D_6. A synthesis could be carried out by polymerising synthetic heavy acetylene. It seems much simpler to bring the benzene into contact with pure heavy water, adding an appropriate catalyst to let the two substances exchange their hydrogen atoms. If we take 10 gm. of heavy water and 1 gm. of benzene, about 90 per cent of the hydrogen in the benzene should be replaced in one process. A repetition of this procedure should give us benzene containing 99 per cent D in its hydrogen. This process is now being tested in Manchester.

The interchange of hydrogen atoms of different compounds has also an interest as a new type of chemical reaction, often related in an interesting way to other 'true' chemical reactions. Consider, for example, the replacement of ordinary by heavy hydrogen in benzene. The quickest way to obtain this replacement is by bringing heavy hydrogen into contact with benzene at room temperature in the presence of a nickel or a platinum catalyst. These catalysts are well known for their capacity to cause the addition of hydrogen to unsaturated compounds; in their presence, ethylene, for example, will react very rapidly with hydrogen to form ethane. Benzene likewise adds on hydrogen, forming hydro-benzene, but much more slowly. The replacement reaction will, therefore, be accompanied by a hydrogenation of benzene. But experience has shown that the hydrogenation is very much slower than the replacement. Only one in a hundred molecules, reacting in the sense of replacement, reacts also in the sense of hydrogenation.

The replacement of ordinary by heavy hydrogen in benzene can also be carried out by bringing heavy water into contact with benzene. This reaction proceeds also in the presence of platinum and nickel catalysts, but it goes much slower than the interchange between ordinary hydrogen and benzene. Higher temperatures and longer times are required when heavy water is used for replacement; there is, of course, no hydrogenation whatever.

We note that both the hydrogenation and the replacement of hydrogen atoms represent a transfer of hydrogen atoms to the benzene. The two processes differ only in the result obtained by the transfer of the hydrogen atom; while in the case of *hydrogenation* the transfer results in the formation of hydrogenated products, like ethane from ethylene, or hydrobenzene from benzene, *replacement* proceeds without any accompanying chemical change.

These alternative reactions can be shown by the following reaction scheme :



A hydrogen atom meeting an unsaturated molecule first forms a half-hydrogenated product. This substance then, if left to itself, decomposes by dropping one of its redundant hydrogen atoms (see upper arrow), whereby there is at least an even chance that the hydrogen atom lost is not the same one as had been added, and that, in consequence, the result is the replacement of a hydrogen atom. This decomposition of the half-hydrogenated state can, however, be forestalled if a second hydrogen atom comes up before it is accomplished (see lower arrow), and links up to the half-hydrogenated molecule, forming a fully hydrogenated compound.

If this explanation is correct, hydrogenation will be rare when the interval between the approach of the first and second hydrogen atom is long. In such cases, the reaction will result almost exclusively in replacement of hydrogen atoms, unaccompanied by hydrogenation.

This conclusion is well borne out by our experiments, which show that while a more energetic action of hydrogen on benzene (when gaseous hydrogen is brought into contact with it) causes a replacement of hydrogen atoms, which is accompanied by a quite appreciable amount of hydrogenation, no hydrogenation is found when the action of hydrogen is slow, as, for example, when water is the source of the hydrogen atoms reacting with benzene. Thus the replacement reaction discovered by the use of heavy hydrogen discloses the nature of hydrogenation, which appears now to be a side reaction of the replacement reaction. Similar success may be expected in many other cases.

Low Reactivity of Heavy Hydrogen Compounds

The study of the hydrogen interchanges, to which we originally turned in order to derive information on the energy differences between the ordinary and the heavy hydrogen compounds, has led us away from our starting point. We return now to the question raised at the beginning of this lecture—the lower reactivity of heavy water as compared with ordinary water.

It is as yet uncertain to what extent the lower reactivity of heavy hydrogen compounds can be considered to be a general rule. But it is certainly a fairly widespread condition. The possible interest of such lower reactivity is, of course, manifold. Hydrogen compounds which ordinarily are readily oxidised or otherwise decomposed might become stable if the ordinary hydrogen is replaced by heavy hydrogen. Reactions might be led into new paths or else their output might change considerably. Theory and practice would profit abundantly by such phenomena.

This lower reactivity of heavy hydrogen and of the compounds of heavy hydrogen can be explained by the theory of permanent energy with which I have already dealt. Indeed, it was predicted from this theory when there was still scarcely any experimental evidence for it.

The essential connexion between permanent energy and reactivity is easily recognised. A molecule undergoes chemical reaction only if it happens to accumulate a certain critical amount of energy. The molecule has to wait until, in the course of the constant fluctuation of energy caused by heat motion, it happens to get an especially big share of energy equal to this critical energy. As soon as it has swallowed this, it goes to pieces —that is, chemical reaction.

Now suppose we have two molecules, one a compound of ordinary hydrogen, the other, the corresponding compound of heavy hydrogen. Let both molecules wait side by side until, by a fortunate fluctuation of thermal motion, they acquire the critical energy necessary for reaction. The ordinary hydrogen molecule is obviously in a better position in this competition, since it has a start on account of its greater permanent energy. The energy required by it is correspondingly smaller, and it will have an earlier chance to get this smaller quantity. It will, therefore, react before its competitor, the heavy hydrogen compound. This is the reason for the lower reactivity of heavy water, and of other heavy hydrogen compounds.

Water with Heavy Oxygen

I have mentioned before that ordinary oxygen of atomic weight 16 is accompanied by small quantities of a heavier isotope of weight 18. This heavy oxygen forms with hydrogen a heavy water of a kind quite different from 'ordinary' heavy water. H_2O^{18} in pure form would have about the same density as D_2O, that is, 10 per cent above that of ordinary water. The two sorts of heaviness could be combined in 'super-heavy' water, D_2O^{18}, which would have a density of 1·2.

It is, however, much more difficult to prepare pure heavy oxygen than it is to prepare pure heavy hydrogen. Although the abundance of heavy oxygen in ordinary water is eight times higher than that of heavy hydrogen, it has not yet been isolated. The difficulty is that the two sorts of oxygens are chemically identical, and hence we have no convenient hold whereby to grasp the one, leaving the other behind. The separation can be carried out only by physical methods which are comparatively ineffective.

The best physical method for the separation of isotopes is at present the 'fractionated diffusion' of G. Hertz. By this method, Prof. Hertz has succeeded in preparing about 300 mgm. of water containing about 1 mgm. of heavy oxygen. Prof. Hertz gave us this sample and Dr. Szabo and the author have made the following use of it.

To the water we added a small quantity of metallic sodium, thus forming an alkaline solution. Then a few milligrams of amyl acetate were treated with this solution until completely saponified. From the amyl alcohol produced by the saponification, the hydroxyl group was split off in the form of water. We examined this water, and found that *its density was normal*.

It follows that this oxygen does not come from the water used for saponification: it must, therefore, come from the oxygen of the ester-bridge. Or, in chemical symbols:

$$\mathrm{AmO \vdots Ac + H_2O^{18} = AmOH + HO^{18}Ac}$$

and *not*

$$\mathrm{Am \vdots OAc + H_2O^{18} = AmO^{18}H + HOAc}$$

This decides a question that had remained open since it was first raised by Van t'Hoff in 1899. Although the answer may only confirm what many chemists had surmised before, still it shows how useful heavy oxygen might become for the elucidation of the mechanism of oxygen reactions such as hydrolysis, oxidation, etc.

Heavy Isotopes of other Important Elements

We have seen that the differences in the chemical properties of ordinary and heavy hydrogen are interesting, both in themselves and as a means of preparing pure heavy hydrogen. But often the heaviness of the new hydrogen is used merely as a convenient 'label' to mark the path which the hydrogen follows, when it becomes mixed and interchanged with other hydrogen atoms. For this labelling purpose, the heaviness of heavy oxygen, O^{18}, has turned out to be just as useful a tool where reactions of oxygen are concerned. The same is obviously true for N^{15} and C^{13}, with respect to the study of reactions involving nitrogen and carbon*.

Heavy hydrogen has a start over the other isotopes of the more important elements, because it was the first to be isolated in quantity. When we have the other isotopes at hand in sufficient quantities, they may well prove even more important than heavy hydrogen. All branches of chemistry will benefit by such progress, but it is likely that the greatest stimulus of all will be given to the chemistry of living matter when such labelled carbon, hydrogen, oxygen and nitrogen atoms will become generally available.

* Labelling of atoms by isotopes was first introduced by Hevesy and Paneth in their method of 'radioactive indicators'. (See, for example, Hevesy and Paneth, "Lehrbuch der Radioaktivität". J. A. Barth, Leipzig (1923), p. 105.)

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Forestry in British Honduras

THE chief note of the annual report of the Forest Trust of British Honduras for the biennial period ending March 31, 1933 (Govt. Printer ; 1934) is one of marking time. The Department has now had ten years experience, but the increasing depression in the trade of the Colony necessitated economy during the period under review and the personnel was reduced to a skeleton service. The Forest Trust had early decided that further sylvicultural work, with its long lock-up of capital, was to be discontinued, and all reserves were placed on a 'care-and-maintenance' basis, an expression which will convey little to the forester possessing an acquaintance with the tropical forest. The energies of the Department are to be applied, therefore, to the furtherance of research work into the exploitation and marketing of the secondary timbers, with the view of taking prompt advantage of the recovery of world trade, when the present depression lifts. So far as it goes, this may be regarded as satisfactory ; but the Department will have a long row to hoe before the position of half a decade or so ago is re-attained. The following extract from the report in connexion with *taungya* is of importance and should interest West African forest officers : "The practice of seeding-up the annual corn-plantation with mahogany continues to give excellent results. Mahogany seed is dibbled in lines with the maize at 10 by 10 feet intervals, and the area is abandoned after the first crop has been harvested. The mahogany is then sufficiently established to compete with the weed growth, which very quickly closes the canopy. Over-topping of the mahogany by weed-growth is found to be beneficial in preventing shoot-borer (*Hypsiphylla grandella*) attack. Tending consists of removing vines. It is becoming very apparent that huamil (secondary growth) conditions are very favourable to the growth of mahogany, which grows well whilst its head is just under huamil canopy, and that heavy cleaning is not only undesirable but often disadvantageous in rendering the mahogany susceptible to the shoot-borer attack."

Preservation of Newspaper Records

NEWSPAPERS are an important class of historical records as they give a clear view of contemporary life and events. The newspaper files preserved in libraries give valuable reference records for historical purposes. Unfortunately, the paper on which they are printed is often made of crude ground wood fibre, which rapidly perishes, and the space they take up in libraries is excessive. In publication No. 145 of the U.S. Bureau of Standards (Washington : 5 cents), B. W. Scribner describes researches that have been made on methods of preserving newspapers. For retarding decay, the use of Japanese tissue paper has been found effective. Transparent cellulose acetate sheeting is also useful. Pending the development of more satisfactory materials and methods, an effort should be made to copy the most valuable of the older newspaper records on permanent paper by photostatic printing or photolithography. Reproduction in miniature is the ideal method of reducing the space required. The technique of making miniature prints of newspaper records on transparent slides and projecting them in enlarged form for reading is making satisfactory progress. The life of the types of flexible film so far used is only about thirty to forty years. It is recommended that a joint effort be made at once by scientific and library organisations to find the most practical means for preserving newspaper records. Special stress should be laid on perfecting materials and methods of reproduction in miniature. The advisability of founding a central agency for supplying reproductions of newspapers and other records to libraries should also be considered.

Rubber and Agriculture

THE rapid development of the rubber industry has been one of the most notable industrial events of the present century. Between 1910 and 1933, the net amount of crude rubber exported from the principal producing countries increased from 94,000 tons to 851,000 tons per annum, while the world absorption of the manufactured product rose from 85,000 tons to 814,000 tons during the same period. Although the demand for motor tyres has been primarily responsible for this expansion, rubber has now found its place in practically every branch of industry. To illustrate the various ways in which it may be used on the farm, the Rubber Growers' Association (2–4 Idol Lane, Eastcheap, E.C.3) has issued a booklet entitled "Rubber and Agriculture". In out-door equipment, not only can tyres of every description be supplied to suit everything from a tractor to a wheelbarrow, but also jointed tracks are successfully made. The inconvenience of the ordinary tipping device for unloading lorries is now avoidable by using a vehicle fitted with a rubber movable floor, which discharges on either side as desired. In the cow-shed and dairy, rubber stalls and flooring, rubber parts to the milking machines and rubber rims to the churns to reduce noise, are some of the uses to which this product can be put. In the farm-house itself rubber is becoming increasingly popular ; rubber floor coverings, brushes and even rubber upholstery now being practical propositions, while for the farmer and his family, rubber clothing of various types is a recognised part of their outfit.

Small Sparks due to Static Electricity

THE small sparks due to static electricity, similar to those sometimes observed when combing the hair or walking over a thick carpet, have caused fires which cost industry an appreciable amount, both in life and property. According to Science Service, of Washington, D.C., a study made by the Fire Protection Association shows that during the last six years 147 fires in the United States have been attributed to this cause. A frequent cause of sparking is the friction of an endless belt running over pulleys. In an atmosphere containing a certain amount of inflammable gases, this would be sufficient to cause an explosion which might result in a serious fire.

