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Aborigines and Administration in the New India

WHEN the Government of India Bill was passing through Committee in the House of Commons last year, considerable uneasiness was expressed by members in reference to the future position of aboriginal and backward peoples, the hill and jungle tribes, in the new constitution. The Bill proposed to set up machinery for the protection of backward peoples by the 'exclusion' or 'partial exclusion' of selected areas from the jurisdiction of the provincial legislatures. Those people to whom the first of these two forms of protection was to apply were relegated to the authority of the Governor, the ministers having no executive powers within such tracts; while those in areas 'partially excluded', though still entitled to representation in their respective provincial assemblies, were not to be affected by legislative action, except at the discretion of the provincial Governor. The areas to which the application of 'exclusion' or 'partial exclusion' was considered to be both desirable and feasible were recited in the Sixth Schedule appended to the Bill.

In the recommendations for the protection of backward peoples embodied in the Schedule, considerations arising out of the administrative functions of the provincial Governments had evidently been of preponderating weight; and this inevitably had inclined judgment in favour of partial exclusion. Areas, and not peoples or ethnic groups, being the units of discrimination between 'protected' and 'non-protected', the method of partial exclusion was less likely to prove an obstacle to a progressive administration in the respective provinces than the complete removal of an area from the jurisdiction of the local legislature. Thus measures not directly affecting the interests or institutions of the tribes, but otherwise applicable to the province as a whole, such as road-making, public health and the like services, would not be held up or interrupted by areas to which regulation could not be applied; while it would still be possible to retain within these partially excluded areas any special provision, such as a method of taxation devised to meet the needs of a peculiar form of culture, or a specialised type of land-tenure that had already been applied to peoples within certain of the areas under consideration.

On broad lines, the policy followed by the provinces in framing the recommendations for the incidence of protection under the Sixth Schedule would seem to have been that which had been applied to 'backward tracts' to meet conditions which had arisen out of the reforms of 1919. So far were the recommendations from taking into account the changed conditions and the far wider powers conferred on provincial legislatures under the Bill, that of the nine provinces no less than four—Bombay, the Central Provinces, the North-West Frontier Province and the Punjab—suggested no provision for the protection of backward peoples by exclusion or partial exclusion. Yet the Central Provinces with more than three million aborigines and backward tribes, and Bombay with more than two million, stand second and third respectively among the provinces of India in the number of their backward peoples.

Opinion in Parliament was not satisfied with the adequacy of the proposals in the Sixth Schedule. A number of detailed amendments were submitted to the House; and finally the Secretary of State for India intimated that the Schedule would be withdrawn and the proposals contained therein submitted to the Government of

India and the Provincial Governments for reconsideration, their recommendations with amendments, if any, after reconsideration to be embodied in a new schedule to be agreed by both Houses of Parliament as an Order in Council. This has now been drafted, and will lie on the table of the House, open to amendment, for the prescribed period as from February 4 before it becomes effective as the instrument by which the provisions of the Act governing the protection of the backward peoples will become operative in due course.

The detailed reports submitted by the Provincial Governments in support of their recommendations (now embodied in a Blue Book*) show their reasons not merely for applying, but also for not applying the form of protection afforded by this part of the Act to areas in which there is any considerable backward element in the population. Hence, while very considerable additions have been made to the recommendations contained in the original schedule, especially in Bombay and the Central Provinces, and further additions to the recommendations of the Provinces have been made by the Government of India, it is still possible to conclude that in many instances 'partial exclusion' has been preferred to 'exclusion' for purely administrative reasons, while in others no protection is afforded where it might very well be required.

It will not be out of place at this point to indicate briefly the nature of the problem. The aboriginal and backward tribes are variously estimated to number at from thirteen to thirty millions, though the higher figure will usually be found to include a considerable number of the depressed classes. They are by no means homogeneous in culture. Some are hunters, others primitive agriculturists, and they include nomads, partial and seasonal nomads and sedentary. In religion they are officially classed as 'animists'; but their spiritual beliefs normally crystallise into the worship of godlings, who tend to be assimilated to the classical deities of the Hindu pantheon. Hence for countless centuries there has been a tendency for the jungle tribes to be absorbed in Hinduism, and no doubt this process will continue, at least in the partially excluded areas—a fact not without political significance. In one instance, at least, this process of assimilation is used as an argument against any form of exclusion—an arguable position provided due provision could be made against the exploitation, which seems to be an inevitable consequence in most of such forms of contact.

The great danger, in fact, to which the backward peoples are exposed is that of exploitation, especially in the agricultural settlements, where the intrusion of the money-lender leads to the expropriation of the peasants' land. Against this, even in the partially excluded areas, representation in the legislature is scarcely likely to prove an effective safeguard. Indeed more than one officer, in reporting on the status of the tribes in his district, suggests that such representation, which in many instances will be of a very limited character, is likely to increase rather than mitigate the danger. Further, it will be long before these primitive tribes, tribes such as the Bhils in Bombay and the Gonds of the Central Provinces, will have advanced sufficiently to obtain any real benefit or protection of their interests through representative institutions. Dr. J. H. Hutton of the Assam Service, to whose experience of administration is joined a wide scientific knowledge of the institutions of the primitive peoples, not only of Assam, but also of other parts of India, points out how completely inapplicable are representative institutions to the character and conditions of hill tribes. The Garos, he says, who were nominated to represent the 'backward tracts' in the existing constitution were unable to contribute anything to its working. His comments suggest that those who were responsible for the proposed application of representative institutions to these hill peoples could have had little personal knowledge of conditions among them.

It is remarkable that on more than one occasion little weight has been attached to expressions of opinion from officials who have a direct administrative or scientific knowledge of the primitive tribes, such as that possessed by Dr. Hutton, when it leans to the side of exclusion. The views of one official who argues strongly for the 'exclusion' of peoples living in the hills near Darjeeling, on account of their backward institutions, their inability to benefit from representation and the danger they run from exploitation, are put aside in the report of Bengal Province by arguments which carry no more conviction than scoring points in a debate.

An impartial view which does not look to the political predominance of one or other interest in the provincial legislatures will see in the recommendations, even as they now stand, the loss of a great opportunity to apply the results of the

* Government of India Act, 1935. Excluded and Partially Excluded Areas (Section 91): Recommendations of the Provincial Governments and the Government of India. (Cmd. 5064.) Pp. xli+248. (London: H.M. Stationery Office, 1936.) 4s. 6d. net.

scientific study of the institutions of the primitive peoples of India to their government and to their advancement in the long run. It may be that it is not possible, for example, in Bombay and the Central Provinces, to do more than suggest protective measures for something like ten per cent only of the aboriginal population. Yet would it really have thrown an intolerable burden on the Governor of either province to have charged him with the personal responsibility of deciding on the extent to which acts of the legislature were to apply to each and every one of the areas which their effective protection would have demanded? The knowledge and experience of the local officer in charge of the district would have been at his disposal.

It is in this connexion that regret may most fittingly be expressed that a suggestion, made in the House of Commons and forwarded by the Secretary of State for the consideration of the Governments, has not proved acceptable to more than one or two and has not been carried further by the Government of India. This suggestion was that the Governor, in carrying out his discretionary powers in the matter of the application of legislative action to the partially excluded areas, should have the assistance of a special officer, well acquainted with the peoples affected, to assist him in arriving at a decision. The principle of this suggestion is susceptible of wide extension. It is possible that many of the undoubted difficulties of the situation, especially where the method of exclusion would involve a number of relatively small 'islands' in the administrative tract, would vanish, if the aborigines and other primitive tribes were entrusted, under the Governor, to a scientifically trained and experienced officer in each Province, who would act as their 'protector', as has been done in other parts of the Empire where a similar problem has arisen.

Science and Economics in Human Welfare

Health and Human Progress: an Essay in Sociological Medicine. By René Sand. Translated from the Author's revised French text by Dr. C. F. Marshall. Pp. x+278. (London: Kegan Paul and Co., Ltd., 1935.) 10*s*. 6*d*. net.

THIS review of social progress in the principal countries of the world should be studied by those interested in the application of science and economics to human welfare. Dr. Sand quotes impressive statistics from authoritative sources in support of the argument that poverty is the main limiting factor for human progress. Housing, nutrition, medical care and leisure vary with income, and these are the predominant factors determining health, physique and even intelligence. "At all ages of life, at all times and in all countries, physical and intellectual development follow, on the whole, the curve of social opportunity. Descending successively from the independent class to the middle class, the skilled workers and to the labourers, we find that disease and death gather an increasing harvest of human lives."

The influence of heredity is discussed. It is pointed out that hereditary factors cannot be easily separated from environmental factors. Until the environment of the different classes is approximately similar, it would be impossible to assess the part which heredity plays in the biological differences which distinguish the social strata of society from each other. Proof of the overwhelming influence of environment is given in evidence showing that, as the standard of living of the poorest classes rises, there is a reduction of disease, an increase in the average length of life and an improvement in intelligence.

The argument leads one to the inevitable conclusion that human life can be bought. Man is the master of his destiny. "Every country fixes for itself, within certain limits, its own death rate." In the last hundred years there has been a remarkable advance, but conditions are still deplorable for large sections of the community. Even in the United States, the richest country in the world, the income of sixty per cent of the total number of families is insufficient to supply the basic necessities.

Dr. Sand takes the view that social conditions should take priority over the financial balance sheet. "Ill-nourished or neglected children, deserted women, men atrophied by unemployment and lives sacrificed" are worse for the State than a deficit in the Budget. He looks forward to the time when progress will be measured by human economics and not by the economics of money. We shall then escape from the present anomalous position in which poverty, with its accompanying debasement and loss of human life, still reigns in the midst of infinite potential wealth. J. B. O.

Experimental Science in the Fourteenth and Fifteenth Centuries

A History of Magic and Experimental Science By Prof. Lynn Thorndike. Vols. 3 and 4: Fourteenth and Fifteenth Centuries. (History of Science Society Publications, New Series, 4.) Vol. 3. Pp. xxvi + 827. Vol. 4. Pp. xviii + 767. (New York: Columbia University Press; London: Oxford University Press, 1934.) 2 vols., 50*s*. net.

THERE is a periodic urge to reinterpret in terms of philosophy the current view of the mechanism of the universe. This need declares itself to-day in regard to problems raised by recent investigations and conceptions in many departments. It leads also to a fresh examination of older interpretations of the scientific point of view.

The monumental work of Prof. Lynn Thorndike yields invaluable material to scholars who are concerned with these older interpretations. His "History of Magic and Experimental Science during the first Thirteen Centuries of our Era" was reviewed in these columns in 1923. He has now continued the story through the yet more complex and difficult literature of the fourteenth and fifteenth centuries. The mere choice and arrangement of the writers whose works are described in these volumes constitute a great achievement of scholarship. Prof. Thorndike further enhances the value of the new volumes by providing appendixes with the original texts of a number of the works he discusses, and also by a quaintly named "Index of Incipits". There is also an exceptionally complete "General Index", a matter of great importance in a work of this kind. Moreover, in addition to their encyclopædic character, these pages afford much valuable new knowledge set down casually in the course of the story. Thus we owe to Prof. Thorndike a new realisation of the contribution of Blasius of Parma (*floruit* 1377), whose method of estimating the relative weight of various substances anticipated part of the "Static Experiments" of Nicholas of Cusa in the following century.

One of the first writers brought to our attention in these volumes is Agostino Trionfo of Ancona (1243–1328) whose work is described as "a brief résumé of intelligent orthodox attitude, theological and scientific, towards various forms of superstitution and occult arts". The presentation of the variations in this attitude during the fourteenth and fifteenth centuries might almost be described as the unifying theme of Prof. Thorndike's great work.

Probably no one has so extensive a knowledge as Prof. Thorndike of the immense store of manuscript material dealing with the subjects of magic and experimental science in the great European libraries. The very richness of his scholarship makes the reviewer wish that he had dealt rather more extensively with certain departments. For example, he gives only cursory attention to the extensive plague literature that was current in these centuries in many vernacular tongues. The range of plague tractates affords interesting links between learned and popular beliefs. But it is perhaps ungrateful to demand more amid so rich a store of material. Moreover, we owe to Thorndike the discovery in Munich of the pest tractate of Augustine of Trent, written in 1340, some years before the Black Death.

A great part of Thorndike's work is connected with alchemy and with astrology. Very interesting sections deal with medieval weather records.

"Instead of daily weather maps . . . the middle ages put their faith in annual astrological predictions as to the state of the air for the ensuing year. Not being blest with barometers and thermometers, anemometers and hygrometers, they relied on observations made with astrolabe and quadrant or on various weather signs in the air and the behaviour of plants and animals."

Thus we are introduced to the work of Robert of York (*fl. c.* 1348) or Perscrutator, "a self confident scientist", as he is dubbed by Prof. Thorndike in one of the descriptive chapter subtitles that help to fix his authors in the reader's memory. Perscrutator is, however, less concerned with laborious observations than with general theories of meteorology based on doctrines concerning the elements and on astrology. This Yorkshireman is emphatic that "he would rather have another person approve or dismiss his tables than alter them", and he challenges the critic "if he does not like mine let him keep to his own". It appears, however, that neither John of Eschenden (1339) nor Giovanni Pico della Mirandola (1463–94) was prepared to follow him blindly. Astrological prediction is indeed a thread which runs through medieval writings on such diverse subjects as meteorology and medicine as well as the efficacy of poisons. But the rare pioneer *records* of weather also have their place in the story of the fourteenth century, and mention is made of the few months' record ending February 28, 1269–1270 in a British Museum Royal manuscript, and to the more extensive record of William Merle of Merton College, Oxford (died 1347).

In one of the few excursions that Thorndike allows himself into the general philosophy of medieval views on these subjects, he makes a very interesting comparison between the influence on philosophic thought of the critical dialectic of William of Occam in the first half of the fourteenth century, and the influence of the criticism of occult science by Nicholas Oresme and Henry of Hesse, a few years later than Occam. Oresme, the reader may be surprised to learn, is one of the earliest medieval writers to correlate astrology with magic for, in these centuries, astrology represented rather the positive and 'scientific' as distinguished from the 'supernatural' view of man's life-course on this planet. Oresme, like his predecessors, distinguishes reasonable and legitimate 'natural magic' from credulous and impious belief and practice of the art. One of Prof. Thorndike's most interesting chapters is devoted to Jehan Charlier de Gerson (1363–1429) whom he styles a "pre-Reformation Puritan", since his objection to magic was theological rather than intellectual, wherein he differed from Nicholas of Oresme. The theme of 'magic in dispute' is again discussed in two most interesting chapters concerned with Pico della Mirandola, Bernard Basin, Pedro Garcia, Jaques Lefevre of Etaples, Reuchlin and Trithemius.

It is impossible in a summary description to give any adequate view of the great range and interest of these two volumes. Prof. Thorndike has succeeded in presenting something of a continuous story, linking the great variety of figures with whose works he deals. The complete impartiality of the earlier work is preserved in the present volumes. The reader can be confident that no shaft in the author's vast mine of knowledge has been screened by prejudice or exhibited in distorted perspective. Every student of the Middle Ages is under a lasting debt of gratitude to Prof. Thorndike.

DOROTHEA WALEY SINGER.

Structure of the Alps

Tectonic Essays: mainly Alpine. By Prof. E. B. Bailey. Pp. xii+200. (Oxford: Clarendon Press; London: Oxford University Press, 1935.) 12*s*. 6*d*. net.

A SENTENCE from this book could appropriately be its device: "Personally I never feel safe of my foothold, when I try to follow . . . into the dim recesses of the past; but this does not lessen my admiration". Like the reviewer, one may not agree with the theoretical considerations regarding the structure of the Alpine mountain ranges, but one must appreciate the work done by the French and Swiss explorers.

The author selects several examples of decided interest, which are discussed and debated to-day, out of a vast collection of studies, facts and theories now available. He brings to throw on them the light of his sober conceptions for the benefit of his British disciples, for whom the book is written and to whom this part of geological research may be difficult to understand. The papers on western Alpine tectonics are to a great extent dictated by local enthusiasm, and involve a good deal of fancy. But both these agencies are necessary in that field of investigation, which occupies a prominent position among the branches of our science.