Static sparks have also been observed when 'dry' liquids like petrol or ether are being handled. When any inflammable liquid is being poured from one vessel into another it should always be discharged so that there is no appreciable fall through the air into the lower vessel. It is well-known that the human body can store electricity sufficient to cause a small spark when it is brought near an earthed conductor. Coal gas can be ignited in this way. Cases have been recorded where static discharges from a painter's hand have ignited the vapour from a paint remover. In another case, vapours from rubber cement were ignited by a spark from the body of a woman who was working near it.

Cæsalpinus and Harvey

In a letter to the *Lancet* of November 17, dealing with the remarkable absence of any reference in Harvey's writings to his predecessor Cæsalpinus, who is still regarded by some Italians as the discoverer of the circulation of the blood, Dr. D. F. Fraser-Harris remarks that he has recently found the three words "J. Cæsalpinus Aretinus" in a translation of the MS. notes of Harvey's lectures edited by a committee of the Royal College of Physicians in 1886. He points out, however, that the Christian name of Cæsalpinus of Arezzo was Andreas, so that the initial letter should have been A. instead of J. He therefore suggests that Harvey, whose handwriting was execrable, really wrote "J. Cæs. Arantius", an abbreviation of Julius Cæsar Arantius, the celebrated anatomist of Bologna (1530–89), to whom Harvey afterwards referred in his essay on the placenta when dealing with the relation of the umbilical vein to the uterine vessels. In support of this suggestion is the context, in which Harvey is describing the three semi-lunar valves at the base of the aorta and pulmonary artery, on the cusps of which the corpora Arantii are found.

Ramanujan Memorial Prize in Mathematics

In 1933 the University of Madras offered a Ramanujan Memorial Prize for the best thesis based on original contributions submitted by an Indian (or one domiciled in India) on some definite branch of mathematics, applied or pure. The underlying idea was to stimulate interest among the younger mathematicians of India and to attempt in some way to commemorate the spirit of the late S. Ramanujan, the first Indian fellow of the Royal Society, whose untimely death in 1920 at the early age of thirty-two years robbed the world of one of the most brilliant mathematicians of his time. A number of theses were submitted and the University of Madras has now announced that the prize of value about £70 (nine hundred rupees) has been divided equally between the following: S. Chandrasekhar, fellow of Trinity College, Cambridge; S. Chowla, reader in mathematics, Andhra University, Waltair, India; D. D. Kosambi, professor of mathematics, Ferguson College, Poona, India. Ramanujan was the first Indian to be elected to a fellowship at Trinity College, Cambridge, and it is interesting that two of the successful candidates (S. Chandrasekhar and S. Chowla) are both Trinity men.

Air-Conditioning in Mines

We are informed that air-conditioning plant is about to be installed in the well-known Robinson Deep Mine, Johannesburg, South Africa, the deepest point in the mine being 8,380 ft. below the surface of the earth. The mine is naturally hot and damp, the high temperature (100°–120° F.) being due to adiabatic compression at the lower levels; it is calculated that the temperature increases 5° for an average depth of every 1,000 ft. of the mine. The air is also very moist, having a relative humidity of 90–100 per cent, owing of course to the necessity of wetting the mine walls after every blast to prevent siliceous dust from being thrown into the air and being inhaled by the workers, thus causing the silicosis which is well known to be the scourge of South African mining. It is stated that the air-conditioning, cooling and dehumidifying plant is the largest in the world, and will be capable of dealing with 400,000 c. ft. of air per minute. It is stated that the cooling effect is equal to 4,000,000 pounds of ice.

Research on Silicates

In *Veröffentlichungen aus dem Kaiser Wilhelm-Institut für Silikatforschung in Berlin-Dahlem* are reprinted a large number of papers published since the beginning of 1932. There are two papers on chemical and thermodynamic aspects of the constitution of glass, two on cements, and one on the specific heats of calcium-aluminium silicates with special reference to the Neumann-Kopp rule. Many of the papers are incomplete in the sense that they are part of a series and must be judged as such. One paper of particular interest deals with the reactions of glass-forming oxides under high pressures of oxygen, up to 350 atmospheres. The authors, H. Möttig and W. Weyl, consider that in glasses containing lead, plumbates are formed; in glasses containing barium they have evidence of the presence of the peroxide. High oxygen pressure modifies the colouring effect of a given amount of manganese additive.

Greenland Researches

The Oxford University Exploration Club has published in one volume the collected reports from various journals on the work of the Club's expedition to Greenland in 1928 ("Greenland and Spitsbergen Papers". Oxford University Press, 1934). This expedition, under the leadership of Dr. T. G. Longstaff, aimed at an intensive study of the ecology of a small area in Godthaabs Fjord, and its results have been published in some ten British and foreign journals. These nineteen reprints are now conveniently bound together and include important papers on the vegetation, birds and insects. In addition, the volume embraces four papers, principally geological, on Spitsbergen, the outcome of the Oxford Expeditions to Spitsbergen in 1921, 1923 and 1924. These are supplementary to the collected papers of those expeditions which appeared previously in the two volumes of "Spitsbergen Papers". The volume shows the extent of valuable work that can be done by a small summer expedition to polar regions, especially when the sphere of work is well defined.

Map of Central America and West Indies

A useful map, embodying the latest information, of Mexico, Central America and the West Indies on a scale of 90 miles to an inch is published by the National Geographic Society at Washington. It is in the main a political map and relief is shown only by hachures, but a number of spot heights are given. Railways and the main highways are shown, and there are many names. Insets show the more important West Indian islands on larger scale. The colour printing is very clear.

Eradication of Prickly Pear in Queensland

The reclamation in Queensland of land formerly infested with prickly pear (*Opuntia* spp.) steadily continues. During the year which ended on June 30, 1934, 5,300,000 acres were made available for selection or for lease under developmental tenure. The total area reclaimed and thrown open for settlement during the past three years is 13,750,000 acres, or approximately 20 per cent of the whole infested region.

International Congress of Americanists

The twenty-sixth session of the International Congress of Americanists, which was to have taken place during November in Seville, had to be postponed owing to financial and political difficulties in Spain. The work of organisation is, however, well advanced and it is hoped that it may still be possible to hold the Congress early in 1935. It is unfortunate that the deliberations of this body, which are invariably of great scientific interest to students of the cultures of aboriginal America, should be subjected to interruption through political unrest. It will be remembered that when the Congress last met in La Plata at the close of 1932, conditions were anything but favourable to an international scientific assembly, and, indeed, had it not been for a certain disorganisation arising out of these conditions, it is probable that the invitation of Great Britain would have been accepted and the Congress would have met in London in close association with the First International Congress of Ethnological Sciences in August last.

Imperial Botanical Conference

An Imperial Botanical Conference, commencing on August 28 and lasting two to three days, according to the programme which may finally be arranged, will be held in London this year. The subjects set down for discussion are of general interest to Empire botanists, and include such topics as pasture research within the Empire, the ecology of tropical forests, the application of ecological methods to the study of native agriculture, problems of fruit storage and transport with special reference to tropical conditions, the furtherance of schemes for the closer co-ordination of botanical research within the Empire, etc. It is hoped that this Conference will furnish a convenient meeting ground for home and overseas botanists who are on their way to attend the International Botanical Congress which meets at Amsterdam in the week following. The chairman of the Organising Committee of the Conference is Sir Arthur Hill, director of the Royal Botanic Gardens, Kew, and the honorary secretary is Prof. W. Brown, Imperial College of Science and Technology, South Kensington, London, S.W.7, from whom further particulars may be obtained.

Announcements

Mr. Francis N. Ratcliffe, assistant in the Natural History Department, University of Aberdeen, has been appointed to the head-quarters staff of the Council of Scientific and Industrial Research, Commonwealth of Australia.

The first volume of the new international botanical yearbook to be known as *Chronica Botanica*, to which reference was made in Nature of September 29, p. 493, will be published shortly. Heads of botanical institutions, etc., who have received the questionnaire are therefore requested to return it to the publisher, Fr. Verdoorn, P.O. Box 8, Leyden, Holland, as soon as possible. Answers should reach Leyden before January 10 from Europe, January 20 from the United States and Canada, and January 30 from other parts of the world.

A recently issued catalogue of books and periodicals on natural history for sale by Bernard Quaritch, Ltd., covers zoology, geology and palæontology, and contains a good selection comprising more than 2,000 items.

Applications are invited for the following appointments, on or before the dates mentioned :—A lecturer in science and hygiene in the Liverpool City Technical School for Women and F. L. Calder College of Domestic Science—The Director of Education, 14 Sir Thomas Street, Liverpool, 1 (Jan. 7). An assistant lecturer in pharmacy in the Technical College, Bradford—The Director of Education, Town Hall, Bradford (Jan. 15). Three chemists at the Rubber Research Institute of Malaya—The Secretary, London Advisory Committee for Rubber Research (Ceylon and Malaya), Imperial Institute, S.W.7 (Jan. 18). Assistant lecturers in metallurgy in the University of Birmingham—The Secretary (Jan. 21). Two research bacteriologists in the Medical Research Department of the Government of India—The High Commissioner for India, General Department, India House, Aldwych, W.C.2 (Jan. 26). A bacteriological research assistant to the Metropolitan Water Board—The Clerk, 173, Rosebery Avenue, E.C.1 (Jan. 26). A research assistant in tissue culture and assistant lecturer in histology at the University of Birmingham —The Secretary (Feb. 1). A lecturer in chemistry at University College, University of Rangoon—The Secretary, Universities Bureau of the British Empire, 88a Gower Street, London, W.C.1.

Letters to the Editor

The Editor does not hold himself responsible for opinions expressed by his correspondents. He cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

NOTES ON POINTS IN SOME OF THIS WEEK'S LETTERS APPEAR ON P. 37.

Passage of Helium through apparently Compact Solids

IT has been known for some time that helium can pass at the ordinary temperature through silica glass, and also, to a less extent, through pyrex glass. Common glasses, however, are not known to be sensibly permeable.

It was thought of interest to search for other solid materials which might have the property of passing helium far more readily than air.

I have found, in fact, that sheet gelatine, celluloid and cellophane, all behave somewhat like silica glass.

Silica glass and celluloid, when carefully examined in the polariscope, are found to be of the nature of crystalline mosaics, and it is likely that the helium finds its way between the crystals. The same probably applies to gelatine.

There is, however, an interesting field of work in examining whether helium can pass through various crystal lattices (single crystals). A few preliminary experiments have been made. I have confirmed the known result that helium cannot pass through crystalline quartz, and have found further that it cannot get through mica. The case of beryl is of special interest. According to the analysis of W. L. Bragg and J. West[1] the structure of this crystal is exceptionally open, having unobstructed tunnels parallel to the optic axis, each tunnel being about the same diameter as an oxygen atom in the crystal. It seemed worthy of investigation whether helium would go through. I had a slice cut 0·6 mm. thick perpendicular to the axis of a clear and apparently flawless aquamarine. This did in fact transmit helium as indicated in the table below. It is not yet certain whether the helium really passed through the lattice, or merely through flaws or cracks in it. No flaws could be seen, however. The test of whether air would pass through has been applied, but for technical reasons it is more difficult to be sure about the non-passage of air than about the passage of helium. In any case, helium would be expected to pass through more quickly, even if the transmission were through flaws. More severe tests are in progress. It will be important to determine the behaviour of a slice cut parallel to the axis.

Material	Transmission in c.mm. per day Helium	Air	Ratio Helium/Air
Fused silica	4×10^{-1}	—	—
Gelatine	$9{\cdot}23 \times 10^{-1}$	$5{\cdot}02 \times 10^{-3}$	185
Celluloid	39·5	1·94	20
Cellophane	$1{\cdot}36 \times 10^{-1}$	$3{\cdot}23 \times 10^{-3}$	42
Quartz cut ⊥ to axis	$< 1{\cdot}01 \times 10^{-4}$	—	—
Mica	$< 2{\cdot}5 \times 10^{-5}$	—	—
Beryl cut ⊥ to axis	$1{\cdot}34 \times 10^{-1}$	$< 2.0 \times 10^{-2}$	> 7

The accompanying table gives the main results so far. The transmission has been taken provisionally to be inversely proportional to the thickness, and the results are reduced to 1 mm. thickness and 1 sq. cm. area. The gas passes from atmospheric pressure on one side to vacuum on the other.

It should be mentioned that the actual figures for the organic materials are provisional, there being some evidence that the rate falls off with time. This may be the effect of continued mechanical stress due to the gas pressures.

RAYLEIGH.

Terling Place,
Chelmsford.
Dec. 17.

[1] *Proc. Roy. Soc.*, A, **111**, 691; 1926.

Penetration of a Magnetic Field into Supra-Conductive Alloys

USING the same method as in our work on tin[1], we have investigated the behaviour of supra-conductive alloys in a magnetic field. We studied a carefully prepared sample of Bi_5Tl_3 and a lead-thallium alloy containing approximately 65 per cent thallium.

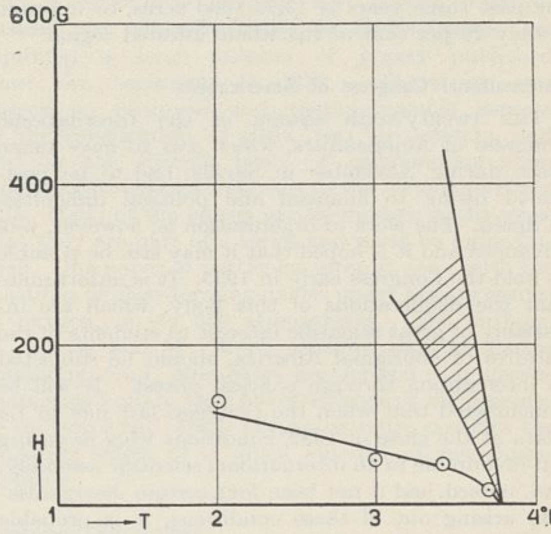

FIG. 1.