The author is right in expounding to his readers these facts by choosing the historical way of progress and evolution of our knowledge about the main questions of Alpine geology. He shows the rapid changes of opinions and theories, and the succession of errors, which suggest also that existing explanations may be of no long duration in the future. He prepared himself for his work by visits to the most decisive localities under the guidance of the very best experts and by the study of the extensive literature we owe to them.

The great overthrust of Glarus, the eastern-Alpine zone of the Préalpes and the Swiss Klippes, the vault of nappes of the Wildhorn mountain group, are clearly expounded from the point of view of the French and Swiss geological schools. The difficult problems of the metamorphosed Pennine zone are interpreted in the same most personal way; and always it is shown how the interpretations have changed.

The special didactic value of the book consists in the description and interpretation of the facts observed, which are illustrated by exceptionally clear maps and sketches, adapted to the understanding of students who have never seen mountains of Alpine structure. For these readers the localities become familiar, and even the geologist who has visited them obtains much information from the work.

In his admiration of the light which has been thrown upon these structural riddles, the author does not observe the contrary opinions which are

rising all around in the scene and will surely mark progress in the future. He selects only one example from the Eastern Alpes—the great problem of the "Window of the Hohe Tauern". This is seen from the point of view of the West Alpine geologists, and it is regrettable that Prof. Bailey does not take into consideration the most recent papers of a line of young geologists who have more or less got rid of the far-reaching theory of nappes. To expose the structures of the folded ranges of the Provence was relatively easy, as they appear like embryos compared with Alpine tectonics and thus offer a good training school for higher problems.

The story of a visit of the French Geological Society to the Northern Pyrenees affects us rather dramatically. A thorough change of the interpretation of these mountain ranges took place at this session. For them the theory of nappes of Alpine scale was abolished, and a 'decollement'—a shearing off—of the Mesozoic and Tertiary strata was put in its place.

The struggle of conceptions of significant geological problems has found in the author its most trustworthy historian, and surely it will inspire its disciples with profound respect for the generations of explorers whose names are intimately connected with the progress of geology. F. X. SCHAFFER.

Peter Porcupine: a Study of William Cobbett, 1762-1835

By Marjorie Bowen. Pp. xii+312. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1935.) 10*s*. 6*d*. net.

MISS MARJORIE BOWEN has chosen a most interesting historical character living through modern times (1762–1835). Her portraiture of Cobbett as a public figure follows rather closely a contemporary sketch quoted by her: "strong sense, masculine English, extravagant prejudice, political economy, currency radicalism, universal invective, all jumbled together! personally a homely, independent, vigorous farmer".

Miss Bowen's own opinion of reform is a shock to us: "that unchanging human nature creates the same conditions about it in whatever circumstances and in whatever period it is placed" (p. 234). Her historical judgments are not always impartial. She refers to "the incompetent Rockingham, the honest North, the voluble and showy Fox", and again —"however mediocre or mistaken might be his [Pitt the younger's] motives; he was a master of the unanswerable, well graced platitude".

The background of the book is the growth and unfolding of Cobbett's character, and the scene is generally rural and domestic. Much of it is straightforward narrative, but some psychological treatment is used, in regard to Cobbett's relations with Caroline of Brunswick, his influence on his children, his weakness for running away from danger and the unusual intellectual results of his upbringing and self-education.

Miss Bowen laments the decision of Cobbett to divide his strength and interests between an establishment in the country—the happy scene of his youth and the source of his inspiration, social standing and robust health—and his absorbing career as editor, journalist and political writer. She brings home to us his talent for popular journalism with which he laboured to stem the rising flood of pauperism, attacked what he felt to be abuses and made himself "a leader of the working classes and the mouthpiece of the poorest people". She shows us something of Cobbett's feeling for Nature as when he wrote thus of Long Island:

"No daisies, no primroses, no cowslips, no bluebells, no daffodils, which, as if it were not enough for them to charm the sight and smell, must have names too to delight the ear."

Dictionary of Organic Compounds

Edited by Prof. I. M. Heilbron and H. M. Bunbury. Vol. 2: Eccaine—Myrtillin Chloride. Pp. xiii+846. (London: Eyre and Spottiswoode (Publishers), Ltd., 1936.) £6 6*s*. net; 3 vols., £15 15*s*. net.

THE second volume of this important work follows the general plan already described in NATURE (November 17, 1934, p. 751). The range of the selected compounds has been extended, particularly in the direction of biochemistry, and somewhat more space has been allocated to the data and literature references: consequently, the second volume exceeds the first by some 140 pages. The literature has been surveyed up to the end of 1934, and in some instances the references extend into 1935. This volume is particularly useful, since it includes the entries under "methyl" (229 pp.) and "hydroxy" (133 pp.); these, together with "iso" (70 pp.) and "ethyl" (40 pp.), constitute, in fact, slightly more than half the volume.

Despite its wide scope, the reader will not necessarily find all his familiar friends between its covers (the reviewer misses hydroxymethylenecamphor and menthoxyacetic acid, for example), for that would be an unreasonable expectation in a work which is essentially selective. Occasionally there are noticeable omissions from the entries: for example, the latest references for 1-hydroxy-2-hydrindamine (1893) and menthol (1911) are much out of date. No work of this scope and character, however, could hope to emerge unscathed from criticism of its fine detail.

Prof. Heilbron and his collaborators are to be congratulated on having maintained in their second volume the high standard which they set up in their first. The appearance of the concluding volume will enable organic chemists and biochemists to turn to this work as R. L. Stevenson turned to his beloved maps, with the reflection: "This, of all books, is the least wearisome to read and the richest in matter". J. R.

Education in Germany

By A. W. Fletcher. Pp. vi+61. (Cambridge: W. Heffer and Sons, Ltd.; London: Simpkin Marshall, Ltd., 1934.) 2*s*. 6*d*. net.

MR. FLETCHER offers no criticisms of national socialism. His book is a brief report. The general impression we get is that German schools are more courageous than those of Great Britain in revising and pruning their curricula, and that the overcrowded, unco-ordinated curriculum is giving way to an ordered group of subjects around the theme of the "development of mankind", studied in longer and less hurried school periods.

Mr. Fletcher tells of the influence of and parallel progress with English reformers: the influence of the Abbotsholme idea—morning, intellectual work; afternoon, sport or manual work; evening, "artistic performances"—multiple-option schools ousting classical education, parents' conferences—in Germany, in the community schools (elementary)—but both secondary school systems are examination-ridden.

Looking more deeply we discover the German methods of directly aiding the right development of character. Mr. Fletcher's report is rather one-sided. Of the intellectual side he only tells us that the place of religious teaching is as yet unsettled, as indeed it is with us. He also stresses the encouragement of free discussion among pupils and teachers, and his references to the ridicule of Germany and France of the prefect system, very naturally, specially of the licence to cane other boys, reminds us that that system in England is often too laxly or too severely supervised to make it of genuine value to the boys.

Germany is ahead of us in supplying her elementary schools with teachers of university education.

The other part of character development, in common with other educational reforms, owes much to the youth movement, the training of the body "as a means of spiritual expression".

The account of the farm school near Berlin is among the more attractive items in the book.

Under national socialism we are told that the tendencies outlined in this book have been hurried forward, a serious study of biology begun and the claims of the Fatherland emphasised.

If we visited German schools we might not, like Mr. Fletcher, welcome the use of the newspaper as a school book.

An Introductory Course in College Physics

By Prof. Newton Henry Black. Pp. ix+714. (New York: The Macmillan Co., 1935.) 15*s*. net.

AMERICAN introductory courses in college physics are offered to students whose needs and earlier training differ considerably from those of most students of the same age at English universities. Prof. Black has written his book to cover a one-year course for university students who have not previously studied the subject or have, at most, done the three-term physics course customary at many American schools. He has taken care to eliminate mathematical difficulties not essential to his exposition of particular physical principles. Nothing more than the simplest mathematical knowledge is assumed or needed. The book therefore is quite unlike the text-books used for advanced classes in English secondary schools or for pass degrees at universities; here it has become customary to assume that the student has already done a science course for three years, and that he has acquired or is acquiring a knowledge of more advanced algebra and calculus.

There is considerable resemblance to the 'Everyday Physics' used in many English schools, but the subject is carried further in a form suited to rather more mature students. There are many pictures illustrating details of scientific and domestic apparatus and a considerable number of portraits of men of science with brief biographical details. The book should therefore be compared with other American surveys of physics such as those of Kimball and of Saunders. The type and the quality of the illustrations and plates call for special praise. The text is pleasant to read and gives an up-to-date review of the main principles of the subject, introducing the neutron in its brief explanations of atomic structure. The reviewer misses the admirable summaries of modern theory which distinguished Saunders's book, but the author has expressly stated that he has confined himself to what can be done in one year with beginners.

This work and the earlier one by Prof. Saunders ("A Survey of Physics", Holt and Co., 1930) are well worth places in the science libraries of English secondary schools.

Scouting and Nature:

for Scouts, Guides, Schools and Hikers. By Martin Baker. Pp. 136. (Glasgow: Brown, Son and Ferguson, Ltd., 1935.) 1*s*. 6*d*. net.

THIS is a small book, but within its well-written and well-illustrated 136 pages it contains a two-fold purpose which it should go far to achieve, namely, on one hand, that of strengthening and popularising the Scout movement by emphasising one of its most attractive activities, and, on the other hand, of inculcating a better and more intelligent appreciation of Nature. Nature study properly carried out in the true spirit of the Scouts affords wide scope for exploration and adventure, especially when undertaken with the stimulating guidance of such capable and well-informed leaders as Mr. Martin Baker.

Here we have a series of delightful rambles in the more remote haunts of Nature—on the lonely shore, the bleak uninhabited moorland and hill country, in the depths of great forests, or wild and picturesque valleys; followed by many attractive pages of archæological lore simply and eloquently presented, in which the past of this little island of ours lives again. The author, without any pretence at profound or specialised knowledge, of which we believe he has more than he cares to admit, is surely a born naturalist and keen observer, with the gift of describing what he sees. With the rapidly growing momentum of the hiking and camping movement, the need for a little book of this kind, from the point of view of bird protection and much else, is abundantly evident.

Neutron Capture and Nuclear Constitution*

By Prof. Niels Bohr, For.Mem.R.S.

AMONG the properties of atomic nuclei disclosed by the fundamental researches of Lord Rutherford and his followers on artificial nuclear transmutations, one of the most striking is the extraordinary tendency of such nuclei to react with each other as soon as direct contact is established. In fact, almost any type of nuclear reactions consistent with energy conservation seems likely to occur in close nuclear collisions. In collisions between charged particles and nuclei, contact is, of course, often prevented or made less probable by the mutual electric repulsion ; and the typical features of nuclear reactions are therefore perhaps most clearly shown by neutron impacts. Already in his original work on the properties of high-speed neutrons Chadwick recognised their great effectiveness in producing nuclear transmutations[1]. Especially after the discovery of artificial radioactivity by Mme and M. Joliot-Curie, most instructive evidence regarding nuclear reactions has been obtained through the researches of Fermi and his collaborators on radioactivity produced by bombardment with high-speed neutrons as well as with neutrons of thermal velocities[2].

A typical result of the experiments with high-speed neutrons is the great probability that a collision with a nucleus of not too large atomic number will give rise to the ejection of an α-ray or a proton, accompanied by the capture of the neutron and the formation of a nucleus of a new element which in general will possess β-ray radioactivity. The effective nuclear cross-sections for collisions with such effects are in fact of the same order of magnitude as the cross-sections responsible for simple scattering of high-speed neutrons by nuclei, which in turn agree with ordinary estimates of nuclear dimensions. Another typical experimental result is the surprisingly great tendency even for a fast neutron in collision with a heavy atom to attach itself to the nucleus with the emission of γ-radiation and the formation of a new isotope which may be stable or radioactive according to the circumstances. In fact, for processes of this kind cross-sections are found which although several times smaller are still of the same order of magnitude as nuclear dimensions.

Capture processes of high-speed neutrons of the last mentioned type are especially significant in offering a direct course of information about the mechanism of collision between the neutron and the nucleus. Indeed, the remarkable sharpness of the lines of the characteristic γ-ray spectra of radioactive elements proves that the lifetime of the excited nuclear states involved in the emission of such spectra is very much longer than the periods, *circa* 10^{-20} sec., of these lines themselves. In order that the probability of emission of a similar radiation during a collision between a high-speed neutron and a nucleus shall be large enough to account for the experimental cross-sections for these capture processes, it is therefore clear that the duration of the encounter must be extremely long compared with the time interval, *circa* 10^{-21} sec., which the neutron would use in simply passing through a space region of nuclear dimensions.

The phenomena of neutron capture thus force us to assume that a collision between a high-speed neutron and a heavy nucleus will in the first place result in the formation of a compound system of remarkable stability. The possible later breaking up of this intermediate system by the ejection of a material particle, or its passing with emission of radiation to a final stable state, must in fact be considered as separate competing processes which have no immediate connexion with the first stage of the encounter. We have here to do with an essential difference previously not clearly recognised between proper nuclear reactions and ordinary collisions among fast particles and atomic systems, which have been our main source of information about the structure of the atom. In fact, the possibility of counting by means of such collisions the individual atomic particles and of studying their properties is due above all to the openness of the systems concerned, which makes an energy exchange between the separate constituent particles during the encounter very unlikely. In view of the close packing of the particles in nuclei we must be prepared, however, for just such energy changes to play a predominant part in typical nuclear reactions.

If, for example, we consider an encounter between a high-speed neutron and a nucleus, it is obviously not permissible to compare the process to a simple deflection of the path of the neutron in the inner nuclear field, possibly combined with

* Address delivered on January 27 before the Copenhagen Academy (Kgl. Danske Vidensk. Selskab.).

a collision with a separate nuclear particle, resulting in the ejection of the latter. On the contrary, we must realise that the excess energy of the incident neutron will be rapidly divided among all the nuclear particles with the result that for some time afterwards no single particle will possess sufficient kinetic energy to leave the nucleus. The possible subsequent liberation of a proton or an α-particle or even the escape of a neutron from the intermediate compound system will therefore imply a complicated process in which the energy happens to be again concentrated on some particle at the surface of the nucleus.

At the moment it is scarcely possible to form a detailed picture of such processes. In fact, we must recognise that we have no justification even for assuming the existence within nuclei of the particles set free in nuclear disintegrations. In particular, the well-known difficulties of attributing within a space region of nuclear dimensions an individual existence to charged particles with so small a rest mass as have electrons and positrons, forces us to consider β-ray disintegration as a process by which an electron is created as an entity in a mechanical sense[3]. In this respect the situation is, of course, essentially different for the heavier particles emitted in nuclear disintegrations, like neutrons, protons and α-rays. Especially the fact that all nuclear masses in the first approximation are integral multiples of a unit nearly equal to the neutron mass, makes it very reasonable to regard particles of such masses as mechanical entities within nuclei. On account of the small difference between the masses of the neutron and the proton compared with the binding energies in nuclei measured by their so-called mass defect, it would, however, seem more hypothetical to assume the existence in nuclei of particles with the same electric and magnetic properties as those possessed by free neutrons and protons. In view of the scarcity of our knowledge of the extraordinary dense state of matter with which we have to do in nuclei, we may rather regard the integral values of unit electric charge possessed by nuclei and their disintegration products as a fundamental aspect of the atomicity of electrification, which cannot be accounted for by present theories of atomic constitution.

Quite apart from the problem of the nature of the nuclear constituents themselves, which is not of direct importance for the present discussion, it is, at any rate, clear that the nuclear models hitherto treated in detail are unsuited to account for the typical properties of nuclei for which, as we have seen, energy exchanges between the individual nuclear particles is a decisive factor. In fact, in these models it is, for the sake of simplicity, assumed that the state of motion of each particle in the nucleus can, in the first approximation, be treated as taking place in a conservative field of force, and can therefore be characterised by quantum numbers in a similar way to the motion of an electron in an ordinary atom. In the atom and in the nucleus we have indeed to do with two extreme cases of mechanical many-body problems for which a procedure of approximation resting on a combination of one-body problems, so effective in the former case, loses any validity in the latter where we, from the very beginning, have to do with essential collective aspects of the interplay between the constituent particles.