A cylindrical rod with a channel along its axis was made of each material, and a thin bismuth wire with current and potential wires was fitted inside this channel; we measured the change of resistance of the bismuth wire as a function of a transverse magnetic field (that is, of a field perpendicular to the axis of the cylinder). At a temperature below the transition point of the alloys, the bismuth wires did not show any change of resistance when a weak magnetic field was applied. When the strength of the field exceeded a certain critical value, a change of resistance was produced, though the alloy itself remained supra-conductive.

The value of the critical field is different for the two alloys and depends on the temperature. Fig. 1 shows the value of the critical field as a function of the temperature; in the shaded region the resistance of the alloy is gradually coming back. In the case of Bi_5Tl_3 the result was analogous.

When the field was switched off, the resistances of the bismuth wires did not return to their normal value[2]; we have not yet determined exactly the maximum value of the magnetic field which may remain in the alloy, but it seems to be of the order of magnitude of the critical field. We are inclined to believe that the critical value of the field, that is, the value at which the field starts to penetrate into the alloy, as distinguished from the threshold field at which the resistance is coming back, may come into play in several phenomena, for example, in experiments on thermal conductivity[3].

A detailed account of the influence of a magnetic field on alloys will shortly appear in *Physica*.

W. J. DE HAAS.
J. M. CASIMIR-JONKER.
Kamerlingh Onnes Laboratory,
Leyden.
Dec. 7.

[1] W. J. de Haas and J. M. Casimir-Jonker, *Physica*, 1, 291; 1934.
[2] cf. T. C. Keeley, K. Mendelssohn, J. R. Moore, NATURE, **134**, 773, Nov. 17, 1934.
[3] W. J. de Haas and H. Bremmer, *Leiden Comm.*, 220 *c*.

Further Experiments with the Magnetic Cooling Method

CONTINUING our experiments[1] with the magnetic method, we investigated the suitability of a number of substances. The efficiency of a substance for this purpose can be defined by a characteristic temperature θ_m, which may be calculated by means of a formula which we derived under certain simplifying assumptions about the splitting of the ground state of the magnetic ions. According to this formula, the final temperature reached in demagnetising to the field zero is inversely proportional to the initial magnetic field, proportional to the initial temperature and to the temperature θ_m, characteristic for each substance, defined by $\theta_m = U/k$ (U = energy difference between the adjacent levels of the ground state, k = Boltzmann's constant). Thus, the smaller θ_m, the more suitable is the substance for attaining low temperatures.

We found that the numerical values of θ_m for the substances investigated lay between about 0·2° and 0·06°. Gadolinium sulphate[2] has the highest value; next, approximately equal, come manganese ammonium sulphate and chromium potassium alum (the substance chiefly used in the Leyden experiments[3]). Manganese ammonium sulphate, however, shows at very low temperatures deviations from the formula of a kind which suggest the existence of a Curie point slightly below 0·1° [4]. Finally follows iron ammonium alum which proved to be the most suitable of the substances we investigated. With it, for example, a temperature of 0·04° was obtained, starting at 1·25° and 14 kilogauss. Preliminary experiments with mixed crystals showed that by diluting the magnetic ions one can reduce the characteristic temperatures.

The technique was further developed, so that there is now no special difficulty in reaching the lowest temperatures, or in keeping even small amounts of substances (some tenths of a gram) at these temperatures for considerable periods. We generally chose a rate of warming up between $\frac{1}{3}$ and 1 millidegree per minute.

Investigations on supra-conductivity in this region were also continued. Two further new supraconductors were found, namely, zirconium and hafnium, pure samples of which were very kindly lent to us by Dr. J. H. de Boer of the Philips Company. The transition point of zirconium lies at 0·7₀°, the initial slope of the magnetic threshold values being about 300 gauss per degree. In the case of hafnium we could use only a very small sample (25 c. mm.) so that the accuracy of the numerical values is not very high. Extrapolation to zero measuring field gives a transition point between 0·3° and 0·4°. Copper, gold, germanium, bismuth and magnesium, at least the samples used by us, did not become supra-conducting down to 0·05°.

In investigating these metals we had still another purpose. It is to be expected that the entropy due to the random distribution of the nuclear spins will vanish within the new temperature region, where kT may be of the order of the interaction energy between the nuclear spin and the surrounding particles[5]. From their hyperfine structure (separation 10^{-2} cm.$^{-1}$ to 1 cm.$^{-1}$) it appears that the corresponding temperature for the free atoms should lie in the region between 0·01° and 1°. For compact metals nothing can be accurately predicted, but it is likely that the interaction energies will be smaller than in the gas.

By mixing a substance with a paramagnetic salt, one should be able to render observable the entropy due to the change of the distribution of the nuclear spin, since in this case one would not reach such low temperatures as with the pure salt. In cooling to 0·05°, using a mixture of equal volumes of metal and salt, one should detect these effects if the separation were greater than about 10^{-2}–10^{-3} cm.$^{-1}$. As no difference in the final temperatures which could be definitely attributed to this effect was found, it appears that the separations in the solid are lower than the limit mentioned above. In the case of bismuth this means that the separations are reduced, at least by the factor 100, on passing from the gaseous to the metallic state.

N. KÜRTI.
F. SIMON.
Clarendon Laboratory,
Oxford.
Dec. 15.

[1] N. Kürti and F. Simon, NATURE, **133**, 907; 1934. *Physica*, 1, 1107; 1934. A detailed report will appear shortly.
[2] Our results with this substance agree satisfactorily with those of Giauque and MacDougall, *Phys. Rev.*, **44**, 235; 1933.
[3] W. J. Haas and E. C. Wiersma, *Physica*, 1, 779; 1934.
[4] See Debye, *Sitzungsber., Math. Phys. kl. Sachs. Akad. Wiss.*, **83**, 105; 1934.
[5] See, for example, F. Simon, *Z. Phys.*, **81**, 826; 1933.

The Vortex Concept

RECENTLY Great Britain has lost two of its chief promoters (W. M. Hicks and H. Lamb) of vortical hydrodynamics, a science which was in the main line of physical suggestion forty years ago. Some historical reflections are thereby suggested.

One would think at first glance that the whole affair is implicit in a few sections at the end of Lagrange's "Mecanique", when he asserts, but without irreproachable proof, that every portion of uniform non-viscous fluid whose motion at any time involves a velocity potential continues to move subject to that restriction. For the Lagrangian principle implies that portions of the fluid mass the motion of which is vortical remain separate from the surrounding non-vortical portions. Rather, that inference ought to have come immediately to Stokes nearly half a century later; for it was he who fortified the Lagrangian analysis and introduced vorticity or local spin as the property negated by a velocity potential. But the matter was not so obvious.

It was left for Helmholtz to inquire whether there could in fact be persisting motion without a potential, and to explore its laws on the basis of Riemannian continuity. The motion must, as he found, be made up of filaments of spin which preserved their material identity, and which if finite must close up as rings. Thus a vortex-ring could be imagined as made up of adjacent threads like a hank of silk; and the question is whether they could hold together or would reduce themselves to confusion by mutual disturbance. This is the question of stability of vortex motion, which gave rise to so much difficult analysis, with only limited results for cases in which facile experiment had led the way. There is no limit to the thinness of the filaments, but they must not go down to molecular cross-section; so that as in other molecular science the convenient terms macroscopic and microscopic claim their places, and there is no transition from fluid-theory to gas-theory.

Thus a vortex ring, even though thoroughly stable, fades gradually owing to the viscidity of the molecular medium. It would be interesting and valuable to consider, on the foundation also established by Stokes, whether, for example, a straight vortex cylinder fades from core outwards, and how rapidly: perhaps the complex analysis involved has already been worked out. The interest is mainly that in actuality a vortex ring is a carrier of momentum, and the distance it is transferred is thus an essential feature, for example, in aeronautic theory.

It is needless to recall that the behaviour of vortex rings in fluid was the stimulant and earliest actual illustration of how a molecular medium could exist in and be controlled by an aether in which the molecules subsist as regions of permanent singularity.

JOSEPH LARMOR.

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Dec. 5.

The X-Ray Crystal Scale, the Absolute Scale and the Electronic Charge

IN 1928 I published some investigations[1] on the X-ray wave-length of the aluminium $K\alpha_{1,2}$ line on the absolute scale, as obtained with the plane ruled grating method. From this the wave-length in question came out as about 0·15 per cent higher on the absolute scale than that found by the ordinary crystal method. This difference was considerably greater than expected from the stated uncertainties of the constants involved in the computation of the crystal lattice of calcite, which constitutes the crystal scale. As is well known, this result therefore was looked upon with decided scepticism.

Later measurements on the same subject, of which that of Bearden in 1931[2] claims the highest precision, have secured this result. The most simple way of explaining this discrepancy, namely, to ascribe it to the uncertainty in the value of the electronic charge, was systematically avoided. On the contrary, the influence of the mosaic structure was suggested to give the explanation of the difference, or simply that the laws of optics were not applicable to X-rays. The first of these reasons seems to have lost its reality after the investigations of Allison[3] and Tu[4], according to which the effect of such supposed irregularities in the crystal structure is of little importance. The only support for the second suggestion seems to be the discrepancy itself which has been mentioned.

However, the investigations of Allison and Tu favour the opinion that this method (ruled grating and crystal determinations combined) may even be used for a reliable determination of the electronic charge. As the method has often been looked upon with some doubt, perhaps originating from the earlier inconsistent results, it seemed to me that it would be of interest to use the ruled grating method under different conditions. Therefore I have carefully analysed the method and its possibilities with regard to the resolving power, the sharpness of the spectral lines, the reproducibility under different conditions, etc.

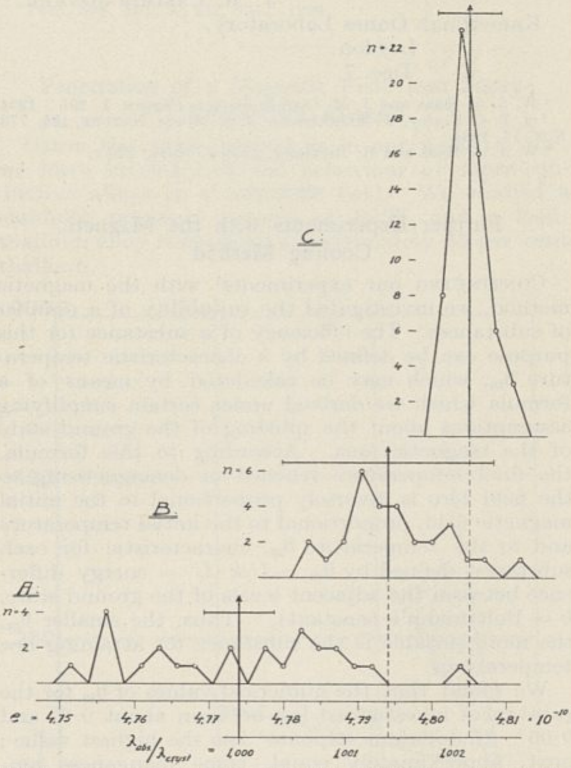

FIG. 1. Diagram showing the shape of the distribution of values of e according to the measurement of (A) Millikan, (B and C) of Bäcklin in 1928 and 1934. n is number of observations within 0·05 per cent intervals.

After some modifications, the precision of my former method has been very much increased, and a series of plates was taken during the month of June, 1934. The result was 56 values of the aluminium $K\alpha_{1,2}$ line up to the 5th order, the mean of which is

$$\text{Al } K\alpha_{1,2},\ \lambda = 8{\cdot}3395 \text{ A.} \pm 0{\cdot}012 \text{ per cent};$$

the $\pm$ indicates the arithmetical mean of the residuals. As to the reliability of this value, it may be noticed that after liberal estimation of all imaginable errors, their total sum does not reach 0·03 per cent.

The crystal value of this wave-length from Siegbahn's "Spektroskopie der Röntgenstrahlen", 1931, and corrected for diffraction (8·32135) gives the relative increase

$$\frac{\lambda_{\text{abs.}} - \lambda_{\text{cryst.}}}{\lambda_{\text{cryst.}}} = 0{\cdot}218 \text{ per cent and } \frac{\lambda_{\text{abs.}}}{\lambda_{\text{cryst.}}} = 1{\cdot}00218$$

corresponding to a value of the electronic charge

$$e = 4{\cdot}805 \times 10^{-10} \text{ E.S.U.}$$

instead of that ($e = 4{\cdot}774 \times 10^{-10}$) used by fixing the crystal scale. This new value is in very good accordance with Bearden's 1931 value.

For comparison with older results I have used a similar diagram (Fig. 1) as before[5] showing the error distribution for Millikan's measurements and my own in 1928 and 1934. On account of the very small dispersion of the new values, the interval (within which n is the number of observations) has been diminished from 0·1 per cent to 0·05 per cent.

A more detailed description will soon be published elsewhere.