In this connexion it is of importance to remember also that the successful quantum mechanical explanation of the simple law combining the lifetime of α-ray products with the energy of the emitted particles, is essentially independent of any special assumption regarding the behaviour of the individual particles in the nucleus. In fact, on account of the extremely long lifetime of these products compared with all proper nuclear periods, the probability of such disintegration depends in the first approximation only upon the electric field outside the nucleus, which constitutes a so-called potential barrier hindering the escape of the α-rays. It is even very doubtful that α-particles exist in nuclei in the manner assumed in present theories of α-ray decay. Indeed, the frequent appearance of α-rays as a result of natural and artificial nuclear disintegrations may rather be explained by the fact that energy is set free by the very formation of α-particles, and that the liberation of such particles might thus involve a smaller degree of concentration of the excess energy than the liberation of protons or neutrons. So far, the study of the α-ray disintegrations and their intimate connexion with the γ-ray spectra, especially cleared up by Gamow, gives us, therefore, information only about the possible values of the energy and to a certain extent of the spin momenta for the stationary states of the nuclear systems concerned.

The circumstance that the nuclear states involved in the last mentioned phenomena are found to represent a discrete distribution of very sharp energy levels might perhaps at first sight seem to contrast with our assumptions of the existence of a semi-stable intermediate state of the compound system formed by neutron collisions within an apparently continuous range of the kinetic energy of the incident neutron. We must realise, however, that in the impacts of high-speed neutrons we have to do with an excitation of the compound system far greater than the excitation of ordinary γ-ray levels. While the latter at most amounts to a few million volts, the excitation in the former case will considerably exceed the energy necessary

for the complete removal of a neutron from the normal state of the nucleus. The measurements by Aston of the mass differences of isotopes show that this energy is about ten million volts.

This striking difference in the level schemes for low and high excitations of heavy nuclei is, however, just what we would expect according to the view of nuclear reactions here discussed. In contrast to the usual view, where the excitation is attributed to an elevated quantum state of an individual particle in the nucleus, we must in fact assume that the excitation will correspond to some quantised collective type of motion of all the nuclear particles. On account of the rapid increase of the possibilities of combination of the proper frequencies of such motions for increasing values of the total energy of the nucleus, we should therefore expect that the distance between neighbouring levels would become very much smaller for the high excitation concerned in neutron collisions than in the ordinary γ-ray levels where we have probably to do with states of collective motions of the most simple types. Even for excitations where the levels are very close together the probability of radiative transition will not, however, on this view be very much different from that in the lower γ-ray states and any material increase in the width of the levels will not arise, until the probability of escape of material particles becomes comparable with the radiation probability.

Now, in experiments on high-speed neutron impacts on heavy nuclei, the effective cross-section for scattering is normally several times larger than the cross-section for capture. Accordingly, we must conclude that in this case the probability of the escape of a neutron from the compound system is greater than the probability of radiative transitions and that the energy levels of the semistable state are therefore somewhat broader than ordinary γ-ray levels. This circumstance, together with the rapidly decreasing distance between neighbouring levels in the energy region concerned, makes it indeed very likely that such levels will not here be separated at all, as is required for the explanation of the apparently non-selective character of the capture phenomena. For decreasing velocities of the incident neutrons, however, escape of a neutron from the compound system will rapidly become very improbable, corresponding to the decreasing probability of the necessary concentration of the excess energy of the system on a particular neutron. The sharpness of the levels of the intermediate state must therefore be expected to approach that of the γ-ray levels, as soon as the kinetic energy of the free neutrons becomes small compared with the total excitation energy in this state.

Most interesting support for these considerations is afforded by the remarkable phenomena of selective capture of neutrons of very small velocities. Working with neutrons of temperature velocity obtained by passing neutron beams through thick sheets of substances containing hydrogen, Fermi and his collaborators found, as is well known, values for the effective cross-sections for neutron capture, which vary in a most capricious way from element to element. While for most elements these values were of the same order of magnitude or not much larger than ordinary nuclear cross-sections, values several thousand times larger were found in certain irregularly distributed elements or isotopes. These at first sight most surprising effects must obviously be attributed to the fact that for such slow neutrons the de Broglie wave-length is very large compared with nuclear dimensions and that, therefore, the simple ideas of path and collision, which can be applied at any rate approximately to high-speed neutron impacts, here fail completely.

Instructive attempts have also been made to explain the phenomenon of selective capture as a quantum mechanical resonance phenomenon, due to the close coincidence between the energy of some almost stable stationary states of the neutron within the nucleus and the sum of the energies of the initial state of the nucleus and of the free neutron[4]. These theories, in which the state of motion of the neutron within the nucleus is treated as that of a particle in a conservative field of force, have failed, however, to account for the fact that the cross-section for neutron scattering in all selective absorbing elements investigated is much smaller than the cross-section for capture. It is true that the large probability of reflection of the waves describing the behaviour of the neutron in the nucleus—arising from the fact that its wave-length here is very short compared with the wave-length for the free motion of the neutron—implies that the mean time interval which a neutron may be said to stay in a nucleus is very long compared with the time interval a high-speed neutron on such a model would take in passing through the nucleus. Still, even in the case of complete resonance, the probability of neutron escape is in this way found to be larger than the probability for emission of radiation. From the far more intimate interaction between the neutron and the nucleus, which the explanation of high-speed neutron capture demands, this remarkable absence of selective scattering of very slow neutrons is, however, just what we should expect for small excess energy, on account of the vanishing probability of neutron escape compared with that of radiative transition.

Moreover, experiments of Fermi and others[5] during the last few months have revealed an extreme sensitiveness of the phenomena of selective neutron capture for small variations in the neutron velocity which necessitates a degree of resonance quite incompatible with the above-mentioned nuclear model. In fact, by the filtration of low-speed neutron beams through thin sheets of different selective absorbing elements great modifications in the cross-sections of selective capture were obtained, showing that the resonance is restricted to narrow neutron energy regions which are differently placed for different selective absorbers. By using for comparison the capture of neutrons in light elements resulting in the ejection of α-particles, where the selectivity is much less pronounced—and where therefore from general quantum mechanical arguments the probability of capture within the energy region concerned must be expected to be inversely proportional to the neutron velocity—it has even been possible to conclude that the energy region of resonance for certain selective absorbing elements is confined within a fraction of a volt[6].

From this small breadth of the energy levels of the compound system formed by low-speed neutron capture, we arrive by a simple statistical consideration of the occurrence of selective capture among the heavier elements at an estimate of about ten volts for the distance between neighbouring energy levels for the excitation concerned in these phenomena. This is not only in full agreement with the conclusions about the close distribution of energy levels of highly excited nuclei to which we were led through the discussion of the non-selective capture of the high-speed neutrons; but the extreme sharpness of the levels with which we are concerned in the phenomena of selective neutron capture offers also most interesting support for our primary assumption of the long lifetime of the intermediate state in neutron collisions. In fact, the narrowness of the levels of the compound system proves in a striking way the extreme smallness of the probability of radiative transitions in nuclei and leads to an estimate for the duration of an encounter between a high-speed neutron and a nucleus as large as a million times the interval which the neutron would use in simply traversing the nucleus.

The lack of selectivity in high-speed neutron impacts concerns strictly speaking only the probability of neutron capture by the nucleus and the ejection of a material particle from it. The detailed course of these phenomena will, however, depend in general essentially on the level system of the nucleus finally formed. In fact after the collision process this system must be in some stationary state and if the kinetic energy of the incident neutron is not very large the states between which there can be a choice will all be in the region of ordinary discrete γ-ray levels. If then the kinetic energy of the neutrons impinging on a heavy nucleus is smaller than the lowest excited level of this nucleus, any neutron escaping from the compound system will necessarily possess the same energy as the incident neutron. In the case, however, of neutron impacts with higher energy there is obviously a certain probability that the nucleus may be left in an excited state after the escape of a neutron with a correspondingly smaller energy. Actually, the probability of the process following such a course, which implies a smaller concentration of the excess energy of the compound system on the escaping neutron, may often be considerably greater than the probability of neutron escape without excitation. There seems, too, to be experimental evidence for the occurrence of nuclear excitation in neutron collisions, namely in the observation of energy loss of high-speed neutrons traversing substances of high atomic weight[7], where a direct transfer of translational energy between the neutrons and the nuclei would be expected to be negligibly small.

As was mentioned earlier, collisions between high-speed neutrons and the nuclei of elements of small atomic number will in most cases result in the ejection of an α-ray or a proton. We may conclude here also from the great cross-sections for collision of such effects, that the encounter leads in the first place to the formation of a semi-stable compound system with a continuous range of energy levels. Even though the lifetime of this system may be very much shorter than that of the γ-ray states of heavy nuclei, we must still realise that the subsequent escape of α-rays or protons necessitates a separate concentration process for the excess energy and that in particular we cannot draw any decisive conclusion from these phenomena about the presence of such particles in nuclei under normal conditions. For example, the great probability of emission of α-rays compared with neutron escape from the compound system must, as already indicated, rather be explained by the comparatively small degree of energy concentration involved in the former process. As regards the emission of charged particles we must of course also take into account the repulsion from the rest of the nucleus and in particular the greater difficulty experienced by a charged than by an uncharged particle with the same final kinetic energy in passing the potential barrier round the nucleus.

As has often been pointed out, the last circumstance offers a simple explanation not only of the rapid fall in the output of α-particles and protons as a result of high-speed neutron impacts for

increasing nuclear charge, but also of the decrease with increasing neutron energy of the ratio between the probabilities of ejection of these two differently charged kinds of particles. The probability of the nucleus being left after the ejection of such particles in the normal or in an excited state depends in each case on the distribution of the energy levels of the final system—which are in general more separated for light than for heavy nuclei—and also on the balance between, on one hand, the greater facility of faster particles than of slower ones in penetrating the potential barrier and, on the other hand, the greater demands for energy concentration in the former than in the latter case. Similar considerations will apply for the finer details of the ordinary α-ray disintegrations like the weak groups of long range α-particles and the fine structure of the stronger α-ray lines.

In the case also of nuclear transmutation caused by the impact of charged particles as well as for the nuclear disintegration produced by γ-rays, the formation of an intermediate semi-stable compound system seems decisive for the explanation of the great variety of the phenomena. Besides typical non-selective effects like the ejection of neutrons and protons by fast α-rays, we meet, as is well known, with pronounced resonance effects for slower α-ray impacts, as well as in the capture phenomena of artificially accelerated protons in light nuclei. On account of the very much shorter lifetime of the intermediate state in such cases the degree of resonance here obtained is, however, much smaller than for selective neutron capture by heavy nuclei. In this connexion it is perhaps not out of place to note that expressions like α-ray levels or proton levels, such as are used in the ordinary discussion of these effects, based on the attribution of the excitation to a single nuclear particle, lose all meaning on the view of nuclear excitation adopted here. In fact, the essential feature of nuclear reactions, whether incited by collision or by radiation, may be said to be a free competition between all the different possible processes of liberation of material particles and of radiative transitions, which can take place from the semi-stable intermediate state of the compound system.

A detailed discussion from this point of view of the available empirical evidence regarding spontaneous and induced nuclear transmutations will be published shortly[8] in collaboration with Mr. F. Kalckar, who has given me most valuable assistance in tracing the consequences of the general argument here developed. There we shall also discuss the limitation of this argument in the case of very light nuclei like the deuteron, where the distinction between the mechanism of the storing of the energy in the nucleus and the mechanism of the liberation of particles, so pronounced for the reactions of heavy nuclei, gradually loses its significance. Here, however, I should still like briefly to indicate what modifications in the preceding considerations are to be expected even for heavy nuclei should the energy of the intermediate system too far exceed that of its normal state. Even if we could experiment with neutrons or protons of energies of more than a hundred million volts, we should still expect that the excess energy of such particles, when they penetrate into a nucleus of not too small mass, would in the first place be divided among the nuclear particles with the result that a liberation of any of these would necessitate a subsequent energy concentration. Instead of the ordinary course of nuclear reactions we may, however, in such cases expect that in general not one but several charged or uncharged particles will eventually leave the nucleus as a result of the encounter. For still more violent impacts, with particles of energies of about a thousand million volts, we must even be prepared for the collision to lead to an explosion of the whole nucleus. Not only are such energies, of course, at present far beyond the reach of experiments, but it does not need to be stressed that such effects would scarcely bring us any nearer to the solution of the much discussed problem of releasing the nuclear energy for practical purposes. Indeed, the more our knowledge of nuclear reactions advances the remoter this goal seems to become.

In concluding this address, I should just like to point out that even if the problem of nuclear constitution does lack the special simplicity in a mechanical respect characteristic of the structure of the atom which has so much facilitated the disentanglement of the relationships of the elements as regards their ordinary physical and chemical properties, it presents, nevertheless, as I have tried to show, peculiar facilities for a comprehensive interpretation of the characteristic properties of nuclei in allowing a division of nuclear reactions into well separated stages to an extent which has no simple parallel in the mechanical behaviour of atoms.

[1] J. Chadwick, *Proc. Roy. Soc.*, A, **142**, 1 (1933).

[2] E. Fermi, and others, *Proc. Roy. Soc.*, A, **146**, 483 (1934); **149**, 522 (1935).

[3] Cf. N. Bohr, Faraday Lecture, *J. Chem. Soc.*, 349 (1932), and W. Heisenberg, "Zeeman Verhandelingen", p. 108.

[4] Fermi, and others, *Proc. Roy. Soc.*, A, **149**, 522 (1935). Perrin and Elsasser, *J. Phys.*, **6**, 195 (1935). Béthe, *Phys. Rev.*, **47**, 747 (1935).

[5] Fermi and Amaldi, *La Ricercio Scientifica*, A, **6**, 544 (1935), Szilard, NATURE, **136**, 849 (1935). Frisch, Hevesy and McKay, NATURE, **137**, 149 (1936).

[6] R. Frisch and G. Placzek, NATURE, **137**, 357 (1936).

[7] W. Ehrenberg, NATURE, **136**, 870 (1935)

[8] N. Bohr and F. Kalckar, *Kgl. Dan. Vid. Selsk. Math-fys. Medd.* (in preparation).

The Modern Trend of Cancer Treatment

OF the special reports issued by the Medical Research Council, so far as we are aware, only one has assumed an annual character. We refer to the reports on the "Medical Uses of Radium", which have been issued yearly from 1922. Taken together, they form a valuable, interesting and concise summary of the progress of radium therapy in Great Britain, and show the important part which has been taken by the Council in its development. Although primarily intended for workers in a particular branch of therapy, they may, nevertheless, be consulted with profit and interest by all who are interested in the treatment of malignant disease.

The latest of these reports, issued in 1935*, differs from its predecessors in that the space allotted to purely experimental work is approximately equal to that occupied by clinical results and details of treatment. In previous issues, clinical methods and their comparative values formed by far the greater part of the report ; now, owing to standardisation of certain methods of therapeutic technique, less space is necessary for their description. By standardisation of methods it is not meant that the radiation treatment of malignant disease can be carried out simply as a routine ; each case must be treated as a separate problem, and the details of treatment modified to meet individual requirements. It does, however, mean that substantial progress has been made in advancing from the empirical to the scientific treatment of cancer. Not many years ago, surgical operation alone was regarded as the only possible method of giving relief ; operations became more and more extensive in the hope of eradicating the disease, and, as is but too well known, were often ultimately ineffective. How complete has been the change in medical opinion during recent years can be seen from the figures quoted in the latest report, which are based upon the returns made by the various centres acting in collaboration with the Council. Since these centres include most of the great hospitals both in the metropolis and in the provinces, their practice may fairly be taken as representative of the best medical opinion of the day. Out of a total of 2,475 cases of malignant disease treated during the year 1934, only 612, or 24·7 per cent, were treated by purely surgical methods ; in the remaining 1,863 cases some form of radiation therapy was employed, with or without more purely surgical methods ; and in no less than 1,145 cases treatment was by radium alone, and in 251 by X-rays alone.

The most striking results of radiation treatment have been seen in cancer of the tongue and cancer of the uterus ; in nearly all such cases now the treatment of choice is by radium combined with high-voltage X-rays. The treatment of cancer in other sites presents many technical and inherent difficulties, sometimes from inaccessibility of the primary growth or of the paths by which the disease may spread, and sometimes from a combination of both these adverse factors. Such cases are receiving close attention, and the effects of combined radiation and electro-surgery and of massive radium radiation by one- to five-gram units* are under investigation at various centres.

The story of the part taken by the Medical Research Council in the development of radium treatment in Great Britain may be worthy of a brief note. In the year 1919 it acquired from the Ministry of Munitions about 5 gm. of hydrated radium bromide, equivalent to about 2·5 gm. of radium element. In the first instance this was put in the charge of the Middlesex Hospital, and used for experimental work upon the action of radiation upon normal and malignant tissues. The report upon this work was issued in 1922, and forms the first volume of the series which has been continued to the present time. The radium was then divided between various centres, after having been suitably mounted at the Medical Research Council's expense. Throughout, the Medical Research Council has worked in the closest and most harmonious co-operation with the National Radium Commission, and the result has been the acquisition of a vast amount of valuable information.

We have said that in the latest report nearly half the space is devoted to experimental work ; this work has been of a most varied character, ranging from experimental findings in pure physics to facts relating to the reactions of the tissues under irradiation. We sincerely hope that these purely experimental findings will continue to appear in the same volume along with the results of radiation therapy. Such a combination will serve to emphasise the essential need for the co-ordination and co-operation of physicists, biologists, chemists and other special workers with the clinicians who translate scientific findings into their practical applications for the treatment of disease.

* Medical Research Council. Special Report Series, No. 204: Medical Uses of Radium ; Summary of Reports from Research Centres for 1934. Pp. 45+2 plates. (London: H.M. Stationery Office.) 1*s.* net.

* This is the so-called 'bomb' treatment, an absurd terminology which should be banished from scientific literature.

Obituary

Sir Charles Ballance, K.C.M.G., C.B., M.V.O.

BY the death, in his eightieth year, of Sir Charles Ballance, British surgery has lost one of its most dignified and distinguished leaders.

Charles Alfred Ballance was born in 1856. His medical career began at St. Thomas's Hospital, with which institution he remained connected throughout his life. As an undergraduate he gained numerous prizes and medals, including gold medals at the University of London at the examinations for the degrees of B.S. in 1880 and M.S. in 1881. When a young graduate, he spent some time in Germany, working at histological research. As a result, he published a scholarly book on "Ligation of Great Arteries in Continuity". Returning to London, he was appointed to the staff of St. Thomas's Hospital, occupying successively the posts of aural surgeon, assistant surgeon, full surgeon and ultimately consulting surgeon. Amongst other hospital appointments he was surgeon to the Evelina Hospital for Children; to the National Hospital, Queen Square; and to the West End Hospital for Nervous Diseases.

Equipped with a sound knowledge of pathology, Ballance was one of the earliest workers in the histological investigation of the processes of repair, first of arteries and, later, of the peripheral nerves. Throughout his professional life, he remained a general surgeon, but with a special bent for aural diseases and for neurological surgery. As an aural surgeon he devised and taught a special radical operation for mastoid infection, a procedure which was a marked advance on preceding methods. His long experience at the National Hospital enabled him to attain a distinguished position as a pioneer of brain surgery, although he was overshadowed to some extent by his brilliant and dashing colleague Sir Victor Horsley.

From 1899 until 1901, conjointly with one of his former house-physicians, Purves-Stewart, he carried out a research upon the processes of degeneration and regeneration in peripheral nerves. This subject, the repair of peripheral nerves, continued to interest him throughout his life, so much so that after his retirement from active practice he spent a couple of years in the United States, where he undertook a new and successful research upon the methods of therapeutic anastomosis of divided nerves, with special reference to the treatment of facial palsy.

During the Great War, Sir Charles served as consulting surgeon to the Mediterranean Forces with the rank of colonel, being posted at Malta. There, in conjunction with Sir Charters Symonds, he organised, supervised and inspired with enthusiasm the large number of emergency military hospitals which during the Gallipoli campaign came to throng the island. In recognition of his services there, the University of Malta conferred on him the honorary degree of M.D. Meanwhile he was created C.B. in 1916 and K.C.M.G. in 1918, having previously in 1906 been made a member of the Victorian Order.

On his return to civilian practice, Sir Charles continued to work with indomitable energy at some of the more difficult and recondite problems of modern surgery. He published books on the history of brain surgery, on the surgery of the heart and on the surgery of the temporal bone. In 1930 he gave the MacEwen Memorial Lecture in Glasgow, and was afterwards made LL.D. of that University. In 1933 he delivered the Lister Memorial Lecture at the Royal College of Surgeons, of which he had been vice-president in 1920. Most appropriately, in 1933 the College awarded him the Lister Medal in recognition of his distinguished contributions to surgical science.

Apart from his professional eminence, Ballance was a man of wide general culture. Every official oration delivered by him was enriched and embellished by classical quotations, Shakespearian and others, to such a degree that their literary charm sometimes tended to divert the reader's attention from the solid scientific facts which they so admirably clothed. In his book upon the "Healing of Nerves", in addition to apt quotations from Bacchylides, Manilius, Shakespeare and R. L. Stevenson, he paid a compliment to the erudition of his colleagues at the National Hospital by a charming dedication couched in elegant Latin.

Ballance's personality and character were dignified, impressive and attractive. To his professional colleagues and friends, his kindness, hospitality, loyalty and generosity were proverbial. His family life was singularly happy, although he suffered tragic blows by the death of his wife and later of his only son, Dr. Alaric Ballance, who served with gallantry and distinction in the War and was a source of justifiable pride to his father. The high quality of the stock to which Sir Charles belonged is further exemplified by the distinguished career of his brother, Sir Hamilton Ballance, of Norwich, happily with us still. Sir Charles Ballance's memory will long be treasured by his friends, pupils and admirers all over the world.

WE regret to announce the following deaths:

Mr. Richard Bentley, president of the Royal Meteorological Society in 1905–6, on February 23, aged eighty-one years.

Sir Theodore Morison, K.C.S.I., K.C.I.E., C.B.E., in 1919–29 principal of Armstrong College, Newcastle-upon-Tyne, and previously (1899–1905) principal of the Mahomedan Anglo-Oriental College of Aligarh (now the Aligarh Muslim University), on February 14, aged seventy-two years.

Miss Grace Stebbing, sister of the late Rev. T. R. R. Stebbing, F.R.S., and one of the oldest members of the British Association, on February 25, aged ninety-five years.

News and Views

Neutron Capture and Nuclear Constitution

THE new views of nuclear structure and the processes involved in neutron capture, presented by Prof. Niels Bohr in an address which appears elsewhere in this issue, were expounded by him in a lecture to the Chemical and Physical Society of University College, London, on February 11 and were illustrated by two pictures here reproduced. The first of these is intended to convey an idea of events arising out of a collision between a neutron and the nucleus. Imagine a shallow basin with a number of billiard balls in it as shown in the accompanying figure. If the basin were empty, then upon striking a ball from the outside, it would go down one slope and pass out on the opposite side with its original velocity. But with other balls in the basin, there would not be a free passage of this kind. The struck ball would divide its energy first with one of the balls in the basin, these two would similarly

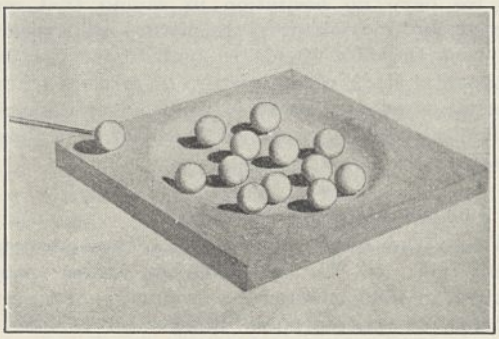

FIG. 1.

share their energies with others, and so on until the original kinetic energy was divided among all the balls. If the basin and the balls are regarded as perfectly smooth and elastic, the collisions would continue until the kinetic energy happens again to be concentrated upon a ball close to the edge. This ball would then escape from the basin and the remainder of the balls would be left with insufficient total energy for any of them to climb the slope. The picture illustrates, therefore, "that the excess energy of the incident neutron will be rapidly divided among all the nuclear particles with the result that for some time afterwards no single particle will possess sufficient kinetic energy to leave the nucleus".

Nuclear Energy Levels

THE second figure illustrates the character of the distribution of energy levels for a nucleus of not too small atomic weight. The lowest lines represent the levels with an excitation of the same order of magnitude as ordinary excited γ-ray states. According to the views developed in Prof. Bohr's address, the levels will for increasing excitation rapidly become closer to one another and will, for an excitation of about 15 million electron volts, corresponding to a collision between a nucleus and a high-speed neutron, be continuously distributed, whereas in the region of small excess energy of about 10 million volts excitation they will still be sharply separated. This is illustrated by the two lenses of high magnification placed over the level-diagram in the two above-mentioned regions. The dotted line in the middle of the field of the lower magnifying glass represents zero excess energy, and the fact that one of the levels

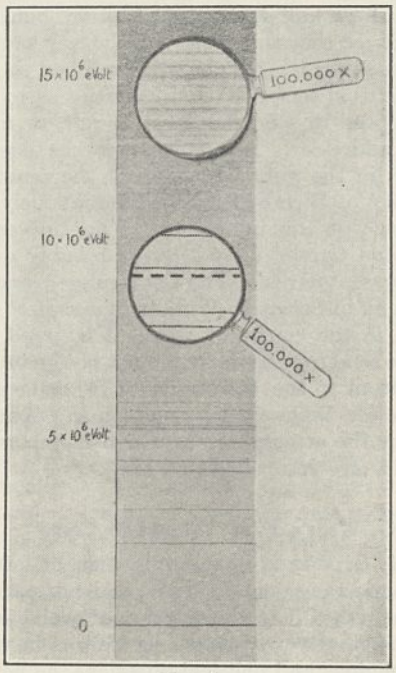

FIG. 2.

is very close to this line (about $\frac{1}{2}$ volt distant) corresponds to the possibility of selective capture for very slow neutrons. The average distance between the neighbouring levels will in this energy region be about ten volts as estimated from the statistics for the occurrence of selective capture. The diagram shows no upper limit to the levels, and these actually extend to very high energy values. If it were possible to experiment with neutrons or protons of energies above a hundred million volts, several charged or uncharged particles would eventually leave the nucleus as a result of the encounter; and, adds Prof. Bohr, "with particles of energies of about a thousand million volts, we must even be prepared for the collision to lead to an explosion of the whole nucleus".

Heidelberg and Academic Freedom

TRANSLATIONS of extracts of speeches made at the ceremonial dedication of the Philipp-Lenard-Institut at Heidelberg in December last were given in an article in NATURE of January 18, p. 93. The speech made by Prof. J. Stark, president of the Physikalisch-Technische Reichsanstalt and of the Deutsche Forschungsgemeinschaft, is published in full in the February issue of *Nationalsozialistische Monatshefte*. This journal, edited by the "Reichsleiter für weltanschauliche Schulung", Alfred Rosenberg, is intended to be the leading periodical for German intellectual and academic circles. Prof. Stark's speech expresses even more extreme views than were represented in the extract given in NATURE. It appears from a letter published this week in our correspondence columns that 1935–36 is not really the 550th anniversary of the University of Heidelberg, but the 549th. The facts as stated by our correspondent have been verified by reference to original sources at the British Museum. It has seemed curious to many of us that the University should have arranged for a half-century celebration, but it is even more strange that the 549th anniversary should have been chosen for it. No news has reached us officially from scientific societies or universities as to whether they propose to send delegates or not, or merely to present addresses. Announcement has been made, however, in the public Press, that the senate of the University of Birmingham has unanimously decided not to accept the invitation. The Universities of Oxford and Cambridge will also probably decline to send representatives. The Cambridge branch of the Association of Scientific Workers has sent to NATURE a letter, in the course of which it is urged that "a refusal to send representatives must not be interpreted as an affront to the University of Heidelberg, but as an indication that scientific opinion in Great Britain condemns the atmosphere in which members of that University are compelled to work".

Mr. H. G. Wells's Film "Things to Come"

MR. H. G. WELLS is the only man of letters who understands the scientific spirit, and has consistently urged the use of it in the solution of social problems. In his imaginative romances, as well as in works on social, religious and political questions, he has always presented science as a progressive influence and has remonstrated against the unworthy ends for which it is often used. The hope expressed in his "Anticipations" and "A Modern Utopia" took different form in "The Shape of Things to Come" published two years ago and was accompanied by a warning of disaster unless human purposes were determined by reconstructed principles. Science has put into the hands of civilised man the power to destroy himself or to make the world a celestial dwelling place; and the sooner this is widely realised the safer will the world be for humanity. There is no better way to-day of making this message universal than through the motion picture; and this is done in the marvellous film "Things to Come", the world première of which was given in London on Friday, February 21. The film has been produced by Mr. Alexander Korda; and Mr. Wells, whose scenario of it was noticed in NATURE of January 11 last, has taken an active part in the production of the picture.

THE general story is that of the destruction of the civilised world by war-fever and pestilence, and after almost every material structure had been destroyed and intellectual culture had been lost, a new world government arises in which scientific leaders have control. Through the three generations represented in the film, some basic human attributes remain unchanged, and they are represented by Dr. Harding's devotion to medical research even when the world is in ruins; Cabal, who never falters in his confidence in the power of science to promote human welfare; the military autocrat, who regards gladiatorial conflicts as the only means of securing peace; his mistress, Roscana, with the eternal 'sex appeal' diverting ethical aims; Theotocopulus, the sculptor who even in a beautiful and regenerate world, raises a revolt against mechanisation and looks with longing to the Golden Age of the past; and finally the two young people who, still with the spirit of adventure in them, start for a journey around the moon in spite of all efforts of reactionaries to restrain them. It is scarcely within our province to comment upon the technique of this remarkable production, but we have no hesitation in saying that every moment and movement of the picture has a meaning and that the film stands as high above the usual sentimental stock of the picture house as a triumph of creative art does above a gaudy advertisement or a classical literary work is superior to a 'penny dreadful'.

The Lumière Celebration in London

WHILE the credit of inventing cinematography rightly goes to W. Friese Green, whose patent, obtained in 1889, covered the production of a perfect sequence of photographic images on a band of celluloid film taken by one camera with one lens and from one point of view, it remained to the brothers Lumière to invent the *cinematographe* and to show moving pictures to the public. In December 1895, Louis Lumière gave his first exhibition in Paris (see NATURE, Nov. 16, 1935, p. 803) and the new invention was introduced to British audiences through the enterprise of the Polytechnic in Regent Street on February 20, 1896. Figures given by Mr. Simon Rowson at a recent meeting of the Royal Statistical Society show how important is the position now held by the cinema in the social life of the country. In 1934, 957,000,000 people in the United Kingdom paid £40,950,000 to see moving pictures.

TYPICAL of the change which has come about and of the present status of the industry is the fact that the Polytechnic, which was the scene of the first exhibition, now possesses a School of Kinematography where students receive technical training in all branches of the industry. To honour M. Lumière, a celebration was held in the Polytechnic on February 20, the fortieth anniversary of the date on which his

invention was first shown to the English public. M. Lumière was present and was the recipient of a gold fountain pen and pencil as a memento of the occasion. The events of forty years before were re-enacted and copies of some of the films then shown were screened. In one or two cases the original projector was used, and the quality and steadiness of the pictures were remarkable. Among other films shown were early news reels and examples illustrating the stages in the development of motion picture technique and invention, including two short colour sequences. Fyvie Hall contained exhibits, many of them from the collection of Mr. Will Day, illustrative of the history of cinematography, ranging from moving lantern slides of one hundred years ago to examples of the most modern motion picture cameras and projection equipment. The exhibition remained open to the public and the films were shown for three days.