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Physics Laboratory,
Uppsala.
Nov. 25.

[1] Erik Bäcklin, Diss., Uppsala Univ. Årsskrift.
[2] J. A. Bearden, *Phys. Rev.*, (2) **37**, 1210; 1931.
[3] S. K. Allison, *Phys. Rev.*, (2) **44**, 163; 1933.
[4] Y. Tu, *Phys. Rev.*, (2) **40**, 662; 1932.
[5] loc. cit. and NATURE, **123**, 409; 1929.

Experimental Analysis of Population Growth

HUMAN populations have always proved favourite material for analysis by statisticians and others interested in mathematical theories of population growth. From the experimental aspect, however, humans are far from being ideal biological material, so that other animals, such as protozoa, mammals and insects, have to be used; although it does not yet appear to be fully realised how suitable the latter are for this type of work. The theory of biotic potential and environmental resistance[1] has done much to create a new interest in population studies in that it attempts to place the problem upon a quantitative experimental basis. Working with *Tribolium confusum*, Chapman demonstrated that, irrespective of the initial density, a point of equilibrium is eventually attained after which the population remains relatively constant, provided the floury medium is renewed frequently enough to remove waste products and maintain an abundance of food. He concludes that equilibrium is attained when the biotic potential is equalled by the environmental resistance, and that the lack of population increase is not due to the absence of eggs or their infertility, but on account of the eating of eggs and pupæ by the adult beetles.

Later, it was shown by one of us[2] that this explanation of the stationary character of the population is only partially correct, since, in the higher densities, there is a rapid falling off in the number of eggs oviposited and a considerable decrease in their fertility. At the same time, it was demonstrated for *Tribolium confusum* and *Calandra granaria* that there is an optimum density, above and below which reproduction takes place at a reduced rate. In attempting to explain this phenomenon, it was pointed out[2] that important factors were involved in "the frequency and chances of interruption of copulation in the various densities". These factors have now been analysed in detail. Our experiments show conclusively that there is a definite biological law relating frequency of copulation to population density in *Calandra granaria* and *C. oryzæ*, and that there is an 'optimum' density for frequency of copulation in these, and presumably other, insect species. The data are presented graphically in Fig. 1.

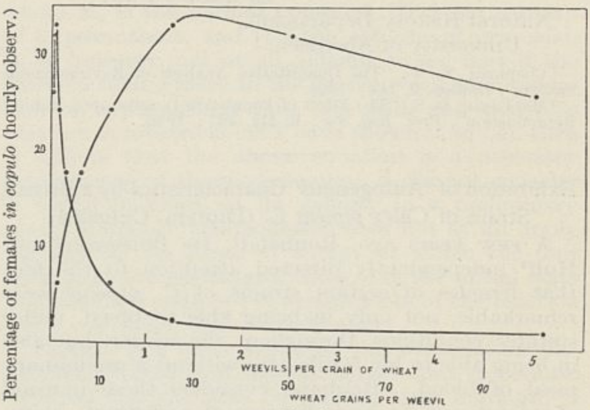

FIG. 1.

For densities higher than the 'optimum', our experimental data conform very closely to the theoretical relationship represented by the formula

$$\text{Log } Y = \log a + b \log X,$$

where Y is the frequency of copulation and X the number of wheat grains per weevil. Further, it is apparent (see accompanying table for data) that the rate of oviposition is highly correlated with the frequency of copulation, and the latter is, therefore, a dominant factor in the rate of population growth when other factors are at or near their optimum for the species. The 'optimum' densities for the above processes are not absolute and can be shifted in either direction by altering the physical or biotic factors of the environment, such as the temperature or the sex-ratio.

No. of Weevils	4	8	16	32	64	128	128	128
No. of Wheat Grains	800	400	400	400	400	200	100	25
Weevils per grain	0·005	0·02	0·04	0·08	0·16	0·64	1·28	5·12
Grains per Weevil	200	50	25	12·5	6·25	1·56	0·78	0·19
Copulation Frequency*	22·85	31·97	33·06	24·23	17·68	5·89	2·56	1·60
Eggs per Female per day	6·75	3·52	—	3·02	—	1·60	—	0·59
Species	*Calandra oryzæ*, L. Temp. 25° C. Rel. humid. 90 per cent. Sex-ratio 50 : 50.							

* Average percentage of females *in copulo* per hour.

Our studies are being continued and will appear in detail later, but so far as they have gone, some important points emerge. (1) In determining certain biotic constants (for example, oviposition rate) it is not sufficient to define the temperature-humidity conditions of the experiment—the density and sex-ratio of the population must also be stated. (2) In the limitation of population growth, the greater the favourability of the physical factors of the environment the less significant do they become, and (assuming absence of parasites and predators) the greater the importance of the rôle of *autobiotic* factors. In Nature, these factors will be of greatest moment when the population approaches 'plague' dimensions. (3) It seems, therefore, that natural populations can exert an automatic check on their numerical increase, and that the organism itself imposes the ultimate limit to its own abundance when all other factors normally inhibiting population increase have failed.

STEWART MACLAGAN.
EDWARD DUNN.
Natural History Department,
University of Aberdeen.

[1] Chapman, R. N., "The Quantitative Analysis of Environmental Factors", *Ecology*, 9, 111; 1928.
[2] MacLagan, D. S., "The Effect of Population Density upon Rate of Reproduction", *Proc. Roy. Soc.*, B, 111, 437; 1932.

Exhibition of 'Autogenous' Characteristics by a British Strain of *Culex pipiens* L. (Diptera, Culicidæ)

A FEW years ago, Roubaud[1], De Boissezon[2] and Huff[3] independently directed attention to the fact that females of certain strains of *C. pipiens* were remarkable, not only in being able to breed, under suitable conditions, throughout the winter, but also in being able to lay fertile eggs without a preliminary meal of blood. Roubaud considers these unusual characteristics to be indicative of a distinct, 'autogenous' race of *C. pipiens*, which thrives (in his opinion) exclusively in urban areas where artificially-heated buildings are common. De Boissezon, on the other hand, denies the existence of such a race of *C. pipiens*, and asserts that the biological peculiarities in question may be caused to manifest themselves in any strain of *C. pipiens* (whether town- or country-bred) merely by giving the larvæ plenty of rich food and keeping them warm.

During the year 1932, two separate 'autogenous' strains of this species were imported into England—one, in the form of adults, from Hungary, and the other, in the form of larvæ and eggs, from Germany—and were investigated by Miss M. Vincent[4] and Dr. Malcolm MacGregor[5] respectively. From the material thus obtained, both of these experimenters succeeded in rearing a number of generations of *C. pipiens* without providing any of the females with blood-meals. The adults derived from both of the above-mentioned countries were markedly stenogamic, the German ones mating satisfactorily in cages having a volume of only one-eighth of a cubic foot, and the Hungarian ones in "small cardboard tubes".

So far as we are aware, no case of autogenous characteristics being exhibited by a British strain of *C. pipiens* has ever been recorded. The following facts may therefore be of interest.

On October 6 we found, on the surface of water in an outdoor tank (in which, it may be noted, a species of *Chara* is growing), a small raft comprising 105 eggs of *C. pipiens*. We transferred this raft into a laboratory tank containing ditch-water, into which crumbs of wholemeal bread were thereafter introduced from time to time. The eggs composing this raft hatched on October 8, and by October 24 most of the larvæ had reached the fourth instar. Owing to the mildness of the weather throughout October, the central heating of the building was not put into action until October 31: the temperature of the laboratory during the previous four weeks having varied between 10° and 18° C.

On November 1, with the view of obtaining some freshly-hatched adults for mounting, we transferred the larvæ and some water from the laboratory tank into a small breeding-jar, which has since then been kept in close proximity to a hot-water radiator. Pupæ first appeared in the jar on November 8, and adults commenced to do so on November 12. Adults were removed from the jar when required for mounting, but in no case was a blood-meal given.

On the evening of November 23 we were surprised to see a small egg-raft on the surface of the water in the jar, and we found a second one on the following morning. The first raft (which consisted of 38 eggs) hatched in the evening of November 26, and the second one (of 40 eggs) hatched during that night.

The portion of the breeding-jar above the water-level (that is, the space in which the adults are confined) has a volume of 600 c.c.—about one-sixth that of the cages employed by MacGregor.

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J. STALEY.
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Hayling Island, Hants.
Nov. 29.

[1] *C.R. Acad. Sci. Fr.*, 188 (10), 735–738; 1929. Also, *Bull. Soc. Path. exot.*, 23 (2), 196–201; 1930.
[2] *Bull. Soc. Path. exot.*, 22 (7), 549–553; 1929. Also *Ann. Parasit. hum. comp.*, 12 (3), 182–192; 1934.
[3] *Biol. Bull.*, 56 (5), 347–350; Woods Hole, Massachusetts, 1929.
[4] *Arb. ung. biol. Forsch. Inst.*, 6, 119–122; Tihany, 1933.
[5] *Trans. Roy. Soc. Trop. Med. and Hyg.*, 26 (3), 307–314; 1932.

Do Whales Descend to Great Depths?

As I have stated elsewhere[1], a difference of opinion exists as to the depth to which whales descend. Diver's paralysis or caisson disease is the usual consequence of descending below about 130 ft. Do whales descend below this depth? For obvious reasons, the answer to this question is of considerable interest from a physiological point of view.

Quite a number of awkward facts might be presented to those who, on theoretical grounds, deny that whales descend below very moderate depths. Perhaps the following will suffice:

1. The whaling ships that used to sail from Dundee and Peterhead each carried a number of five-oared boats and several miles of 2½-in. or 2¾-in. whale-line; and when the ships reached the ice, 600 fathoms of whale-line were coiled into each of the boats. It was, however, only in the deeper parts of the Greenland Sea and Davis Strait that it was necessary to coil so much line into the boats: as may be gathered from what Scoresby says, in shallow situations near Spitsbergen and the west coast of Greenland where the whales were caught at an earlier date, a shorter length of line sufficed.

2. When a harpooned Greenland whale 'sounded', or went vertically down, it took out the whale-line very quickly; the wooden bollard in the boat's bow sometimes smoked and threatened to catch fire. At the same time, the boat's bow was pulled down, and if, as sometimes happened, the line became entangled, the boat was liable to be pulled right down. After an interval the whale reappeared near where it went down and was killed.

3. When harpooned whales 'sound' they take out a limited amount of line only.

(*a*) Large Greenland whales took out from 700 to 800 fathoms; half-grown animals from 400 to 600 fathoms, and calves apparently very much less.

(*b*) A full-grown male Bottlenose took out 700 fathoms; females and young males from 300 to 400 fathoms.

(*c*) Large narwhals took out about 200 fathoms.

Except in the vicinity of certain kinds of ice, Greenland whales when harpooned nearly always sounded or dived towards the bottom. What kind of refuge they expected to find at the bottom is not very apparent. Sometimes they died at the bottom and had to be hauled up, occasionally, according to Scoresby, with broken jaw-bones. A log-book, dated 1871, now in the Hull Museum, contains the following entry: "June 25th (Lancaster Sound): Killed a whale which died at the bottom in 600 fathoms of water". ROBERT W. GRAY.

8, Hartley Road,
Exmouth.
Nov. 17.

[1] "The Diving Powers of Whales", *Naturalist*, December 1932. "Arctic Regions", vol. 11, p. 173 and p. 389.

Vision in the Ultra-Violet

WITH regard to the discussion which has been taking place in NATURE recently[1], the following observations may be of interest. In 1929, whilst working at the National Institute for Medical Research, Hampstead, with T. C. Angus, in the course of which we used, incidentally, a double monochromator, and whilst we were fitting this up, we decided to try on ourselves how far we could see into the ultra-violet. We decided that one of us could see the λ3130, and the other could not see shorter than λ3650 in the mercury spectrum. Another young physicist could see λ3130 quite easily. An elderly man could only see λ3650.

I have just repeated these observations. I can see λ3130 quite easily, as can an assistant of mine and a youth who works in the clinic. Only a single monochromator was used for this purpose; this is a Hilger monochromator for the ultra-violet, and as Fabry[2] says, there is always a certain amount of background but this remains constant as the wave-length drum is rotated slightly. This later procedure brings the line on to and removes it from the collimator slit. Thus the line can be picked out against the background. The λ3130 line appears as a dark violet colour much the same as λ3650. Since people varying from fifteen to thirty years of age are able to get the sensation of sight with λ3130, it does not seem to be the prerogative of extreme youth.

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Nov. 26.

[1] NATURE, **134**, 416, Sept. 15, 1934.
[2] NATURE, **134**, 736, Nov. 10, 1934.

Oxidation-Reduction Potentials of Hypoxanthine ⇄ Xanthine and Xanthine ⇄ Uric Acid

IN a recent paper, D. E. Green[1] published values of the potentials of the systems hypoxanthine ⇄ uric acid, xanthine ⇄ uric acid, which I had already determined[2].

Green claims to be the first to have demonstrated the reversibility of the system hypoxanthine ⇄ uric acid. He states this, because my data are based on measurements made on equimolecular mixtures of hypoxanthine and uric acid, and consequently the constancy of the normal potential when the proportions of the constituents of the system are varied is not evident. Green asserts this, in spite of the fact that I have shown that the same state of equilibrium (the same potential) is found, whether hypoxanthine is oxidised, or uric acid is reduced. It seems to me then that the curve presented in my work leaves no doubt as to the reversibility of the system.