Utilisation of Fuel

TECHNICAL problems of the utilisation of fuel have long been a popular subject of discussion, but the troubles of the coal trade have recently evoked an unusual number of contributions. Sir Harold Hartley, in a paper before the Institution of Chemical Engineers, examined our "National Coal Resources", Sir Frank Smith discussed "Coal, Power and Smoke" before the Junior Institution of Engineers, Sir William Larke addressed the Fuel Luncheon Club, an anonymous "Observer" has recently issued a pamphlet on "Miners, Owners and Mysteries", and Mr. O. W. Roskill discussed before the Institute of Fuel the "Co-ordination of National Fuel and Power Supplies", while chairmen of public utility companies have much to say about coal when addressing their shareholders at this season. The reader will find considerable repetition in these discussions, but cannot escape the impression of the extreme complexity of the problems.

THE technical problems involved, though naturally complicated, are obviously capable of solution, and indeed would present no fundamental difficulty if national fuel services were being planned *ab initio*. The more difficult questions arise from the necessity for reconciling conflicting financial and industrial interests, conflicting local interests, conflicting national interests such as economics and defence, the promotion of fuel economy and the provision of employment. Most of the proposals for promoting efficiency or economy would involve a reduction, at least for a time, of labour or employment for some, and the adjustment of the coal industry to a new level of stability will clearly be long and difficult. Mr. Roskill, after surveying all the coal-using industries, advocates a concentration of the Ministry of Mines, Transport and the relevant section of the Board of Trade, into a new Ministry of Fuel, the chief object of which would be to reconcile now competing interests of the fuel industries. The "Observer", apparently an engineer, believes that the coal trade should adopt the methods of the engineering industry in its treatment of labour problems.

The Municipal Smoke Problem

THE problem of air pollution by smoke has long engaged the attention of scientific workers, but only latterly has the public realised that its solution is of first-class importance to the civil life of the community. The presence of pollutants in the atmosphere is proof of wastage of fuel. If fuel is properly and completely burned, the maximum amount of heat will be obtained without smoke, whereas if it is incompletely burned, smoke will be produced. The ultimate source of all heat, or energy, is the sun, which in its direct form of sunshine should be accessible, and in its indirect form of fuel should be conserved. Air pollutants must therefore be attacked for the two-fold reason that they blot out the sunshine, and are produced only by wastage of fuel. In November last, at the request of members of the General Science Club of teachers in the Pittsburgh High Schools, who considered it essential for all students to have a rudimentary knowledge of fuels and their uses, Messrs. H. B. Meller and L. B. Sisson, of the Mellon Institute of Industrial Research, issued a pamphlet on the subject. Therein are listed the fuels most commonly used, namely, coal (anthracite, semi-bituminous and bituminous), coke, oil and gas (natural and manufactured). Data are adduced to show in as compact a form as possible of what these fuels are composed, how and why they burn, what products they give off and whether such products exert a beneficial or deleterious effect. Finally, indication is given of the efforts which have been made to date to rid the atmosphere of pollutants. The booklet is in effect an exposition of facts which every citizen should know if he is to help in the solution of the problem of obtaining maximum heat from fuel with minimum air pollution.

The Indian Academy of Sciences

IN his presidential address in January of last year to the premier Indian academy, the National Institute of Sciences of India, Sir Lewis Fermor welcomed the formation in Bangalore of the Indian Academy of Sciences, which owes its inception to the energies of Sir Venkata Raman. The Indian Academy of Sciences is already well known through the medium of its publications, and in December last Sir Venkata Raman delivered his presidential address at the first annual meeting, which was held in Bombay. In this he clearly set forth the aims of the Academy, and at the same time he appealed for funds to enable it to continue and extend its activities, and also for the erection of a suitable building for which the generosity of the Maharajah of Mysore had already provided a site adjacent to the Indian Institute of Science. It is somewhat surprising to find in the address no reference to the National Institute of Sciences with which, from Sir Lewis Fermor's remarks, we had gathered it was to co-operate. We trust that the absence of such reference does not imply that this co-operation has ceased. If the growing body of scientific thought in India is to exercise that influence on the government of the country, which is its due, or if it is to be adequately repre-

sented at international conferences, it can only be through the agency of a national organisation. Valuable as may be the local activities of the Asiatic Society of Bengal, and of the Academies at Allahabad and Bangalore, they cannot fulfil these duties.

Preparation of Woad in England

IN a paper on "The Preparation of Woad in England", read by Messrs. H. O. Clark and R. Wailes on February 19 to the Newcomen Society, the authors said that, after being cultivated for centuries, dyer's woad (*Isatis tinctoria*) was last grown and prepared at Skirbeck, Lincolnshire, in 1932, and that it is not likely to be grown again either in England or elsewhere. Much has been written on the history, botany and chemistry of the plant and the dye, and the object of the paper was to place on record information as to the technology and the cost of the preparation of woad. Fortunately, on farms at Algarkirk and Skirbeck, the machinery used in the industry remains almost intact and many photographs and drawings have been made of it. At Algarkirk, too, are old account books covering the period 1844–56, and these show that the output of the farm varied from 75 tons to 178 tons and the price obtained for the prepared woad from £9 to £15. The operations involved in the preparation of woad include sowing, weeding, cropping, grinding, balling, drying, couching and packing. The most interesting of these processes was the grinding in large horse- or steam-driven mills. In the mill at Algarkirk is a circular track of oak blocks about 24 ft. in diameter on which the leaves of the plants were crushed and chopped by means of four great tapered rollers each furnished with about thirty-six cutters. The rollers were towed round the track by a large overhead cast-iron wheel with cast-iron spokes and a toothed rack with 456 teeth. Such mills were fine specimens of millwrighting. After the woad leaves were crushed, they were kneaded into balls by hand, and dried. A few weeks later the balls were broken up and the woad spread over the floor of the 'couching house' to a depth of about three feet. It was allowed to ferment for six to eight weeks, being turned over daily, and then was again dried, after which it was packed in barrels for dispatch to the dyers.

Academic Assistance Council

AT a meeting of the Academic Assistance Council, under the presidency of Lord Rutherford, in the rooms of the Royal Society on February 21, the Council recorded its gratitude for the generous gift from Mr. and Mrs. Simon Marks, Mr. and Mrs. Israel M. Sieff, Mr. and Mrs. Harry Sacher, Mr. and Mrs. Norman Laski and Miss Mathilda Marks of two research fellowships for displaced German men of science of the value of £450 per annum each for a period of five years. After consultation with the Royal Society, the Council awarded one fellowship for a period of three years to Dr. Walter Heitler, to enable him to continue his research in theoretical physics at the University of Bristol. Dr. Heitler, formerly of the University of Göttingen, is best known for his work in connexion with the quantum theory of valency and more recently in connexion with the theory of absorption of particles and radiation of high energy. The Council will shortly award the second fellowship. From its general funds the Council established a third fellowship for a period of three years, which it awarded to Dr. Veit Valentin, to enable him to continue his work in German history at University College, London. Dr. Valentin was head archivist and director of the research department for the history of culture of the German State Archives at Potsdam.

THE officers of the Academic Assistance Council reported that the dismissal of university teachers in Germany on account of opinion or race is continuing, and that even after dismissal scholars are further victimised by being denied access to libraries and forbidden to accept invitations from universities and learned societies abroad. The officers also reported that six university teachers have been dismissed in Portugal for other than professional reasons. There is, therefore, continuing need for a non-political organisation to assist displaced men of science and other scholars, and the Council has made plans for the creation of a more permanent body, a Society for the Protection of Science and Learning, to take over its activities. An invitation will shortly be issued for persons to join this Society, and at the same time an appeal for funds will be made.

The Universities, Social Sciences and Local Government

REFERENCE is made in the annual report to the Court of Governors of the University of Birmingham, presented by Sir Charles Grant Robertson (vice-chancellor) on February 20, to the criticisms of Miss Fry, at the recent Annual Conference of Educational Associations: (*a*) that in the ratio of number of university students to population Great Britain attains only to the fifth place among the European nations; (*b*) that there does not exist a single university department in Great Britain dealing with causes, incidence and treatment of crime; and (*c*) that too large a percentage of university graduates go down almost ignorant of the structure of society and its claims upon them. As to these criticisms, the Vice-Chancellor says that "unless the community can annually and suitably absorb the output of the Universities, an increase in the number of university students will defeat the purpose for which it is made. . . . What is needed even more than a knowledge of the existing social structure is the power to amend it and strengthen its capacity to absorb the trained mind . . . ignorance of the structure of society is not confined to graduates; it is shared by a huge percentage of the community, including the House of Lords at one end and the recipients of Public Assistance at the other". He quotes with approval Miss Fry as reported in *The Times* of December 31, 1935: "In the local service there was too little bringing in of generally well educated people in the early twenties, as in the State Civil Service. The

Recent Scientific and Technical Books

Volumes marked with an asterisk (*) have been received at "NATURE" Office

Mathematics : Mechanics : Physics

Andrade, E. N. da C. The Atom. New edition, entirely revised, extended and reset. Fcap. 8vo. Pp. ix +129. (London and Edinburgh : Thomas Nelson and Sons, Ltd., 1936.) 1*s.* 6*d.* net.*

Aristotle. Aristotle's Physics. A revised Text, with Introduction and Commentary, by W. D. Ross. Demy 8vo. Pp. xii +750. (Oxford : Clarendon Press ; London : Oxford University Press, 1936.) 36*s.* net.*

Beeching, R. Electron Diffraction. (Methuen's Monographs on Physical Subjects.) Fcap. 8vo. Pp. viii +108. (London : Methuen and Co., Ltd., 1936.) 3*s.* net.*

Brard, R., et **Gorceix, Ch.** Radiesthésie scientifique : Balance pendulaire de précision (2e édition) suivie du Journal de Laboratoire de 1935 contenant les percepteurs B.G., notions scientifiques utiles, expériences nouvelles diverses. Roy. 8vo. Pp. 277. (Paris : Paul Lechevalier, 1935.) 25 francs.*

Braunmühl, H. J. von, und **Weber, Walter.** Einführung in die angewandte Akustik : insbesondere in die neueren Probleme der Schallmessung, Schallübertragung und Schallaufzeichnung. Roy. 8vo. Pp. v +216. (Leipzig : S. Hirzel, 1936.) 9.20 gold marks.*

Brillouin, Léon. Notions élémentaires de mathématiques pour les sciences expérimentales. 8vo. Pp. 251. (Paris : Masson et Cie, 1935.) 40 francs.

Brown, J. T., and **Manson, C. W. M.** The Elements of Analytical Geometry. Cr. 8vo. Parts 1-2 : The Straight Line and the Circle. Pp. vi +167 +x. (London : Macmillan and Co., Ltd., 1936.) 2*s.* 6*d.*

Chambers, F. W. The Arithmetic of the Equation. (Macmillan's Senior School Series : Arithmetic Terminal Book F.) Cr. 8vo. Pp. v +66 +viii. (London : Macmillan and Co., Ltd., 1936.) 1*s.* ; with Answers and Notes, 1*s.* 3*d.*

Dänzer, H. Grundlagen der Quantenmechanik. Wissenschaftlichen Forschungsberichte, Band 35.) 8vo. Pp. xii +163. (Dresden und Leipzig : Theodor Steinkopff, 1935.) 12 gold marks.

Defant, Albert. Der äquatoriale Gegenstrom. (Sonderausgabe aus den Sitzungsberichten der Preussischen Akademie der Wissenschaften, Phys.-math. Klasse, 1935, Band 28.) Sup. Roy. 8vo. Pp. 25. (Berlin : Walter de Gruyter und Co., 1935.) 1.50 gold marks.*

Department of Scientific and Industrial Research : Illumination Research. Technical Paper No. 17 : Seasonal Variation of Daylight Illumination. Roy. 8vo. Pp. iii +8 +1 plate. (London : H.M. Stationery Office, 1936.) 4*d.* net.*

Faraday. Faraday's Diary : Being the various Philosophical Notes of Experimental Investigation made by Michael Faraday, D.C.L., F.R.S., during the Years 1820-1862 and bequeathed by him to the Royal Institution of Great Britain, Now, by order of the Managers, printed and published for the first time, under the editorial supervision of Thomas Martin. Vol. 7 : Nov. 24, 1875—Mar. 12, 1862. Sup. Roy. 8vo. Pp. xvii +465 +2 plates. Index. Pp. 64. (London : G. Bell and Sons, Ltd., 1936.) 7 vols., and Index, £12 12 0 net.*

Gause, G. F. Exposés de biométrie et de statistique biologique, 9 : Vérifications expérimentales de la théorie mathématique de la lutte pour la vie. (Actualités scientifiques et industrielles, 277.) Roy. 8vo. Pp. 63. (Paris : Hermann et Cie, 1935.)*

Grimsehls Lehrbuch der Physik : zum Gebrauch beim Unterricht, neben Akademischen Vorlesungen und zum Selbststudium. Neubearbeitet von R. Tomaschek. Band 1 : Mechanik, Wärmelehre, Akustik. Neunte Auflage. Med. 8vo. Pp. vii +674. (Leipzig und Berlin : B. G. Teubner, 1936.) 19.80 gold marks.*

Hadley, H. E. A Class Book of Magnetism and Electricity. Cr. 8vo. Pp. x +512. (London : Macmillan and Co., Ltd., 1936.) 6*s.* 6*d.*

Hausdorff, F. Mengenlehre. (Göschens Lehrbücherei, Gruppe 1, Band 7.) Dritte Auflage. Roy. 8vo. Pp. 307. (Berlin und Leipzig : Walter de Gruyter und Co., 1935.) 13.50 gold marks.

Jones, T. J. Thermionic Emission. (Methuen's Monographs on Physical Subjects.) Fcap. 8vo. Pp. viii +108. (London : Methuen and Co., Ltd., 1936.) 3*s.* net.*

Jordan, P. Physikalisches Denken in der neuen Zeit. 8vo. Pp. 59. (Hamburg : Hanseat. Verlags-Anstalt, 1935.) 2 gold marks.

Lambert, H. G., and **Andrews, P. E.** Light and Sound. (Elementary Science Series.) Cr. 8vo. Pp. vii +183. (London : University Tutorial Press, Ltd., 1935.) 2*s.* 3*d.*

Lange, Bruno. Die Photoelemente und ihre Anwendung. Roy. 8vo. Teil 1. Pp. 132. (Leipzig : Johann Ambrosius Barth, 1936.) 9.60 gold marks.

Larcombe, H. J., and **Fletcher, J. K.** School Certificate Mathematics. Algebra, Part 3. Cr. 8vo. Pp. viii +96. (Cambridge : At the University Press, 1936.) 2*s.* ; with Answers, 2*s.* 3*d.*

McKenzie, A. E. E. Heat. Cr. 8vo. Pp. viii +160. (Cambridge : At the University Press, 1936.) 2*s.* 6*d.*

Mayer, Ernst. Kleine Einführung in die Ostwald'sche Farbenlehre. Pott 8vo. Pp. 32. (Berlin-Schöneberg : Dähne Verlag, 1935.) 0.50 gold mark.

Naske, C. Integraltafeln : für Ingenieure und verwandte Berufe sowie für Studierende technischer Hoch- und Fachschulen aufgestellt. 8vo. Pp. 48. (Leipzig : Otto Spamer, 1935.) 2.80 gold marks.

Nielsen, J. Vorlesungen über elementare Mechanik. Übersetzung und bearbeitet von W. Fenchel. (Die Grundlehren der mathematischen Wissenschaften in Einzeldarstellungen, herausgegeben von R. Courant, Band 44.) Roy. 8vo. Pp. 500. (Berlin : Julius Springer, 1935.) 38 gold marks.

Prüfer, H. Projektive Geometrie. Roy. 8vo. Pp. 314. (Leipzig : Robert Noske, 1935.) 9.50 gold marks.

Rahn, Otto. Invisible Radiations of Organisms. With an Introduction to the Physics of Radiation, by Sidney W. Barnes. (Protoplasma-Monographien, Vol. 9.) Med. 8vo. Pp. x +215. (Berlin : Gebrüder Borntraeger, 1936.) 13.20 gold marks.*

Robb, Alfred A. Geometry of Time and Space. Roy. 8vo. Pp. vii +408. (Cambridge : At the University Press, 1936.) 21*s.* net.*

Schouten, J., und **Struik, D.** Einführung in die neueren Methoden der Differentialgeometrie. Zweite vollständig umgearbeitete Auflage. Roy. 8vo. Band 1. Pp. 202. (Groningen : P. Noordhoff, 1935.) 10 gold marks.

Tertsch, H. Das Kristallzeichnen auf Grundlage der stereographischen Projektion. Roy. 8vo. Pp. 38. (Wien und Berlin : Julius Springer, 1935.) 3.60 gold marks.

Thienhaus, E. Das akustische Beugungsgitter und seine Anwendung zur Schallspektroskopie. 8vo. Pp. 59. (Leipzig : Johann Ambrosius Barth, 1935.) 2.40 gold marks.

Thompson, A. J. Logarithmetica Britannica, Part 7 : Numbers 70,000 to 80,000. (Tracts for Computers, No. 20.) Demy 4to. 6 reproductions. (Cambridge : At the University Press, 1936.) 15*s.* net.

Zimmer, Ernst. The Revolution in Physics. Translated, and with a Preface, by H. Stafford Hatfield. Demy 8vo. Pp. xiv +240 +13 plates. (London : Faber and Faber, Ltd., 1936.) 12*s.* 6*d.* net.*

Engineering

Barrett, A. M. Aero-engines: Inspection during Manufacture, Overhaul and Test. (Aeronautical Engineering Series: Ground Engineers.) Third edition. Demy 8vo. Pp. 125. (London: Sir Isaac Pitman and Sons, Ltd., 1936.) 3*s.* 6*d.* net.

Bergtold, F. Messbuch für Rundfunk- und Verstärkertechnik. 8vo. Pp. 215. (Berlin: Weidmann Verlag, 1935.) 8 gold marks.

Bolton, D. J. Electrical Engineering Economics: a Study of the Economic Use and Supply of Electricity. Second edition, revised and enlarged. Demy 8vo. Pp. xiii +365. (London: Chapman and Hall, Ltd., 1936.) 21*s.* net.*

Collins, R. W. Road Vehicle Performance. Demy 8vo. Pp. 36. (London: Draughtsman Publishing Co., Ltd., 1936.) 2*s.* net.*

Dennhardt, A., und **Himmler, E. H.** Leitfaden der Rundfunkentstörung. 8vo. Pp. 106. (Berlin: Julius Springer, 1935.) 3.75 gold marks.

Fellbaum, G. Was weisst du vom Rundfunk? 8vo. Pp. 98. (Dresden: Laube-Druck, 1935.) 1.50 gold marks.

Forestier, V. Béton armé, à l'usage des ingénieurs, architectes, entrepreneurs et conducteurs de travaux. (Agenda Dunod 1936.) Pp. cxii +380. (Paris: Libr. Dunod, 1935.) 20 francs.

Fowler's Electrical Engineer's Pocket Book, 1936. Thirty-sixth edition. Pott 8vo. Pp. 587. (Manchester: Scientific Publishing Co., 1936.) 3*s.* net.

Fowler's Mechanical Engineer's Pocket Book. Thirty-eighth edition. Pott 8vo. Pp. 602. (Manchester: Scientific Publishing Co., 1936.) 3*s.* net.

Golding, E. W. Electrical Measurements and Measuring Instruments. Second edition. Demy 8vo. Pp. 812. (London: Sir Isaac Pitman and Sons, Ltd., 1936.) 20*s.* net.

Hemardinquer. Entretien, mise au point, dépannage des appareils radio-électriques (récepteurs de T. S. F., amplificateurs, cinématographe sonore). Tome 1: Unités et formules pratiques; Tables de mesures rapides; Les appareils de mesure, de verification et de dépannage; Leurs principes et leur construction. 8vo. Pp. 214. (Paris: Léon Eyrolles, 1935.) 30 francs.

Hofmann, A. Cl. Sender-Praktikum für Kurzwellen-Amateure. (Deutsche Radio-Bücherei, Band 58.) Zweite erweiterte Auflage. 8vo. Pp. 151. (Berlin-Tempelhof: J. Schneider, 1935.) 3.25 gold marks.

Koop, H. Der Fahrzeugdieselmotor. (Kraftfahrzeugkunde, Teil 5.) Sup. Roy. 8vo. Pp. 64. (Berlin: Schmidt und Co., 1935.) 2 gold marks.

La Touche, J. N. Digues. The Young Engineer: a Manual dealing with Indian Practice designed to assist Students of Engineering generally, and particularly those requiring a Knowledge of Colonial Methods. Cr. 8vo. Pp. xii +242. (London: The Technical Press, Ltd., 1936.) 5*s.* net.*

Lehmann, W., Herausgegeben von. Die Rundfunk- und Tonfilmtechnik. Dritte erweiterte Auflage. Roy. 8vo. Pp. 728 +23. (Nordhausen: Killinger Verlag, 1935.) 26 gold marks.

Lübsen, W. Die Verbesserung der Wirtschaftlichkeit der Dampflokomotive durch konstruktive Massnahmen zur Senkung des Brennstoffverbrauchs. Roy. 8vo. Pp. 104. (Berlin: Julius Springer, 1935.) 7.50 gold marks.

Matthews, F. J. Boiler Feed Water Treatment. Demy 8vo. Pp. 256 +9 plates. (London: Hutchinson's Scientific and Technical Publications, 1936.) 12*s.* 6*d.**

Mechanical World Electrical Year Book, 1936: Notes, Rules, Tables and Data. Twenty-ninth Year. Pott 8vo. Pp. 372. (London and Manchester: Emmott and Co., Ltd., 1936.) 1*s.* 6*d.* net.

Meller, K. Taschenbuch für die Lichtbogenschweissung. Pott 8vo. Pp. 189. (Leipzig: S. Hirzel, 1935.) 5 gold marks.

Nielsen, E. Das Tankstellenwesen des deutschen Kraftverkehrs. 8vo. Pp. 90. (Würzburg: Konrad Triltsch, 1935.) 3.60 gold marks.

Oehme, R. Geradeaus-Empfänger. (Bastle richtig! Band 1.) 8vo. Pp. 168. (Dresden: Laube-Druck, 1935.) 2.20 gold marks.

Palmer, W. T. Outline Notes on Telephone Transmission Theory. Demy 8vo. Pp. 165. (London: Sir Isaac Pitman and Sons, Ltd., 1936.) 4*s.* net.

Petillon, R. Das grosse Funklexikon. Band 2. 8vo. Pp. 405–756 +xii. (Durlach: Widmann Verlag, 1935.) 18.50 gold marks.

Prinzler, H. Der moderne 4-Röhren-Oktoden-Super. (Radio-Bau-Sammlung, Band 7.) 8vo. Pp. 32 +1 plate. (Berlin: Deutsche-Technischer Buchverlag, 1935.) 1.50 gold marks.

Reitz, H. Fernsehen von A—Z. Roy. 8vo. Pp. 39. (Berlin-Wilmersdorf: Gornitzka und Thilo, 1935.) 1.95 gold marks.

Uhland, W. H., Begründet von. Uhlands Ingenieur-Kalender. Jahrgang 62, 1936. In 2 Teilen. Bearbeitet von R. Stückle. Pott 8vo. Teil 1: Taschenbuch. Pp. 1443. (Leipzig: Kröner Verlag, 1935.) 5.40 gold marks.

Ulrich, W. Schiffs-Dieselmaschinen. Zweite erneuerte und ergänzte Auflage. Sup. Roy. 8vo. Pp. 235 +xv. (Leipzig: Max Jänecke, 1935.) 15 gold marks.

Wigand, R. Ultrakurzwellenempfänger. (Radio-Bau-Sammlung, Band 6.) 8vo. Pp. 35. (Berlin-Lichterfelde: Deutsche-Technischer Buchverlag, 1935.) 1.50 gold marks.

Wigge, H. Funk-ABC. Zweite erweiterte und verbesserte Auflage. 8vo. Pp. 291. (Berlin: M. Krayn, 1935.) 6 gold marks.

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attitude of local authorities seemed rather paradoxical. By the award of scholarships they encouraged their ablest scholars to carry on their education till they were too old to have a chance of entering the service of the authorities." Inter-departmental committees in Whitehall have investigated the situation and made valuable recommendations—but nothing has been done to open up a real road from the universities to the local and municipal services other than that long enjoyed by the technicians, for example, medical men or engineers.

Science at the British Industries Fair

THE visit of H.M. The King to the British Industries Fair at Olympia and the White City on February 19 was the first public function which he attended since his accession to the throne. At Olympia he spent some time in the Scientific Instrument Section and inspected the principal exhibits, especially the epidiascopes, microscopes and binoculars. His Majesty expressed his appreciation of the fine display of instruments and of the general lay-out of the grouped stands, for the organisation of which the Scientific Instrument Manufacturers' Association of Great Britain was responsible. This year there were a greatly increased number of buyers from overseas, among whom representatives from Continental countries were predominant, and many of the leading scientific instrument firms report that, through the Fair, they have established valuable connexions in the markets of the Continent and elsewhere.

Romano-British Cave Burial in Yorkshire

SOME interesting questions are raised in the report by Sir Arthur Keith on human skeletal remains discovered last year in a cave in Kingscar, near Langcliffe, Yorkshire. The implements and weapons associated with the remains, according to a statement accompanying the report in *The Times* of February 24, are of Romano-British date. A detailed account of the artefacts will be given when the investigation of the cave, which is being carried out by members of the Pig Yard Club, is complete ; but in the meantime Sir Arthur reports that the skeletal material submitted to him consists of the skeleton of a man, from which certain parts are missing, and fragments of at least four individuals, of whom one is a girl, one a man, and two, or possibly three, are women. The portions missing from the main burial, which was in the extended position, suggest to Sir Arthur that there has been a partial disturbance across the lower part of the body, which brought about the simultaneous removal of the missing parts. He is, however, at a loss to account for the appearance, both here and elsewhere in caves, of the fragmentary remains ; though he is disinclined to regard them, as do some authorities, as evidence of the survival of cannibalism in Britain to so late a date. It will be interesting to see how far the detailed stratigraphic evidence supports the natural presumption of disturbance. It is unfortunate that the missing parts include both the thighbones ; but on the evidence of the left tibia, which has survived, the stature has been calculated as five feet five inches. In the measurements which have been made, the most marked feature is the length of the head, which gives the low cranial index of 69·3. In general character, the remains suggest a population comparable to the late Celtic (Romano-British) population of the west of Britain.

Huskless Oats

So many letters are reaching the National Institute of Agricultural Botany asking for information about huskless oats that Sir Rowland Biffen has prepared a brief account of them. These oats differ from our ordinary varieties in two important respects. The first is that the thin, paper-like husks surrounding the grain do not grip it tightly, with the result that, on threshing, the naked grains are set free just as those of wheat are. The second is that they have some six or seven grains in each spikelet instead of the usual two or three. These grains are loosely strung on a stalk sufficiently long for two or three to protrude and hang down well below the glumes. As the result of this exposure, considerable losses from shattering may be expected in unfavourable harvesting conditions. It is responsible, too, for giving the standing crop the appearance of being very high yielding. But this expectation is not realised on threshing any more than is the expectation that a barley with six rows of grain must out-crop one with two rows only. Most of the huskless oats now in existence come from China, where several distinct forms are in cultivation, but though these have been tried out in many countries during the past half century, their range of cultivation has not increased to any extent. Of late years experimenters have paid a great deal of attention to these Chinese oats. Apparently none of these experimenters, although it is an important part of a plant breeder's work to assess the agricultural value of the material he collects, has seen fit to recommend the general cultivation of huskless oats. One English firm of seedsmen, famous throughout the world for the cereal varieties which it has bred and distributed, has for the past forty years used strains of naked oats for crossing with many varieties of the ordinary cultivated oats. Two years ago the firm abandoned this work, having become convinced that the chances of obtaining any derivative of outstanding agricultural value were negligible.

Recent Acquisitions at the Natural History Museum

AMONG the donations received by the Zoological Department during the last month have been two collections of Indian game trophies, presented by Lieut.-General Sir Henry Keary and Lieut.-Colonel Sir Armine Brereton Dew. The first of these collections consists of a number of mounted heads, mostly from Burma, while the second comprises a number of skulls and horns of Kashmir sheep, markhor and ibex. Eleven hundred specimens of birds, collected by the late Capt. Boyd Alexander in Central and West Africa, have been acquired from his heir. Capt.

Boyd Alexander had during his lifetime presented to the Museum the greater part of the collections made during his extensive travels. The Mineral Department has been presented by the Otago University Museum with a cast of the meteoric stone that was found at Morven, South Canterbury, New Zealand, together with a piece of the original. From Tanganyika Territory have come platy crystals of hematite given by Mr. G. W. Cradduck and apatite crystals given by Mr. H. R. Ruggles-Brise. Mr. O. Ivan Lee has presented a carefully selected piece of radioactive fluorescent and phosphorescent lyalite from North Carolina, and Dr. H. A. Ford a specimen with small brilliant crystals of the new mineral lindgrenite from Chile. Mr. T. H. Manning has presented a series of rocks collected by him in Southampton Island, Canada, in 1934–35. A fine specimen of lapis lazuli from the Badakshan district, Afghanistan, showing large, well-shaped crystals of lazulite with pyrite, and a rhomb of the doubly refracting spar recently found in South West Africa have been purchased. A general collection of about three hundred specimens, including some from the Exhibition of 1851, and various rocks originally described by Prof. H. L. Reynolds and Mr. H. J. Gardiner have been bought. The purchases also include two cut colourless phenakites from Brazil.

Announcements

A DISCUSSION on "Surface Phenomena—Films" has been arranged by the Royal Society for March 12, at 11.30 a.m.; it will be opened by Prof. E. K. Rideal.

DR. ERIC PONDER, investigator in general physiology at the Biological Laboratory of the Long Island Biological Association, has been appointed interim director pending the appointment of a successor to the late Dr. Reginald G. Harris.

IT is announced in *The Times* of February 25 that in order to commemorate the centenary of the death of André Marie Ampère on June 10, 1836, the Minister of Posts and Telegraphs in France has decided to issue on February 27 a special stamp of 75 centimes bearing the effigy of the *savant*.

THE third International Congress for Investigation of Light will be held at Wiesbaden on September 1–7 under the presidency of Prof. W. Friedrich, when discussions will be held on the biology and physics of light and treatment by light. Further information can be obtained from Dr. H. Schreiber, Robert Koch Platz 1, Berlin, N.W.7.

ON the occasion of the fortieth anniversary of the discovery of Röntgen rays in 1895, Prof. Hans Meyer, editor of *Strahlentherapie*, Park Allee 73, Bremen, has issued an appeal to the radiologists of all nations for portraits and short biographies of all the medical men, physicists, nurses and others who, as pioneers in radiology and radiotherapy, have lost their lives in the advancement of science and assistance of humanity.

BY the generosity of Mr. Franklin, Mr. Clifford and Mr. Harvey Thorp, a new room has been added to the house of the Manchester Literary and Philosophical Society. The room, which was formally opened on February 11, will be known as the Thomas Thorp Room in memory of Thomas Thorp, who was a member of the Society from 1896 until 1914. The room will be used for displaying the Society's collection of scientific apparatus and other relics, among which are the MSS. and instruments of Dalton, and apparatus and other memorials of Joule, Wilde, Sturgeon, William Thomson and Baxendell.

IN compliance with the requirements of a gift under the will of the late Francis Amory of Beverly, Massachusetts, the American Academy of Arts and Sciences announces the offer of a septennial prize for outstanding work with reference to the alleviation or cure of diseases affecting the human genital organs, to be known as the Francis Amory Septennial Prize. If there is work of a quality to warrant it, the first award will be made in 1940. The total amount of the award will exceed ten thousand dollars, and may be given in one or more awards. While there will be no formal nominations, and no formal essays or treatises will be required, the Committee invites suggestions, which should be made to the Amory Fund Committee, care of the American Academy of Arts and Sciences, 28 Newbury Street, Boston, Massachusetts, U.S.A.