Green also states that I did not justify the assignment of the value of the number of equivalents in the formula:

$$E_h = E_0 - \frac{RT}{4F} \ln \frac{[Hx]}{[U]}$$

where E_0 is the normal potential, $[Hx]$ the activity of hypoxanthine, and $[U]$ the activity of uric acid. It is, however, not at all difficult to see that if the reaction taking place in the galvanic cell is an oxidation of hypoxanthine into uric acid, and that this reaction is reversible (as I have shown it to be), then it follows that the above equation is a necessary consequence of thermodynamics. I did not consider it useful to insist on its validity in a preliminary note. Moreover, this equation does not at all imply equality of the levels of energy at which the four hydrogens are exchanged, since only the initial state and the final state of the constituents of the reaction are to be taken into consideration.

Finally, if I have neglected the dismutation discovered by Bach and Michlin, I have done so because Wieland was not able to confirm their findings. I quite agree with Green that the short duration of Wieland's experiments may explain why the dismutation of xanthine to hypoxanthine and uric acid was not observed. But I should like to point out that if such a dismutation does exist (in any proportion whatsoever), it would not at all affect my results since the ratio $[Hx]/[U]$ remains equal to 1 when two molecules of xanthine are formed at the expense of one molecule of hypoxanthine and one molecule of uric acid.

Thus, no objection could be made as to the value, which I found for the normal potential of the system hypoxanthine ⇄ uric acid. It is:

$$E'_0 = -0{\cdot}410 \text{ volt at } 38^\circ \text{ C. and at } p\text{H} = 7{\cdot}31$$

(value calculated from my data), or

$$E'_0 = -0{\cdot}399 \text{ volt at } 30^\circ \text{ C. and at } p\text{H} = 7{\cdot}31$$

(value calculated from the temperature coefficient that I have later established).

This value is identical with the theoretical one given by Green, namely, − 0·400.

As for the system xanthine ⇄ uric acid, the dismutation does bring about a correction for the value of E'_0 but it is inferior to the experimental errors if Bach and Michlin's figures are used. If, however, we apply the method of calculation that Michaelis has shown in his well-known work on two-step oxidations, and making use of Green's figures, we arrive at a new value for the dismutation constant. This value should be taken into consideration, although the resulting variation, when applied to equimolecular mixtures, is rather small.

Applying this correction, the value of the normal potential of the system xanthine ⇄ uric acid will then differ from the one that I have indicated by − 0·0048 volt at pH = 7·65.

D. E. Green's confirmation of the existence of a dismutation process is therefore of interest. It entails a correction of the same order as the one brought about by the ionic concentration effect, which I have studied in detail in a memoir actually in press.

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Paris.

[1] *Biochem. J.*, **28**, No. 4, 1550; 1934.
[2] *Compt. rend. Acad. Sci.*, **197**, 1212; 1933. **198**, 930; 1934.

Flavin Transformation by Bacteria

FROM a lactoflavin solution which had become blue-fluorescent, a bacterial species has been isolated capable of changing the usual green fluorescence of the flavin solution, and of developing a blue fluorescence. When a very small amount of these bacteria, taken from agar, is put into each of two tubes, one containing aqueous flavin solution, the other only water, the following observations can be made :

1. The green fluorescence of flavin often disappears in about an hour, due to reduction, and may be recovered by shaking with air.
2. In any case the intensity of the green fluorescence becomes gradually less. At the same time a blue fluorescence develops in the solution. The final disappearance of flavin takes about 12 hours with fresh bacteria and 0·6 γ per c.c. of lactoflavin. More than 3 γ per c.c. of lactoflavin in the solution is toxic, and no change occurs.
3. The tube containing water and bacteria, but no flavin, does not develop a blue fluorescence. No visible growth occurs in either tube.
4. A tube containing the same amount of flavin under sterile conditions continues to fluoresce green indefinitely.

Brewers' yeast and *Clostridium acetobutylicum*, both of which contain flavin, do not effect a similar change in flavin solutions ; nor does *Mycoderma cerevisiae*. The bacteria concerned, after drying, give an alcoholic extract showing no green (flavin) fluorescence, but only blue.

The blue-fluorescing substance, either extracted from the bacteria or formed in a flavin solution by a small amount of bacteria, is extractable by chloroform. It may be extracted from chloroform by alkaline water. The blue fluorescence has the same intensity from *p*H 12 to *p*H 5, but disappears in more acid solutions. It is not affected by hydrosulphite, or by bromine.

The organism is a Gram-negative rod, occurring in pairs (diplo), and apparently non-spore-forming : a possible relationship to Coli bacteria is being investigated.

The nature of the blue-fluorescing substance, and of its apparent production from flavin by this and other organisms, is being studied. The wide distribution of lactoflavin in Nature, and the existence of a related, blue-fluorescing substance (lumichrome), give these observations special significance.

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Nov. 15.

Cosmic Radiation and Stellar Evolution

IN connexion with the recent hypotheses[1] that some of the components of the cosmic rays are ions, it may be noted that the emission of high speed ions from stars would reduce their mass by the same amount as if these ions had been annihilated in the manner suggested by Jeans. The emission of a proton from a star represents the same loss of stellar mass as the transformation of a proton and an electron into a quantum of ultra γ-radiation.

Thus the emission of cosmic radiation in the form of heavy ions from stars may reconcile the theory of stellar evolution suggested by Eddington's mass luminosity law and the Russell diagram (which seems to require stellar lives of the order only possible if we assume an Einstein-de Sitter universe with a time scale of 10^{12} years), and the Friedmann-Lemaître cosmology with an expanding universe, which suggests that the age of the stars is of the order 10^{10} years ; for the emission of heavy ions in such intensity as is indicated by the cosmic ray ionisation observed at high altitudes suggests that stellar mass may decrease appreciably during 10^{10} years, since in addition to the loss of mass due to the emission of heat and light radiation, there is the decrease due to the actual ejection of stellar ions probably of high mass.

The process of stellar evolution in the downward direction of the Russell diagram would thus suggest (if the short time scale of the expanding universe is adopted) that the cosmic ray ions are mainly emitted from the heavier stars ; and by main sequence stars in passing down the sequence. According to this suggestion, the low mass of the white dwarfs (which are usually assumed to represent the final stage of stellar evolution) shows, therefore, that cosmic rays are entirely emitted from the younger stars, and it is probable, therefore, that the white dwarfs emit practically no radiation in the form of cosmic rays.

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[1] Blackett, International Conference on Physics. 1934. Compton and Stephenson, *Phys. Rev.*, **45**, 441 ; 1934.

Formulæ and Equations in Nuclear Chemistry

IN the advance proofs of the International Conference on Physics, held in London and Cambridge in October 1934, and in other recent publications, the Italian authors write the mass-number and atomic number of the element on the right ; for example, He_2^4, Cl_{17}^{35} ; the English authors write them *diagonally*, for example, ${}_2He^4$, ${}_{17}Cl^{35}$, and the French authors on the left, thus, ${}^4_2He$, ${}^{35}_{17}Cl$. When dealing with molecules it is essential to leave a space on the right in which to indicate the number of atoms as in the English formulæ, H_2O, Cl_2, or the French formulæ, H^2O, Cl^2, etc. The Italian scheme blocks both positions and cannot be used by chemists ; the English scheme cannot be used by French chemists, whereas the French scheme is convenient for all nationalities and might with advantage be adopted internationally. It has the incidental advantage that, when the numbers are printed vertically above one another, and are not staggered as in the Italian scheme, it is particularly easy to see by subtraction the number of neutrons in the nucleus.

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Dec. 12.

A New Magnetic Alloy with very Large Coercitive Force

WHILE investigating the magnetic properties of metallic neodymium containing about 7 per cent of iron (the sample was kindly lent to us by Prof. Hopkins of Urbana, Ill.) we found that this material is strongly ferromagnetic. Its specific magnetisation (near saturation) in a field of 20,000 Oersted is about 13 at room temperature.

It is rather difficult to assert at present whether we are dealing with a homogeneous alloy of iron and neodymium, or whether the finely dispersed iron is imbedded among the neodymium grains. The value of the specific magnetisation seems to correspond to about 7 per cent of free iron. Yet the material investigated by us shows an extraordinarily great coercitive force, reaching 4,300 Oersted with a remanent magnetisation equal to 70 per cent of the maximal temporary value. This enormous coercitive force, so far as we know, has never been observed either in pure iron or in any of its alloys. Thus we may conclude that these remarkable magnetic properties are due to a hitherto unknown iron alloy.

We are examining the nature of this alloy and we hope to publish soon elsewhere further details concerning this problem.

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V. DROŽŽINA.
R. JANUS.

Ascorbic Acid and Thiosulphate in Urine

To investigate the metabolism of vitamin C, one can determine the content of ascorbic acid in urine by means of titration with 2 : 6 dichlorophenolindophenol in acid medium. An interfering reducing substance is present in relatively large amount in the urine of diabetics and also in that of cats, and to less extent in the urine of normal persons and dogs; this has proved to be thiosulphate.

The thiosulphate can be separated from the ascorbic acid by means of precipitation with mercuric acetate (a method used to remove cystein, ergothionein and glutathion[1,2]) and by precipitation with barium salts.

Details of the operation will appear in *Acta Brevia Neerlandica*.

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Nov. 22.

[1] Emmerie, *Biochem. J.*, **28**, 268; 1934.
[2] Emmerie and van Eekelen, *Biochem. J.*, **28**, 1153; 1934.

Points from Foregoing Letters

LORD RAYLEIGH finds that helium gas can pass not only through silica glass but also through gelatine and celluloid. He suggests that the gas passes between the individual crystals that compose these materials. Single crystals of quartz do not allow the passage of helium, but beryl, which has an exceptionally open crystal structure, does.

Alloys of thallium-lead or thallium-bismuth (Bi_5Tl_3) when rendered supra-conductive by cooling below 4° K., allow electromagnetic fields above certain critical values to penetrate them. Prof. W. J. de Haas and Mr. J. M. Casimir-Jonker give the relation between the value of the critical electromagnetic field and the temperature.

Experiments with supra-conductive materials are also reported by Mr. N. Kürti and Prof. F. Simon, who have determined the transition points for zirconium (0·70° K.), hafnium (0·3–0·4° K.) and other metals. From these experiments and others with mixtures of a metal and paramagnetic salt, the authors hope to observe the effect (entropy) due to the change of distribution of the spin of atomic nuclei at very low temperatures (0·01°–1·0° K.). The authors, using the magnetic method of producing very low temperatures, have reached a temperature of 0·04° K. with iron alum.

The recent deaths of Prof. W. M. Hicks and Sir Horace Lamb prompt Sir Joseph Larmor to contribute a few historical remarks on vortex theory, and to direct attention to one of its unsolved aspects of importance to aeronautic research, namely, whether a straight vortex cylinder fades from core outwards, and how rapidly.

From calculations based upon the wave-length of X-rays determined by the grating method, and also from crystal diffraction, Prof. Erik Bäcklin finds a value for the charge of an electron which differs appreciably from that obtained directly by means of electrified droplets.

Experiments on the relation between density and frequency of copulation in weevils lead Dr. S. MacLagan and Mr. E. Dunn to the conclusion that the organism automatically limits its own abundance, when other factors normally inhibiting population are not effective.

Certain mosquitoes (*Culex pipiens*) of British origin can lay eggs without a previous meal of blood. Mr. J. F. Marshall and Mr. J. Staley report this fact, already observed with certain races of mosquitoes on the Continent, and ascribed to their adaptation to urban areas, where artificially heated buildings are common.

The electro-chemical potential (electromotive force) obtainable from the oxidation of hypoxanthine to uric acid (final stage of nitrogen compounds eliminated from the body brought about in the presence of enzymes existing in the liver, spleen and in milk), was found by Miss Filitti to be about − 0·400 and − 0·113 volts respectively. Mr. D. E. Green went more deeply into the theory of the reaction, and carried out further experiments, criticising previous work as not proved. Miss Filitti now points out that, as regards hypoxanthine, Green's findings confirm her own, while the xanthine-uric acid potential needs only a small correction due to their 'dismutation' (reversible change in absence of oxygen).

A bacterium which is able to destroy the usual green fluorescence of flavin solutions, producing instead a blue fluorescence, is brought to notice by Dr. L. Bradley Pett, who describes some of the properties of the blue fluorescent substance.

The theory of the expanding universe gives ten thousand million years as the age of the stars, while previous calculations based upon the rate of loss of mass (in the form of energy) necessitated a period a hundred times longer. Mr. H. J. Walke suggests that the discrepancy would be eliminated if the heavier stars give off not only radiant energy but also ions (which form part of the cosmic rays).

Neodymium containing 7 per cent of iron is found by Miss V. Drožžina and Mr. R. Janus to have great power of retaining magnetisation. The reversed magnetic field necessary to reduce its magnetic induction to zero (coercive field) is stated to be greater than that for pure iron or any of its known alloys, which suggests that the material investigated contains a hitherto unknown iron alloy.