ERRATA.—In NATURE of February 15, p. 282, col. 2, the boiling point of carbon tetrafluoride was given as 126°. This should read − 126°. On p. 257, col. 1, the boiling point of chloropicrin should be 112° instead of 26·5°.

APPLICATIONS are invited for the following appointments, on or before the dates mentioned:

A teacher of engineering or building (also senior physics) in the Southport Technical College—The Secretary to the Education Committee, Southport (March 2).

A woman lecturer in geography and nature study in the Glamorgan Training College for Women, Barry—Director of Education, County Hall, Cardiff (March 2).

An assistant (Grade II) in the Admiralty Compass Department, Slough—The Secretary to the Admiralty (C.E. Branch), Whitehall, S.W.1 (March 7).

A teacher of engineering mathematics, science and drawing in the Oxford Schools of Technology, Art and Commerce—The Chief Education Officer, Education Office, 77 George Street, Oxford (March 9).

An advisory assistant at the Board of Greenkeeping Research, St. Ives Research Station, Bingley, Yorks—The Director (March 17).

A temporary assistant for research into virus diseases of potatoes under a scheme organised by the Scottish Society for Research in Plant Breeding—John Stirton, 8 Eglinton Crescent, Edinburgh.

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. 364.

CORRESPONDENTS ARE INVITED TO ATTACH SIMILAR SUMMARIES TO THEIR COMMUNICATIONS.

Capture of Slow Neutrons

IT is known that some nuclei have very large capture cross-sections for slow neutrons. This fact may be explained from the point of view of wave mechanics, which also leads to the consequence that the capture cross-section should decrease with $1/v$ with increasing velocity of the neutrons, so long as the capture probability is constant over the velocity region concerned.

There is, however, a number of experiments which cannot be reconciled with the idea of the validity of the $1/v$ law for all the elements investigated. The influence of temperature[1] and the absorption coefficients of different elements[2,3] have been found to depend on the element used as indicator for the neutrons, and evidence has been obtained for the existence of selective absorption regions[3,4,5], which are different for different elements.

Therefore we have to assume that the capture probability will in general be a complicated function of neutron velocity, depending upon special features of the nuclear model. One would, however, expect a simpler state of affairs in those collisions where the capture of the neutron is immediately followed by the emission of an α-particle, as for example with ^{10}B, because in this case the energy levels of the intermediate excited ^{11}B-nucleus should be very much broadened, on account of its very short life-time; in this case we should therefore expect the capture probability to be fairly constant for low velocities, in any event for the velocity range concerned in the type of experiments described below. One may, therefore, with suitable precautions, try to determine the velocity of neutrons by using the absorption in boron and applying the $1/v$ law.

We have carried out combined absorption experiments with boron and cadmium, using a boron chamber as indicator, which permit an analysis along these lines. Cadmium is known to absorb slow neutrons strongly but to transmit, even in fairly thick layers, a certain part of the neutrons emerging from a paraffin block[6]. Our experiments seem to show that cadmium, though a very efficient absorber for neutrons of thermal energies, becomes almost transparent for neutrons of energies not higher than one volt.

In discussing the absorption in boron, the possibility that the ^{11}B-isotope may contribute to the absorption in a way which deviates from the $1/v$ law must be considered. While this possibility cannot in general be excluded, a detailed discussion, based on the negative result of the search for β-rays under neutron bombardment[7], such as would be expected[8] from ^{12}B, shows that the ^{11}B-absorption cannot be of importance in our measurements.

The surprising sharpness of resonance in cadmium seems to agree with general views on neutron capture and nuclear constitution, recently developed by Bohr[9]. Experiments to investigate along the same lines other cases of selective capture are in progress.

Note added in proof: Experiments on the absorption of a rotating cadmium disk, just published by Rasetti *et al.*[10], indicate a slight variation of the capture probability of cadmium within the thermal energy range. This fact seems to support our conclusions. From these results and our experiments together, we may now deduce that the capture probability in cadmium has a maximum between 1 and 0·03 volt.

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G. PLACZEK.

Institute of Theoretical Physics,
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[1] Moon and Tillman, NATURE, **136**, 66 (1935).
[2] Ridenour and Yost, *Phys. Rev.*, **48**, 383 (1935).
[3] Amaldi and Fermi, *Ric. Scient.*, VI, **2**, n. 9–10 (1935).
[4] Szilard, NATURE, **136**, 950 (1935).
[5] Frisch, Hevesy and McKay, NATURE, **137**, 149 (1936).
[6] Dunning *et al.*, *Phys. Rev.*, **48**, 265 (1935).
[7] Amaldi *et al.*, *Ric. Scient.*, VI, **2**, n. 1 (1935).
[8] Crane *et al.*, *Phys. Rev.*, **47**, 887 (1935).
[9] Bohr, NATURE, [**137**, 344 (1936)].
[10] *Phys. Rev.*, **49**, 104 (1936).

Masses of some Light Atoms measured by means of a New Mass-Spectrograph

SINCE my last letter on this subject[1], I have designed and constructed my third mass-spectrograph which embodies second-order focusing. The dispersion, from 4 mm. to 6 mm. for one per cent difference of mass, was calibrated by means of the twin lines of bromine, which were found to have a difference of $1{\cdot}9983 \pm 0{\cdot}0015$ units. The D, H_2 doublet can now be obtained perfectly resolved, and as the lines are not seriously curved it is not difficult to estimate their separation to 0·005 mm. so that an accuracy of 1 in 10^5 is theoretically possible. Unfortunately, the differences in mass deduced from individual doublets show variations greater than this. These appear to depend on the condition of the discharge and are probably due to the uneven illumination of the front slit causing lateral structure in the lines themselves, which may not be quite the same for particles so different as an atom and a molecule. It is hoped to get rid of this technical difficulty as the work proceeds.

The four doublets linking H, D, He, C and O have been again measured with the following results:

Doublet	Number of doublets measured	Difference of packing fraction	Difference of mass
D, H_2	53	$7{\cdot}5_4 \pm 0{\cdot}2$	0·00152
He, D_2	12	$63{\cdot}5 \pm 0{\cdot}2$	0·02551
C^{++}, D_3	10	$70{\cdot}3 \pm 0{\cdot}3$	0·04236
O, CH_4	14	$22{\cdot}4_8 \pm 0{\cdot}15$	0·03601

As expected, the doublet C++, D_3 was the hardest to produce with lines of equal intensity; but ultimately a number of quite satisfactory spectra were obtained, on several of which the intermediate line HeD was visible. The position of this agreed well with the value of the He, D_2 doublet, which is rather higher than that found by Bainbridge.

The following are the most probable values of the isotopic weights on the physical scale:

H = 1·00812 ± 0·00004
D = 2·01471 ± 0·00007
He = 4·00391 ± 0·00016
C = 12·0035 ± 0·0003.

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Feb. 15.

[1] NATURE, **135**, 541 (April 6, 1935).

Cosmic Ray Particles of High Penetrating Power

I HAVE studied the very penetrating component of cosmic radiation by means of a large vertical Wilson chamber actuated by counters, following the method of Blackett and Occhialini. The chamber is 55 cm. high and 15 cm. broad and is placed between the large poles of 75 cm. diameter of the electromagnet at Bellevue of the Paris Academy of Sciences. The magnetic field is 13,000 gauss over all the chamber. The experimental apparatus is shown in Fig. 1. A 7 cm. block of lead is placed between the counters. Rays such as *AB* were photographed. The cosmic rays photographed with this arrangement are those which are able to penetrate the lead block, that is, the more penetrative component of the spectrum alone is photographed.

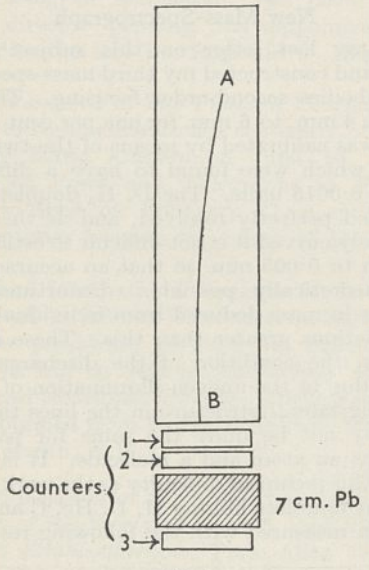

FIG. 1.

To investigate the precision of the measurements, we have taken a number of photographs with no magnetic field and we have measured the displacement of the centre of the track from the straight line joining its ends. We have found that the maximum displacement never reached 0·6 mm. for a length of about 40 cm.; the energy corresponding to such a displacement is 12 × 10^9 e.v. Thus we can determine the sign of the particle producing a track 40 cm. long if the energy is not greater than 12 × 10^9 e.v. The results of the measurements are given in the accompanying table.

Energy Range	Number of Particles		
	+ve	−ve	sign uncertain
> 10^{10} e.v.	4	0	2
2·5 × 10^9 to 10^{10} e.v.	6	1	9
10^9 to 2·5 × 10^9 e.v.	7	6	3

In addition to the tracks tested in the table, one positive particle with energy 900 × 10^6 e.v. was photographed.

(1) We see that for the greatest energies, positive particles are predominant; on the other hand, for the rays of which the energy is less than 2·5 × 10^9 e.v., there are about as many positive as negative tracks.

(2) The minimum of observed energy is of the same order for particles of both signs: we have observed no ray with an energy lower than 900 × 10^6 e.v. This means that a particle of lower energy has but a little probability of crossing the 7 cm. of lead.

These results can be explained by the assumption of two components for cosmic rays, of a different nature: first, negative and positive electrons, some of which are capable of crossing 7 cm. of lead with an energy loss of at least 900 million e.v. This is in agreement with the latest results of Anderson and Neddermeyer[1] and with the predicted increase of the radiation energy loss with increasing electron energy[2]; secondly, a radiation of a different nature, nearly exclusively composed of positive charged particles, such as protons, which is in agreement with the assumptions of various authors[3,4].

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12 rue Lord Byron, Paris VIII[e].

[1] S. H. Neddermeyer and C. D. Anderson, Los Angeles meet., abstr. 32 (1935).
[2] H. Bethe and W. Heitler, *Proc. Roy. Soc.*, A, **856**, 83 (1934).
[3] A. H. Compton and H. Bethe, NATURE, **134**, 734 (1934).
[4] P. Auger, *J. Phys.*, **7**, 226 (1935).

Cosmic Rays and the Origin of Species

UNDER the above title, Dr. Hamshaw Thomas in a recent paper[1] has put forward the suggestion that the large variety of species and high percentage of endemics often found at high altitudes might be due to mutants which have been produced by irradiation with cosmic rays, the intensity of which is known to be much higher at great altitudes than at sea-level.

We wish to point out that this hypothesis is somewhat invalidated for the following reasons:

(1) It is known[2] that the rate of mutations induced by X-rays and similar agents (for example, β- and γ-rays of radium) is accurately proportional to the total ionisation per cubic centimetre of irradiated organic material. From this fact one derives without ambiguity the absolute value of the mutation rate induced by cosmic rays at any altitude in any species, if the X-ray induced mutability for this species is known.

(2) For *Drosophila melanogaster* and some other species (for example, *D. funebris*, *Zea*, *Antirrhinum*, barley) one finds that the number of mutations induced by cosmic rays should be at sea-level about 0·1 per cent, and at great altitudes about 3·0 per cent of the number of spontaneous mutations, and therefore negligible in comparison with the latter[3].

(3) We have no reasons to believe that other species would behave in a different manner.

In this connexion we should like to recall some recent conclusions of radiation genetics and mutation theory: (*a*) the spontaneous and induced mutation capabilities show far-reaching parallelisms[4]; (*b*) we have no reasons to believe that small amounts of radiation would show departures from the proportionality rule stated above; and (*c*) the origin of spontaneous mutation can be explained without an admission of special mutation-inducing agents in the external environment[5].

Thus, for the most interesting facts described and summarised in Dr. Hamshaw Thomas's paper, other explanations should be found. Without being able to discuss here in detail this problem, we believe that such explanations can be based on modern views concerning evolution in Mendelian populations (Fisher, Haldane, Morgan, Muller, Tschetverikov, Wright). Great altitudes in mountainous regions offer to the organisms extremely specialised conditions and a great variety of local biotopes. The latter favour the isolation and selection of specially adapted forms. Different mutations, serving as material for this evolution, are abundantly present (in heterozygous condition and in different concentrations) in every free-living population which is sufficiently large[6].

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[1] NATURE, **137**, 51 (1936).

[2] Citations in: Muller 1928, *Proc. Nat. Acad. Sci.*, **14** (1930); *Amer. Nat.*, **64**; Muler 1934, *Science of Radiology*, Springfield. Timoféeff-Ressovsky 1934, *Biol. Reviews*, 9. Timoféeff-Ressovsky, Zimmer u. Delbrück 1935, *Nachr. d. Ges. d. Wiss. Göttingen*, Fachgr. 6, N.F. Bd. 1, Nr. 13.

[3] Muller and Mott-Smith, *Proc. Nat. Acad. Sci.*, **16** (1930); Timoféeff-Ressovsky, *Erg. med. Strahlenforsch.*, **5** (1931); Efroimson, *Biol. Zentrbl.*, **51** (1931).

[4] Muller 1928, l.c.; 1930, l.c.; Timoféeff-Ressovsky 1934, l.c.

[5] Timoféeff-Ressovsky, Zimmer u. Delbrück, 1935, l.c.

[6] Timoféeff-Ressovsky, *Roux's Arch. Entwmech.*, **109** (1927); *Der Erbarzt*, **2** (1935); Tschetverikov, Verh. 5. Intern. Kongr. Vererb., Bd. 2 (1928); Dubinin and collaborators, *Biol. Zurn*, v. 3 (Russian) 1934; Gershenson, *Amer. Nat.*, **68** (1934); Gordon, *Amer. Nat.*, **69** (1935).

THE considerations put forward by Dr. Delbrück and Dr. Timoféeff-Ressovsky are of undoubted importance and were in my mind when my lecture was written. In fact, my suggestions were based on the parallelisms between induced variation and the so-called spontaneous mutations, together with the quantitative relation mentioned in Section 1 of their letter. But I consider that at present the view that "spontaneous mutation can be explained without an admission of special mutation-inducing agents in the external environment" is an assumption which has yet to be proved. The fact that more 'spontaneous' mutations occur than would be expected to result from natural radiation is not a final objection. For as Prof. Blackett pointed out[1] there are certain differences between the nature of the ionisation produced by cosmic rays and by gamma rays, so that it cannot be concluded that the effects of both, when of the same average intensity, are always identical. The differences are connected with the production of bursts and showers. We know that these occur at sea-level[2] and in water[3] while their frequency increases with altitude[4] more rapidly than the cosmic ray ionisation. Thus we are yet scarcely in a position to calculate the mutation rate due to cosmic rays from the X-ray data. Again, some plant species appear morphologically stable over long periods of time, while others are unstable. Apparently X-radiation may set up conditions causing unexpected variation in more than one successive generation of plants[5], and I think we may have to distinguish between the manifestation of genetic instability and its original cause.

The last paragraph of my paper made it clear, I thought, that I realise the importance of considering other modern views in explanation of the facts described.

May I here direct attention to the important considerations put forward by Prof. H. H. Dixon (NATURE, 125, 992; 1930), who originated the view which I tried to elaborate, since unfortunately this article was omitted from my list of references.

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[1] *Att. 1° Congr. Int. Elet. rad. biol., Venice* 1934, **2**, 1169 (1935).

[2] For references, see Hoffmann, Internat. Physics Conference London, 1934, **1**, 226; also Carmichael, H., *Proc. Roy. Soc.*, A (in press).

[3] Weischedel, *Phys. Z.*, **36**, 796 (1935). Clay and Clay, *Physica*, **2**, 1042 (1935).

[4] Montgomery and Montgomery, *Phys. Rev.*, **47**, 429 (1935).

[5] Prof. Goodspeed at Sixth International Botanical Congress, 1935.

Gases of War

IN NATURE of February 15, Mr. Arthur Marshall contributes an article on the "Gases of War" in which he says of mustard gas "attempts were made to work out a method of manufacture. This was found to be far from easy, and [*a*] no mustard gas of British or American manufacture was actually fired in the War. [*b*] The French were more successful, and in the last months before the Armistice their [*c*] 'yperite' was used by them and [*d*] the British, causing severe casualties to the enemy".