Research Items

Population of Europe. Some comparisons of density and distribution of European population in 1720, 1820 and 1930 are made by Mr. J. Haliczer in *Geography* of December 1934. The data for 1720 involve various calculations back from later years and contemporary estimates. Those for 1820 include census figures for most of the States of Western Europe but, as in 1720, no data of any value are available for the Balkan peninsula. In 1930 reliable census figures are used. So far as comparisons are valid, Mr. Haliczer computes that the population in 1820 was 1·89 times that in 1720 and in 1930 it was 4·51 times that of 1720. Two centuries ago the population everywhere was sparse except in the Rhine valley, central Germany, the English plain and the Po basin. The regulating factor of chief import was then soil fertility, but the black soil area of southern Russia was almost empty. By 1820, the ranges between maximum and minimum densities were small, but industrialised areas were beginning to show marked increases. The peopling of the black earth region was beginning. By 1930 inequalities in density were very marked owing to industrialism, and in Russia the 'centre of gravity' of population had shifted south. A further estimate shows that in 1720 the 'centre of gravity' of Europe's population was about 45 miles east of Munich, in 1820 it was 14 miles east of Passau and in 1930 it had moved to 30 miles north of Vienna. In other words, it has shown a steady tendency to move east, thus decreasing the percentage of the whole population that inhabits western Europe. The total shift in two centuries is 124 miles.

Life-History of *Euphausia krohnii*. Miss Winifred E. Frost has described the occurrence and development of *Euphausia krohnii* off the south-west coast of Ireland (*Proc. Roy. Irish Acad.*, 42, (B), No. 3, 1934). Already in a previous publication (1932) she has considered the distribution of the larvæ of *Meganyctiphanes norvegica* and *Nyctiphanes couchii*, and the present paper is on the same lines. *Euphausia krohnii* is one of the species of euphausiids most frequently taken in these waters, and the adults occur in large numbers. It is interesting that Miss Frost finds the same number of furcilia stages which occurred in Mr. F. S. Russell's material from the Mediterranean (Lebour, 1926) and only these, three in all. No intermediate forms have ever been described, and this indicates the probability of the 'jumping' of several stages, which is apparently not unusual in deep-sea species. Eight cyrtopia stages are described which gradually lead to the adult form. This species is only found in waters of high salinity and is a typical oceanic species. Its normal habitat for living and breeding is on, and westward of, the Atlantic Slope. All the present material, with one exception, came from a depth of more than 100 fathoms, although some of the Mediterranean larvæ were found in only 17 fathoms. They are always found in water of a fairly high temperature. Breeding appears to take place almost throughout the year, with varying seasonal intensity.

Effect of X-Rays on a Sex Cell of Tobacco. In an investigation of the effects of X-rays in producing mutations in *Nicotiana Tabacum* var. *purpurea*, Goodspeed and Avery (*J. Genetics*, 29, No. 3) treated the megaspore mother cells to radiation at about the time of the reduction divisions. The resulting progeny showed a large series of variations. One of these was crossed with the control and the offspring were bred through five generations. In this way were obtained from the descendants of a single X-rayed megaspore 14 derivative types, 7 of which bred true. These types differed from the control in habit, form of leaf, flower and capsule, and in colour of leaf and flower, some of the types being so marked that they would rank as varieties or even species. Two types shown to be due to different genes bore stigmatoid anthers, another had pointed capsules, while the leaves ranged from broadly ovate to elliptic and the flower colour from carmine to rose and orange-red. Cytogenetic analysis showed that at least five of the 24 haploid chromosomes had been altered. Chromosome fragmentations had occurred, leading to homozygous duplications and deficiencies, as well as translocations and gene mutations. Probably plants which are homozygous for a chromosome deficiency can survive because the tobacco is a polyploid species.

Sclerotinia Rot of Patwa in India. Patwa (*Hibiscus sabdariffa*) is a fibre crop grown fairly extensively round the Pusa district of Bihar, India. It is sown with the monsoon rain in July, and is usually harvested for fibre in late October. A few plants to provide seed, however, are left until the end of February. The appearance of a destructive disease in December and January is therefore a serious menace to the continued propagation of the crop. Dr. B. B. Mundkur has studied this disease (*Indian J. Agric. Science*, 4, Part 4, 758–778, August 1934). The fungus attacks the flowering stem, causing brown patches or cankers to appear on the surface. Black sclerotia may also appear, and frequently are found in the seed bolls. They are about the size of Patwa seeds, but are easily distinguished by their colour. The causal fungus has been identified as *Sclerotinia sclerotiorum* (Lib.), de Bary. Ascospores are produced from apothecia lying on the soil in November, and can infect unwounded, healthy plants. The optimum temperature for growth is 22° C. Hand separation of sclerotia from harvested seeds, combined with deep ploughing to bury sclerotia which may lie on the surface, are the control measures recommended.

Advance of Glaciers. In a recent paper to the Royal Geographical Society (November 19) on "Threatening Glaciers", Prof. K. Mason reviewed the evidence available regarding the movement of glacier snouts in the Karakorams during the last twenty years. He believes that substantial advance of the snout follows a period of degeneration or retreat, and that the rate of advance is controlled by topography. After the advance the snout takes some time to settle and if unenclosed is liable to spread. The variations in the dates of advance of various contiguous glaciers suggests that the advances cannot be due to climatic cycles. With some glaciers, periodic rapid advances occur. Prof. Mason thinks that these advances are due to accumulations of ice in the gathering ground either by avalanches, the advance of tributary glaciers or by normal snowfall. The accumulation is slow, and the outflow may be obstructed, but eventually the pressure becomes irresistible and the glacier advances. In discussing what could be done to mitigate disasters due to ice advances and associated floods, Prof. Mason believes the best plan is to study the intermittency of the glacier and so be able to predict its advance. If the causes are of the nature he suggests, no doubt the advances and retreats are rhythmical.

A Forgotten Indian Meteorite. In his presidential address to the Hyderabad Science Association in July last, Mohammad A. R. Khan, principal of Osmania University College, Hyderabad, directs attention to a recorded fall of a meteorite which was omitted from C. A. Silberrad's "List of Indian Meteorites" (*Min. Mag.*, 23, 290; 1932). The circumstances of the fall referred to were recorded at the time by Jahāngīr in his memoirs, of which several translations are available. The meteorite fell in one of the villages of the Jalandhar district, Punjab, in 1621 (30 Fawardin, A.H. 1030) and was brought to the Emperor Jahāngīr, who ordered a sword, a dagger and a knife to be made out of it. The sword-maker found that the meteorite broke to pieces under the hammer, whereupon he was told to mix it with some other iron. This he did, using 3 parts of meteorite to 1 of 'common iron', and made two sword blades, a knife and a dagger, and brought them to Jahāngīr, who found they cut splendidly. The fact that the swords had been made was known to James Sowerby, who, in 1820, published in the *Philosophical Magazine* an account of a sword which he had made in 1814 for Alexander, Emperor of Russia, out of a piece of the Cape of Good Hope meteoric iron. In this instance, the blade was made from the meteorite without any admixture of other metal. It has been suggested by H. Blochmann that the Jalandhar meteorite was a stony iron or siderolite, and not a true meteoric iron, since it broke to pieces under the hammer. Its weight is given as 160 tolas (about 2 kgm.). Mr. Khan has published his address in an abridged form hoping to induce some of his readers to inquire as to the present whereabouts of the swords made from this meteorite. In an appendix he has collected published accounts of a recently recorded fall of meteoric iron at Bahjoi, south of Moradabad, United Provinces, on the night of July 23, 1934. One piece, the only one so far recovered, weighs nearly 23 lb.

Infra-Red Spectrum of Iron. The production of photographic plates sensitive to infra-red light has been of great value in the study of this part of the spectra of both laboratory and other sources. It has also, however, emphasised the need for accurate wave-lengths which can be used as a comparison in this region. The iron arc is a very convenient source of comparison spectra for most types of work, but the wave-lengths in the infra-red have not been satisfactorily studied. This has now been remedied by Prof. H. Dingle (*Mon. Not. R.A.S.*, 94, 866) who has measured the wave-lengths of 68 lines between 8838 A. and 10219 A. The photographs were obtained in the first order of a 10-ft. concave grating, the overlapping second and third orders being used as comparisons for determining wave-lengths. The results are not proposed as ultimate standards, but are probably correct to within 0·01–0·02 A., and should be found of great value to those engaged in infra-red investigations.

Liquefaction of Helium. The liquefaction of helium, using the Joule-Thomson cooling effect, is ordinarily a costly process requiring large quantities of liquid hydrogen for pre-cooling. P. Kapitza (*Proc. Roy. Soc.*, Nov. 1, 1934) has succeeded in liquefying helium by adiabatic expansion, the expanding gas being made to do external work on a moving piston. The difficulty of lubricating a piston working at very low temperatures is surmounted by making the piston fit its cylinder fairly loosely. The loss of helium past the piston is reduced by making the expansion stroke very quickly, and the work is done against hydraulic pressure. The temperature is reduced in this engine to 10° *K*. and the gas is finally liquefied by expansion through a nozzle, using the Joule-Thomson effect. Liquid air only is used for pre-cooling and when the apparatus is working, 2 litres of liquid helium are produced per hour, with a consumption of 3 litres of liquid air (see also NATURE, 133, 708; 1934). This apparatus marks a very important advance in the technique of low temperatures.

Active Chlorine. Various workers have found that an abnormally active form of chlorine is produced by an electric discharge in the gas. E. J. B. Willey and S. G. Foord (*Proc. Roy. Soc.*, A, Nov. 15) have repeated and extended this work under more carefully defined conditions. No pressure charge was observed when an enclosed mass of chlorine was subjected to the silent electric discharge in an ozoniser, and no special optical absorption could be detected in the treated gas. The chemical reactivity was tested in several different ways. A marked increase in the reaction with water was observed when the chlorine was activated by a silent or spark discharge. The chlorination of benzene, both substitutional and additional, was used in much of the work as an index reaction. It was found that the activity was not produced without the presence of a small quantity of impurity, possibly a trace of water or hydrogen chloride. The experiments on this point were inconclusive, but it was thought that the reactivity is genuinely due to chlorine and not to a reactive impurity.

New Methods in Stereochemistry. The purification of crude *d*- or *l*-borneol, obtained directly from natural sources or by reducing *d*- or *l*-camphor, usually falls into two stages: (*a*) the separation of borneol from isoborneol, and (*b*) the stereochemical purification of the resulting borneol. J. Clark and J. Read (*J. Chem. Soc.*, 1773; 1934) now show that crude *d*- and *l*-borneol may be effectively purified by a species of auto-catalytic process. Thus, a specimen of commercial *d*-borneol was converted into impure *d*-bornylacetic acid; the impure *d*-bornyl *d*-bornoxyacetate obtained by esterifying this acid with some of the original *d*-borneol yielded stereochemically pure *d*-bornyl *d*-bornoxyacetate when fractionally crystallised; and upon hydrolysis this ether-ester yielded pure *d*-borneol and pure *d*-bornoxyacetic acid. In a similar way, pure *l*-borneol and pure *l*-bornoxyacetic acid were prepared from a specimen of commercial *l*-borneol. The method permits also of the preparation of stereochemically pure *l*-camphor from commercial *l*-borneol.

Physical Society's Exhibition of Scientific Instruments and Apparatus

THE Physical Society's twenty-fifth annual Exhibition of Scientific Instruments and Apparatus was held at the Imperial College of Science and Technology on January 1–3. It is interesting to recall that the first exhibition organised by the Society was held in the same College in 1905, and, except for the War period, it has been an annual event of outstanding importance in the scientific world. Perhaps it is not too much to say that it provides the regular milestones for British scientific instrument manufacturers, much in the same way that the annual motor show does for the automobile industry.

In 1920 the Optical Society joined the Physical Society of London at these exhibitions, and in 1932 these two bodies amalgamated under the title of "The Physical Society". The first exhibition was open for one evening only and there were 17 exhibitors, nearly all of whom are numbered among the 110 organisations that took part in this year's exhibition. In 1926 the Research and Experimental Section was added ; it was divided into three groups. The first, Group A, was intended to show "typical results of recent physical research of general interest and examples of new and improved laboratory methods" ; the second, Group B, was to include "little known and effective lecture experiments of interest to teachers of physics" ; while the third, Group C, was to provide an "opportunity for demonstrating repetitions of famous historical experiments in physics". This last group was discontinued in 1931.

Largely at the instigation of the exhibitors themselves in general meeting, an annual competition in craftsmanship and draughtsmanship for apprentices and learners employed by exhibiting firms is now organised in connexion with each exhibition, and money prizes to the value of over £40, as well as certificates of honourable mention, are awarded each year. The work submitted is exhibited in a special section. Mr. R. W. Paul, who has done so much to establish these competitions, writing in the February 1934 issue of the *Journal of Scientific Instruments*, says : "At present the principals of some of our leading concerns appear to take no active steps to encourage their apprentices to compete in the Craftsmanship Competition, so that the interest taken in the workshops varies greatly. Obviously the provision of facilities for executing the simple job which suffices to show an apprentice's skill involves some altruism on the part of a firm for the benefit of the industry, but regard should be had to the beneficial effect on the workers of the spirit of emulation aroused and the good effect on the morale of the shops. The stimulus given by the competition to candidates is known in many cases to have had a beneficial effect on their careers. Further, it is believed the competition does something to raise the international status of our instrument trade."

The problem of providing the ever-increasing accommodation and supplies of electrical power necessary is one which, for the past few years, has taxed the ingenuity of those responsible. But with the valuable help of the College authorities and the co-operation of the exhibitors, it has been possible to arrange matters satisfactorily, although perhaps not ideally. It must be remembered, however, that the Society receives the great privilege of free accommodation in the College, often at considerable inconvenience to the academic and research staffs. No charge is made to exhibitors for their stands, who only participate at the invitation of the Society, and it is this feature among others which makes these exhibitions so different from the ordinary trade exhibitions. Another noteworthy feature is that, in a very large number of instances, the directors and leading technical experts of the firms exhibiting are in attendance on the stands, so that competent replies are received to those highly technical questions which those genuinely interested must of necessity ask.

The catalogue is now issued about a fortnight before the exhibition opens, and it is valuable as a handbook to be kept on the desk until the next issue appears. Most exhibitors give a brief description of the principles underlying the action of the instruments and it is this that renders the catalogue so helpful. A limited number of copies is still available and may be obtained from the office of the Society at the Institute of Physics, 1 Lowther Gardens, South Kensington, S.W.7. (1*s.* post free).

The Committee of the Society responsible for the organisation of these exhibitions strongly endorses the view of the Institute of Physics that it is desirable that firms and research organisations taking part in exhibitions organised by scientific societies should include the names of individuals associated with each of the exhibits. The entries in the catalogue for the past few years have displayed a desirable improvement in this respect, and credit is usually given to the designer and others responsible for the development of the various individual exhibits.

Among the devices in the trade section this year were many examples of recent developments and improvements in electrical indicating instruments, galvanometers, radio instruments, relays, pyrometers, thermostats, humidity measuring apparatus, meteorological instruments, microscopes, projection and cinema apparatus, in addition to recorders, controllers and meters for numerous purposes. Representative collections of new technical books and journals were also shown. The recent rapid development of acoustics was represented by several exhibits, and the number of new illumination meters and applications of rectifiers which were shown was worthy of note. In the limited space available here it is impossible to mention individual exhibits shown in the trade section, so many of which appeared to be of special interest and importance. Descriptions of the exhibits may be found in the various trade journals, in the catalogue of the exhibition, and in the February issue of the *Journal of Scientific Instruments*, which is devoted each year to accounts of the most important new devices shown in the various sections ; summaries of the discourses will also be included in that issue of the *Journal*. We must be content here with brief reference to a few typical exhibits, which are mentioned for no other reason than to indicate the wide variety of instruments and apparatus shown. These are : an apparatus intended for the detection of cracks in iron or steel by local magnetisation ; a device for determining the ripeness of fresh tomato juice ; an electrical instrument for determining whether hunting by scent on any particular day is likely to be satisfactory ; a special red light without heat for stimulating plant growth; and, of course, numerous examples of more ordinary instruments in new and improved designs.

The Research and Experimental Section provides always a fascinating display of the research physicists' work before it reaches the commercial production stage. Thirty-one of the research laboratories attached to Government departments, research associations, universities and manufacturing firms exhibited. Many of the devices shown had been developed for testing the properties and behaviour of a wide variety of materials under the differing conditions met with in practice, whilst several others were concerned with applications of cathode ray tubes and electron cameras to all manner of problems. One exhibit was staged to demonstrate the possibilities of ordering a number of different materials to match a given colour by quoting a standard name, number or code word, and another was designed for the routine measurement of the colour values of fabric and similar surfaces viewed by diffusely reflected light. Developments in the method of controlling the speed of small electric and mechanical motions by means of light tuning forks formed the subject of another exhibit. Others were, a galvanometer which is said to be immune from mechanical disturbance of the zero, despite violent pitching and rolling of the type met with in marine work, and a high speed motion picture timing system and camera which is said to take as many as 2,500 pictures a second.

Radio and telephony formed the subject of several important exhibits in the Research Section, and among these mention may be made of a standard receiver for the measurement of radio interference, a map of England and southern Scotland showing the electrical resistivity of the earth, and an 'artificial mouth' for testing telephones.

The growing use of discharge tubes for illumination purposes has led to the development of various devices for studying their behaviour, and some of these were exhibited. Another illumination device shown was a gas burner for producing an intermittent flame or light.

On each evening of the exhibition a discourse was delivered. The first was entitled "The Architecture of Molecules" in which Dr. B. Wheeler Robinson gave an account of recent X-ray investigations of molecular structure made at the Davy-Faraday Laboratory and elsewhere; the second was delivered by Dr. C. V. Drysdale on "The Problem of Ether Drift", a subject which readers of NATURE will know he has recently taken up with characteristic zeal; and on the third day, when the public is admitted to the Exhibition, the Astronomer Royal spoke on "Giant Telescopes".

The attendance at this year's Exhibition is not yet known, but in the past two years it has wanted but a few hundreds to be ten thousand. The Society is justly proud of the record of service it has rendered for so long to all those concerned with instruments, to the instrument industry in Great Britain, and to the public.

HERBERT R. LANG.

Biochemistry of Marine Phytoplankton

A SERIES of papers on "Observations on the Fatty Constituents of Marine Plankton" (*J. Exp. Biol.*, 11, 173–197, 198–202, 203–209; 1934) sheds considerable light on the content of fat and vitamins A and D in plankton, on which all marine animal life is dependent directly or indirectly for existence.

In Part 1, on the "Biology of the Plankton" by E. R. Gunther, in order to convey a more precise idea of the relative importance of each species, an attempt is made to translate by means of suitable measurements the figures representing the numbers of a species present in a given quantity of plankton into figures representing the volume occupied by that species. The oil content of May phytoplankton from near the Isle of Man was about 6·9 per cent on the dry weight, and it is suggested that the oil content may vary with the species and fluctuate during the life-history. The oil content of July zooplankton varied between 15 and 19·3 per cent. In plankton giving a high oil yield, *Calanus finmarchicus* was very prominent.

In Part 2, on the "General Character of the Plankton Oils", G. Collin, J. C. Drummond, T. P. Hilditch and E. R. Gunther show that the fatty acid fraction of the zooplankton oils resembled that from fish liver oils. In the non-saponifiable fraction they demonstrated the presence of cholesterol, cetyl and eicoseneyl alcohols, a hydrocarbon suggestive of squalene and possibly batyl alcohol.

In Part 3, on "The Vitamin A and D Content of Oils derived from Plankton", J. C. Drummond and E. R. Gunther describe the results of an examination of the oils by feeding tests, with antimony trichloride and spectroscopically. They show that the phytoplankton oil is more potent than the zooplankton oil in its growth-promoting action, and this is correlated with a greater richness in lipochrome pigments related to carotene. Vitamin A as such is apparently absent from both phytoplankton and zooplankton. In testing for vitamin D, the degree of healing was determined both by histological (line test) and by X-ray examinations. In daily doses of 50 mgm., phytoplankton oil showed no antirachitic activity but zooplankton showed slight activity. It is suggested that the small amount of vitamin D present in the animals results from their irradiation while in surface waters rather than from a prolonged diet of phytoplankton.

Building in Earthquake Countries

WE have received from Dr. C. E. Adams, Dominion astronomer and seismologist in New Zealand, several papers by Mr. R. W. de Montalk. In these, the author, who is an architect, describes a foundation, called the 'Salvus' foundation, that he has devised in order to lessen the effects of destructive earthquakes. It consists of a platform fixed to the ground. This is made of reinforced concrete, the under side of which may be strengthened, if necessary. Round the edge of the platform rises a rim of the same material, which contains a layer of clean fine shingle, 4–11 in. in depth according to the weight of the building. On this rests a slab, also of reinforced concrete, the foundation proper of the building, a space of about 4 in. being left between the walls and the inner edge of the rim.

When an earthquake occurs, the platform and shingle move with the earth under the building, which, not being fixed to the ground, tends to remain still. It is claimed that the 'Salvus' foundation not only saves the building from damage or destruction, but also lessens the risk of fire during an earthquake and also the effects of wind pressure on the building, while the shingle itself provides an excellent damp-course. The additional cost ranges from 1¼ per cent for large city buildings to 6 per cent for dwelling houses.

It may be recalled that, fifty years ago, Prof. Milne experimented with a similar foundation in Japan, and that, still earlier, lamp tables resting on spheres had been used in Japanese lighthouses by Messrs. Stevenson, the well-known lighthouse engineers[1]. Milne's building, 20 ft. × 14 ft., was made of wood and rested on four iron balls, 10 in. in diameter. These lay on saucer-shaped iron plates fixed on the heads of piles, and similar plates attached below the building rested on the balls. From the records of seismographs placed inside, it was seen that, with an earthquake, there was a slow motion of the building to and fro, but that all the sudden motion or shock was destroyed. Afterwards, in order to increase the rolling friction, Milne lessened the size of the balls until each pier of the building rested on a handful of ¼-in. cast-iron shot. The house then stood firmly during storms of wind and, with the earthquake of February 12, 1884, it remained practically unmoved[2]. C. D.

[1] NATURE, 32, 213, July 2; 222, July 9; 316, Aug. 6; 573, Oct. 15; 625, Oct. 29; 1885. 33, 7, Nov. 5; 435, March 11; 534, April 8; 1886.

[2] "Brit. Ass. Rep.", 248-249, 1884; *Inst. Civil Eng., Min. of Proc.*, 83, 15; 1885.

University and Educational Intelligence

CAMBRIDGE.—The Clerk Maxwell scholarship for original research in experimental physics and especially in electricity, magnetism and heat has been awarded to H. Carmichael, research student of St. John's College. The value of the scholarship is £210 a year for three years.

THE Royal Technical College, Glasgow, after four years of decreasing student enrolments, is able to report for the past year an increase, from 878 to 910, in the number of its day students, and although there was a small further decrease in the number of evening students (to 2,485) the aggregate number of hours of attendance shows an increase, and it is hoped that the downward trend since 1929 has at last been arrested. There was a marked increase in the volume of advanced work. Some indication of the exceptional range and standard of the evening classes is given by the fact that 95 graduates of the Universities of Glasgow, Edinburgh, Aberdeen, St. Andrews, Cambridge, London, Leeds, Sheffield, Belfast, Allahabad, Calcutta, Dacca, Madras, Rangoon and Kyoto were enrolled. The *Research Journal* inaugurated by the College ten years ago has published, in all, 167 original contributions by the staff and senior students, chiefly in the fields of chemistry (48), mechanical engineering (41), natural philosophy (25), metallurgy (16), bacteriology (14) and electrical engineering (11).

Science News a Century Ago

Airy receives the Lalande Medal

The Lalande Medal of the Paris Academy of Sciences, founded in 1802 by the famous French astronomer Jerôme de Lalande (1732–1807), was for some time the blue-riband of the astronomical world. In his "Autobiography", Airy recorded that in November 1834 "the Lalande Medal was awarded to me by the French Institut, and Mr. Pentland conveyed it to me in December". The following year he recorded, "On Jan. 9th 1835 I was elected correspondent of the French Academy; and on Jan. 26th Mr. Pentland sent me £12 6s., the balance of the proceeds of the Lalande Medal Fund".

The Gallery of Practical Science

An advertisement in the *Times* of January 9, 1835, ran as follows: "Gallery of Practical Science, Adelaide-street and Lowther-arcade, Strand.—The Grand Exhibition is re-opened to the public daily, at 10 o'clock—Steam-engine and carriages travelling on a Rail-road—Clifton Suspension Bridge—Magnets of extraordinary power, producing brilliant light and electric phenomena—Steam Gun discharging 20 balls in a second—Beautiful Illustrations in Optics—Steam Boat Models moving in water—Painting—Statuary—Music and many entertaining Novelties, including a splendid Microscope. Admission to the whole 1s."

Sir Felix Booth made a Baronet

On January 10, 1835, the *Mechanics' Magazine* said: "His Majesty has recently conferred a baronetcy on 'Felix Booth Esq, of Roydon Hall, in the county of Essex', avowedly for his public spirited conduct in fitting out at his own expense the expedition to the Polar regions under the command of Captain Ross. Sir Felix Booth served the office of sheriff of London a few years ago, but on that occasion escaped the honour of knighthood, so often inflicted on the holders of that dignity, on some such important occasion as the bringing up of a loyal address. It is believed that the present is the first instance of a civic baronetcy having been bestowed for services in the cause of science. Captain Ross has also been knighted and received permission to wear the insignia of his numerous foreign orders in England." Sir Felix Booth was born in 1775 and died in 1850. Boothia Felix was named after him by Capt. Ross.

American Ice sent to India

In 1834, the American sailing ship *Tuscany* carried a cargo of ice from North America to India, and on January 10, 1835, the *Mechanics' Magazine* recorded that the master of the vessel had been presented with a handsome silver vase bearing the inscription: "Presented by Lord William Bentinck, governor-general and commander-in-chief of India, to Mr. Rogers, of Boston, in acknowledgement of the spirit and enterprise which projected and successfully executed the first attempt to import a cargo of American ice into Calcutta." About 100 tons of ice was conveyed in the *Tuscany*. The selling price was 6½ cents per lb. and it was calculated that "the owners received 12,500 dollars upon an investment which including the cost of all the extra precautions for preserving the ice, did not exceed 500 dollars".

Societies and Academies

PARIS

Academy of Sciences, December 3 (*C.R.*, 199, 1261–1344). L. LECORNU : The abacus of Rateau. The graphical method proposed by Rateau in 1897 for steam consumption in a steam engine is known by experience to give results not more than two or three parts in a thousand in error. The author shows that the equations on which this graph is founded are mathematically incompatible and discusses the reasons why, in spite of this fact, the results are so nearly correct. JULIEN COSTANTIN and EMILE MIÈGE : The preservation in a cellar of potato tubers in the Moroccan Atlas and its effects. GABRIEL BERTRAND and VIRGIL GHITESCU : The elementary composition of some cultivated plants. Analyses of five cultivated plants are given, special attention being given to the correct determination of the oxygen. Possible errors in the results of other workers in the same field are discussed. ARMAND DE GRAMONT and DANIEL BÉRETZKI : The velocity of propagation of sound in quartz. The velocity of propagation of an ultra-sound wave along an electric axis is a function of the orientation of the bar. The extreme values differ by 22 per cent. ANDRÉ MARCHAUD : Continuous fields of convex semi-cones and their integrals. E. G. BARRILLON : Radii of curvature of higher order attached to an analytical function. JEAN LERAY : The problems of conformal representation of Helmholtz : the theory of wakes and prows (of ships).—HENRI CARTAN : The problems of Poincaré and of Cousin for functions of several complex variables. G. DEDEBANT, PH. SCHERESCHEWSKY and PH. WEHRLÉ : A class of natural movements of viscous fluids, characterised by a minimum of power dissipated. The case of the sun. J. CHALOM : The reaction pump. JEAN VILLEY : The isotropy of the pressure in fluids submitted to very high accelerations. RAYMOND TREMBLOT : The applications of the heliometer to astronomical photometry. The instrument described gives an accuracy of the order of one per cent, and requires less time than the usual method. JACQUES SOLOMON : The experimental determination of electronic densities. MAX BORN and LÉOPOLD INFELD : The principles of the new quantic electrodynamics. SCHMITT : The determinations of the vapour pressures of hydrocarbons. The author uses a static method with special precautions for eliminating gases from the liquid and from the glass surfaces. Results are given for benzene, *n*-hexane, methylcyclopentane and toluene. THÉODORE IONESCU and CONSTANTIN MIHUL : The structure of the ionised layer of the atmosphere (ionosphere). The analysis of the results of experiments on ionised gases indicates that there is no thermal equilibrium between the electrons and the molecules, and hence the velocities are not distributed according to Maxwell's law. These results have been applied to calculate the reflection of the electromagnetic waves in the upper regions of the atmosphere. It is concluded that the discontinuities observed experimentally are only apparent and that the true reflection levels vary continuously. RENÉ DUBRISAY : The applications of a method of capillary analysis. MLADEN PAIĆ and MLLE. VALÉRIA DEUTSCH: The refractometric determination of the seric proteins. W. SWIETOSLAWSKI and J. SALCEWICZ : A new determination of the esterification constant in the gaseous phase co-existing with the liquid phase. The apparatus described, designed to eliminate the error produced by the change caused in the composition of the liquid phase by distillation, determines the constant with a possible error of 3 per cent. PIERRE DUBOIS : The oxidation of manganous sulphate by hydrogen peroxide in an alkaline medium. M. and MME. EDOUARD CALVET : The variations of the velocity constant of saponification by soda of amides in saturated solution. RENÉ JACQUEMAIN : Some bitertiary diols derived from diacetone alcohol (2-methyl-2-pentanol-4-dione). HENRI WUYTS : A functional exchange between magnesium compounds and α-bromocampher. GABRIEL LUCAS : The age of the strata of Sidi el Abed (Department of Oran). ROBERT LAFFITTE : The facies of the Aptian, the Albian and the Turonian in Aurès (Algeria). JEAN CUVILLIER : The *Kurkurstufe* in the Lybian desert and their position. RAYMOND CHARONNAT and MLLE. SIMONE ROCHE : Fluorine in French mineral waters. A modification of J. H. de Boer's colorimetric method has been used. The examination of 150 mineral waters leads to some modification of the conclusions of Gautier and Clausmann. JACQUES DUCLAUX : The transparency of the air to Wood's light. A simultaneous measurement of the transparency and proportion of ozone in the atmosphere would give information of interest concerning the general movements of the atmosphere. E. ROTHÉ and F. STOECKEL: The radioactivity of the geological strata of the Rhine valley. EUGÈNE CHABANIER : The *p*H limit of growth of plants in the steppe regions. ROBERT BONNET and RAYMOND JACQUOT : The influence of antioxygens, of methylene blue and of nitrophenol on the growth, the composition and the energy yield of *Sterigmatocystis nigra*. LOUIS BERGER : Sympathicotropic cells and cells of the internal theca in the human fœtal ovary. PH. JOYET-LAVERGNE : The factors of cellular multiplication. A discussion of the possible relation of vitamin A and glutathione in cell division. MLLE. GILBERTE MOUROT : The synthesis of creatinic substances (creatinine and creatine) in the course of protein inanition.

LENINGRAD

Academy of Sciences (*C.R.*, 3, No. 7). V. GOGOLADZE : On the theory of retarding potentials. A. GOLDHAMMER : On the mechanism of viscosity in fluids. V. IOFFE : The Kerr effect in solutions. A. BANOV and N. PRILEZHAJEVA : The fluorescence of vapours of ethylamine. V. SHARONOV : A new method of measuring the haziness of the atmosphere and visibility. Principles of a new instrument are described. N. MELANCHOLIN : The pleochroism of minerals in an ultra-violet spectrum. Ninety-five different minerals have been examined and considerable pleochroism has been found only in some tourmalines. G. GAMBURCEV : The use of mechanical filters in applied seismometry. Theoretical considerations on which mechanical filters for high-frequency waves can be based. A. DINZES and A. FROST : The mechanism of the thermal decomposition of hydrocarbons. Kinetics of the decomposition of ethane and of propane are discussed. C. IOFFE and A. SHAKINA : The influence of water vapour on the velocity of the reactions in the charge of a glass furnace. The presence of water vapour, under pressure, accelerates the reactions between the components of the charge. A. GUHL and R. DOZORCEVA : A contribution to the knowledge of sex determination in Hymenoptera. Two morphologically different types of sex chromosomes have been found in *Pteromales puparum* and this supports Whiting's hypothesis of sex determination in Hymenoptera. L. DOBRUNOV: Problem of the relation of plants to the concentration of nitrogen in the nutrient solution. Not only different species but also different varieties of the same species respond in a different way to the variation in the concentration of nitrogen in solution. I. VASILJEV: On factors of yarovisation of winter varieties. The method of Lysenko is not the only and not the best one by which winter varieties of wheat can be made to mature in the same year. The possibilities for accomplishing this are much more varied. V. CERLING and A. CHEPIKOVA: On the types of the yarovisation process (2). It appears that the yarovisation stage is a gradual process of the formation of new qualities with the accumulation of quantitative changes, rather than an immediate accession of new properties. E. SOTNIKOV: Production of citric acid by the fungus *Aspergillus niger* (3). I. KOZHANCHIKOV: Water balance of the pupæ of *Agrotis* and *Ephestia* as a reaction to the humidity of the environment.

MELBOURNE

Royal Society of Victoria, October 11. G. W. LEEPER: Manganese deficiency of cereals: plot experiments and a new hypothesis. Experiments on an over-limed soil showed that $MnSO_4$ applied with the seed was beneficial, but sulphur in amounts sufficient to bring the pH below 6·7 gave the best yields of wheat grain. Healthy alkaline soils differ from deficient soils in containing large reserves of 'active MnO_2' which are soluble in a 0·2 per cent solution of quinol in normal ammonium acetate at pH 7·0. This active MnO_2 is directly available to plants, whether in the colloidal state or by reduction at the root-soil interface (see NATURE, Dec. 22, p. 972). JEAN PHILLIPSON: Some algæ of Victorian soils. Thirty-four species of algæ have been identified from the Victorian soils, including nine Myxophyceæ, eighteen Chlorophyceæ, five Heterokontæ and two Diatoms. This includes five new species and two new varieties. W. J. HARRIS and D. E. THOMAS: Victorian graptolites (n.s.) (3). A descriptive paper dealing mainly with Upper Darriwilian forms. W. J. HARRIS: The graptolite succession of Bendigo East, with suggested zoning. Attention is concentrated on the beds east of the Whitelaw fault, and it is shown that there is a succession descending towards the east from this line. The Uppermost Darriwilian zone (*D* 1) is divided into two zones, (*a*) with *Diplograptus* (? *Mesograptus*) *decoratus*, Harris and Thomas, and *Didymograptus nodosus*, Harris, as zonal fossils; and (*b*) with *Diplograptus* (*Glyptograptus*) *intersitus*, H. and T., and *Didymograptus compressus*, H. and T., the former being the higher. The zones between that marked by the incoming in force of *Diplograptus* (*D* 2) and of the Dicranograptidæ are grouped as a *Diplograptus* series, and a suggestion is made for the grouping of lower zones according to the chief features of their graptolite assemblages. LEO W. STACH: Victorian Lower Pliocene Bryozoa (1). Twenty-two species of Bryozoa are recorded from Macdonald's locality on Muddy Creek, one, *Otionella grandipora*, being new. All except *Arachnopusia terminata*, Waters, are recent forms, eight of which are initially recorded as fossils, the remainder ranging from the Lower Miocene to the present day. Six species of the Catenicellidæ are recorded, constituting the first record of this group in the Lower Pliocene.

Forthcoming Events

[*Meetings marked with an asterisk are open to the public.*]

Sunday, January 6

BRITISH MUSEUM (NATURAL HISTORY), at 3 and 4.30.—Capt. Guy Dollman: "British Mammals".*

Monday, January 7

SOCIETY OF CHEMICAL INDUSTRY (LONDON SECTION), at 8—(at the Chemical Society, Burlington House, London, W.1).—Prof. T. P. Hilditch: "The Fats: New Lines in an Old Chapter of Organic Chemistry" (Jubilee Memorial Lecture).

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A. M. Champion: "Teleki's Volcano".

Thursday, January 10

INSTITUTION OF ELECTRICAL ENGINEERS, at 6.—A. Monkhouse: "Electrical Developments in the U.S.S.R."

ROYAL EMPIRE SOCIETY (EDUCATION CIRCLE), at 8.—Discussion on "The Background of Education in Papua", to be opened by the Hon. R. L. Turner.

MATHEMATICAL ASSOCIATION, January 7–8. Annual meeting to be held at the Institute of Education, Southampton Row, W.C.1.

A. W. Siddons: "The Food of the Gods" (Presidential Address).

Official Publications Received

GREAT BRITAIN AND IRELAND

Report of the Committee appointed by the Physical Society to consider and make Recommendations on the Teaching of Geometrical Optics. Pp. v+86. (London: Physical Society.) 6*s*. net.

University of Bristol. Annual Report of Council to Court, 1933–34. Pp. 48. (Bristol.)

List of Geological Literature added to the Geological Society's Library during the Year 1933. Compiled by the Library Staff. (No. 36.) Pp. iv+303. (London: Geological Society.) 10*s*.

Tropical Diseases Bulletin. Vol. 31, Supplement: Medical and Sanitary Reports from British Colonies, Protectorates and Dependencies for the Year 1932. Summarized by Dr. H. Harold Scott. Pp. 219. (London: Bureau of Hygiene and Tropical Diseases.) 5*s*. net.

Amgueddfa Genedlaethol Cymru: National Museum of Wales. Twenty-seventh Annual Report, 1933–34, presented by the Council to the Court of Governors on the 26th October 1934. Pp. 42. (Cardiff.)

OTHER COUNTRIES

Memoirs of the Geological Survey of India. Palæontologia Indica, New Series, Vol. 21, Memoir No. 2: Cambrian and Ordovician Fossils from Kashmir. By Dr. F. R. Cowper Reed. Pp. vi+38+2 plates. (Calcutta: Geological Survey.) 2.8 rupees; 4*s*. 6*d*.

Report of the First Scientific Expedition to Manchoukuo under the Leadership of Shigeyasu Tokunaga, June–October 1933. Section 1: Natural Science Research of the First Scientific Expedition to Manchoukuo. By Shigeyasu Tokunaga. Pp. iii+76+69 plates. Section 4, Part 1: Plantæ Novæ Jeholenses, I. By Takenoshin Nakai and Masao Kitagawa. Pp. iv+71+20 plates. Section 5, Part 1: The Fresh Water Fishes of Jehol. By Tamezo Mori. Pp. ii+61+21 plates. (Tokyo: Waseda University.)

Harvard Meteorological Studies published by the Blue Hill Meteorological Observatory of Harvard University. No. 2: Subsidence within the Atmosphere. By Jerome Namias. Pp. 61+3 plates. (Cambridge, Mass.: Harvard University Press.)

School of Tropical Medicine, San Juan, Puerto Rico. Report of the Director for the Year ending June 1934. Pp. 67. (San Juan: University of Puerto Rico.)

Canada: Department of Mines: Geological Survey. Memoir 173: Slocan Mining Camp, British Columbia. By C. E. Cairnes. (No. 2358.) Pp. iv+137+13 plates. 50 cents. Memoir 174: Surface Deposits and Ground-water Supply of Winnipeg Map-area, Manitoba. By W. A. Johnston. (No. 2363.) Pp. v+110. 25 cents. (Ottawa: King's Printer.)

Dominion of Canada. Report of the Department of Mines for the Fiscal Year ending March 31, 1934. (No. 2360.) Pp. iii+44. (Ottawa: King's Printer.) 25 cents.

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