As very important implications involved in a correct appreciation of what actually happened are perhaps imperfectly understood, I shall be glad if space can be afforded to me to correct several misstatements in this short quotation.

As to (*a*), I have a letter of thanks from the War Office for the assistance rendered, stating that in storming the Hindenburg Line, the culminating feat of arms of the Great War, the mustard gas had been of great value, had caused heavy enemy casualties, and according to the accounts of German prisoners, had severely affected the enemy morale and assisted to break down their resistance. That will serve as proof that our mustard gas was actually used with effect on the enemy.

As regards (*b*), the statement that the French process was superior, or that the French were more successful, Colonel, now General Fries, then Chief of the American Chemical Warfare Service, in the course of a letter dated August 5, 1918, wrote to me: "Captain Pope, whom you met, is just leaving for the United States with the complete plans of your plant and process for manufacturing mustard gas. . . . Your process appears to be decidedly the best yet developed and if so is the one apt to be most generally used. I think you fully appreciate how tremendously important the early and extensive production of mustard gas is. The need for it is being emphasized every day on the present battle front, and anything that can be done to hasten by a few days the early production of this gas on a vast scale is worthy of the greatest effort and encouragement on the part of every one."

In 1921, three years later, Fries and West in "Chemical Warfare" (McGraw-Hill Book Co., Inc.) say, on p. 162, "The Chemical Warfare Service investigated carefully the three methods, German, French and English, and finally adopted the Levinstein process". After Capt. Pope's return to America in August 1918, a large 'Levinstein reactor' was installed at Edgewood Arsenal, and according to Fries and West (p. 155) also at Hastings-on-Hudson and Buffalo.

The 'reactor' at Edgewood Arsenal under the able direction of a team of very capable American chemical engineers worked smoothly from the start. Although none of the American product as opposed to the British was actually fired off, so far as I know, a large consignment was on the water at the time of the Armistice, and was eventually dumped in the sea. If the War had continued for a few weeks longer, large quantities of mustard gas from the Edgewood Arsenal would have been in the field.

As Capt. Pope only left England early in August with the plans, and formidable quantities had already been dispatched from Edgewood by early November, it is obvious that "the attempts made to work out a method" were astonishingly successful. Mustard gas is an unpleasant and dangerous material to handle. One drop on the skin is sufficient to cause a dangerous wound. The rapid mass production, under the skilled direction (of this I am a profound admirer) then available at Edgewood, shows the extraordinary efficiency of this process, a thing of the utmost significance in any war where gas is used.

The experiments upon which the process was based were commenced in the Blackley Research Laboratories, under the direction of Prof. A. G. Green, on April 30, 1918. Within three or four days he and his assistant, Mr. Oxley, evolved the laboratory method of making mustard gas, so simple and effective that I decided at once that with due precaution it could be carried out technically in a dyestuff factory without danger to others working therein. The first batch was made at Blackley on June 23; this was dispatched to the shell-filling factory at Chittering on June 25, and approved. From that date to the Armistice deliveries were regularly made.

Thus, only fifty-three days elapsed between the first laboratory experiment and the production of the first batch on a large scale. No such dangerous product had been manufactured before. Laboratory work had been carried out with the greatest speed. There was no previous experience to guide in the design of the plant. Elaborate arrangements for the protection of the workers and to provide against contamination of their clothing had to be made. Finally, within six months, at Blackley alone production dwarfing the German output was just becoming available. The speed and certainty with which the goal was reached was unexampled, save perhaps in some of the war work carried out in the German dyestuff plant.

On the day of the Armistice, I was watching the new giant 'reactor' turning out a stream of pale amber yellow *HS*, free from acid, stable and not liable to precipitate sulphur. A single such reactor could supply an army; a small battery of such reactors quickly erected, skilfully worked, could make ten times as much per day as the Germans made and used during the War.

The importance for defence of a sound dyestuff industry in war, because of the flexibility of the plant and the scientific and technical resources it must have, is now more generally appreciated. Certainly the Hartley report brought out most clearly the great value to Germany during the War of its large dyestuff factories. Yet to-day we have a Commission sitting to determine whether the private manufacture of arms or munitions of war should be permitted, or whether such manufacture should be restricted to the State.

Is it not clear that some factories engaged in industry, innocent of guile, are willy-nilly potential arsenals? You may succeed in avoiding future wars. You may succeed, as many people hope, in arranging that war, if war must come, should again be a field for adventure, honourable and romantic, fought with rules, which forbid killing or maiming your enemy except in certain prescribed fashions. All other methods would be excluded by international agreement, rather as the M.C.C. regulates the l.b.w. rule at cricket. But if, as may be, the discontent and envy and hatred endemic in Europe boils over one day, such factories, not alone dyestuff factories, may yet save civilisation.

The chemical industry in Great Britain hates war, and wishes only for peace, and the opportunity to carry out its creative work. The idea that it favours war for its own benefit is as preposterous as the suggestion that its work, if war did come, could be carried out as efficiently in *ad hoc* Government arsenals. In this connexion, readers of NATURE may care to know that the mustard gas (*HS*) supplied to the Ministry by Levinstein, Ltd., was supplied at cost. In fact, the cost of dismantling the plant contaminated with *HS* was such that the whole operations resulted in an out-of-pocket loss. The process and plans were freely supplied to the U.S.A. and to the Italians, who were going to put down a plant at Cenzo. In war time these peace plants which are potential arsenals have only the desire to help their country and to protect their countrymen. The idea of profits is remote. Looking back on events now eighteen years distant, this appears to me worth remembering, as it affects policy to-day.

HERBERT LEVINSTEIN.

Sand Hill,
Winslow,
Bucks.
Feb. 19.

[Mr. Marshall is at present travelling abroad, so any comments which he may wish to make upon Dr. Levinstein's letter must await his return. Editor, NATURE.]

Academic Freedom

THERE seems to me to be much confusion in recent discussions of this matter. Consider the following propositions :—

In respect of any opinion X and its contradictory Y, there are :

Some people (Class A) who should be allowed to express either X or Y ;

Some people (Class B) who must hold X if they are to perform their duties adequately (for example, cabinet ministers and surveyors, who should not be flat earthers).

Some people (Class C) whose duties involve impartiality so intimately that they should not express publicly either X or Y (for example, judges).

In Great Britain these propositions are accepted so widely that a dispute scarcely ever arises from their denial. It arises either because men do not act in accordance with their professions, or because there are differences concerning the bounds of A, B, C. The question of academic freedom here is how academic persons are to be classified ; the extreme view is that, in respect of *all* opinions, they ought to be placed in A.

In dictatorial countries the propositions are definitely denied, and classes A, B, C are not recognised. The only classes recognised are those (D) of persons who must publicly advocate X, and those (E) who may (not must) remain silent. Our conception of academic freedom, since it involves the recognition of A, B, C, does not arise. To urge a dictatorial government to create a class A in favour of teachers (and not, say, bus-drivers) is to invite them to add imbecility to intolerance ; it is simply ridiculous. If we are to persuade them to abandon intolerance, the less we say about *academic* freedom the better.

Actually opinions in Great Britain are not uniform about the classification of academic persons. Some people (of whom I am one) consider that, in respect of some opinions, they should be C, not A. Where there is a consensus of instructed opinion, and where they hold their post owing to the existence of that consensus, professors should not express personal opinions, except on the condition that they always and deliberately make the distinction clear. For example, I should like to see writers on popular science forbidden (by public opinion, not of course by law) to propagate insidiously opinions that they know to be rejected by persons equally qualified in science. For this reason, too—though I am as anti-dictatorial as any person can be—I think we should settle our own views on academic freedom before we try to enforce them on others.

NORMAN R. CAMPBELL.

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Feb. 9.

X-Ray Analysis of the Orthorhombic Crystalline Modification of 1 : 2 : 5 : 6-Dibenzanthracene

IN a recent paper[1], Krishnan and Banerjee have described a new crystalline modification of the carcinogenic hydrocarbon 1 : 2 : 5 : 6-dibenzanthracene. By means of optical measurements, they show that the crystals are different from the monoclinic variety already known and examined by means of X-rays[2]. In this laboratory similar crystals have been obtained in the way described by the above authors from a solution in ethyl acetate, and they have now been examined by X-rays. The crystals are exceptionally well developed, having more or less uniform dimensions in all directions and show brilliant faces.

The X-ray analysis confirms the conclusion of Krishnan and Banerjee that the crystals are orthorhombic bipyramidal, and the following dimensions have been found for the unit cell :

$$a = 8{\cdot}22 \text{ A.} ; \quad b = 11{\cdot}39 \text{ A.} ; \quad c = 15{\cdot}14 \text{ A.}$$

Assuming four molecules of $C_{22}H_{14}$ per unit cell, these values give a crystal density of 1·295, which is in good agreement with the observed value[1], 1·282. The axes have been named differently from those of Krishnan and Banerjee, so that the optical vibration direction γ is along c, and α along a, this arrangement being more convenient for comparison with other similar structures, and in this case the axes are crystallographically indistinguishable. The a, b and c of the above authors have been renamed b, c and a respectively. The axial ratios are, $b : c : a$ 0·752 : 1 : 0·543 compared with 0·755 : 1 : 0·546 given by Krishnan and Banerjee.

The observed halvings are $(0kl)$ when l is odd, $(h0l)$ when h is odd and $(hk0)$ when k is odd. The space group is therefore $Q_h^{15} - Pcab$. It is interesting to note that in this space group with four molecules per unit cell, the molecules can possess only a centre of symmetry, whereas in the case of the monoclinic variety[2] there are two space groups available, in one of which no molecular symmetry is necessary and in the other the molecule can possess either a centre or a plane of symmetry.

As regards the molecular orientation which has been deduced by Krishnan and Banerjee[3] from measurements of magnetic and optical anisotropy, one can only say at this stage of the analysis that the intensity of reflections observed seems to support their conclusions that the length of the molecule is perpendicular to the (001) plane and its width inclined to the b axis.

I am indebted to Prof. J. W. Cook for supplying a pure specimen of the substance.

JOHN IBALL.

Research Institute,
The Cancer Hospital (Free),
London, S.W.3.
Jan. 8.

[1] *Z. Krist.*, **91**, 170 (1935).
[2] Iball and Robertson, NATURE, **132**, 750 (1933).
[3] *Z. Krist.*, **91**, 173 (1935).

Relation between the Toxicities and the Boiling Points of Related Substances

IN attempts to relate the toxicity of physiologically active substances to their chemical constitution or physical properties, it has been the custom to use as comparative indexes of toxicity the numerical values of the molar doses or concentrations producing equal physiological effects. It is well known that the degree of physiological response to different doses or concentrations of the same substance, in many cases at least, varies directly as the logarithm of the dose or concentration applied. Hence, when the toxicities of different substances are being compared, it would appear probable that the use of the logarithms of equi-effective molar doses is more likely to yield quantitative relationships between toxicity and, say, physical properties than the simple numerical values.

Following Moore's work[1] on the toxicities of many volatile organic compounds to house flies, it has been generally recognised by entomologists that there is at least a rough negative correlation between the toxicity of a substance and its volatility. Toxicity generally increases with increasing boiling point in a homologous series until the volatility becomes so slight that the toxic concentration cannot be attained.

Now, if instead of the numerical values of molar lethal doses to insects of related volatile compounds the logarithms of these are taken, it will be found that an exact linear relationship frequently exists between the boiling point at atmospheric pressure and these logarithmic values.

This is well shown by some work recently completed in this laboratory by M. D. Price on the action of the vapours of the chlorinated ethylenes on grain weevils (*Sitophilus granarius*). Ten points on the characteristic mortality curve were determined usually for each substance, 30–100 weevils being used for each point. The median lethal doses in 5 hours' exposure for the five chlorinated ethylenes used, expressed as millionths of a gm. mol. per litre of air, are given in the following table.

Substance	M.L.D.	B.P. ° C.	k
Unsym. Dichlorethylene	5,990	37	—
trans ,,	4,340	48·4	0·0123
cis ,,	3,090	60·3	0·0123
Trichlorethylene	1,450	86·7	0·0124
Perchlorethylene	550	120·8	0·0124

The fourth column gives the increment in the logarithm of the toxicity in passing from the first member of the series to each of the others divided by the corresponding increment in boiling point. The constancy of this quotient indicates the exactness of the linear relationship between boiling point and the logarithm of the toxicity in this case.

Examination of various data in the literature reveals the existence of this linear boiling point relationship in the most diverse cases. Examples are to be found in Tattersfield and Roberts' determinations of the lethal doses of aliphatic and aromatic hydrocarbons and of halogen substituted benzenes for wire-worms[2], Fühner's results for the isonarcotic concentrations of pentane, hexane, heptane and octane for white mice[3], Fühner's work on hæmolytic action on red blood corpuscles of solutions of the alcohols from methyl to octyl[4], Batelli and Stern's observations on the effect of the alcohols on the precipitation of nucleo-proteins in the liver[5], Wirgin's determinations of the equal disinfectant concentrations of the alcohols[6], Czapek's observations on the influence of alcohols on the osmosis of tannins from plant cells[7], etc.

Other characteristic constants closely related to the boiling point, such as the molecular heat of evaporation at the boiling point or the critical temperature, will, of course, also yield a linear relationship if substituted in place of the boiling point.

When a homologous series or a series of substituted derivatives of a parent substance shows this linear relationship between boiling point and acute toxicity, it may be suggested that the effect of the substituent groups is a purely physical one in that their substitution increases the 'availability' of the toxic grouping of the parent substance—possibly by increasing its adsorbability. The existence of this relationship should therefore enable physical effects to be disentangled from true absolute toxicity, which is presumably directly determined by chemical constitution. Tattersfield and Roberts' observations on the effect of benzene and substituted halogen derivatives of benzene on wire-worms exhibit the relationship. Hence it may be concluded that halogens when substituted in the benzene nucleus are not themselves toxic groups, but merely increase the availability of the toxic benzene ring. It may also be significant that when the logarithms of the molar lethal doses of tetrachlorethane and of the aliphatic hydrocarbons to wireworms are plotted against the boiling points, the points lie on the same straight line.

To elucidate this question further the study of the toxic action of a number of homologous series is now in progress.

J. FERGUSON.

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Castner-Kellner Research Laboratory,
Runcorn.
Jan. 20.

[1] *J. Agr. Res.*, **9**, 371 (1917).
[2] *J. Agr. Sci.*, **10**, 199 (1920).
[3] *Biochem. Z.*, **115**, 235 (1921).
[4] *Archiv. f. exper. Pathol. u. Pharmakol.*, **56**, 333 (1907).
[5] Hefter's "Handbuch der Experimentellen Pharmakologie", 460 (1923).
[6] *ibid.*, 375 (1923).
[7] *ibid.*, 460 (1923).

Verification in Mice of the Possibility of more than Fifty per cent Recombination

EXTENSIVE data in *Drosophila* and maize show that the recombination fractions between two loci in the same chromosome increase at first nearly proportionally to the map distance, but tend for very high map distances to a limiting value, not exceeding 50 per cent. With other organisms only two cases of a greater apparent frequency seem to have been claimed, namely, a case reported by Wellensiek (1929) in *Pisum*, and one by Clausen (1926) in a *Viola* hybrid.

It is widely recognised, as Emerson and Rhoades (1933) point out, that with crossing over in a four strand stage, recombinations exceeding 50 per cent would be impossible in the absence of chromatid interference; in particular, unless the strands crossing over at one chiasma were for this reason less likely to cross over at a second chiasma in the same chromosome. An unequivocal case of recombination exceeding 50 per cent provides, therefore, a definite proof of the existence of chromatid interference.

In 1934 it was decided to carry out an extensive linkage test with mice at the Galton Laboratory. Among other factors those for the well-known colour difference 'dilute', and for the hair character 'wavy', discovered by Crew, were included. It was intended to breed 1,000 back-cross mice from males heterozygous in six factors. The experiment is now nearing completion, and it appears certain that wavy and dilute show a recombination fraction exceeding 50 per cent.

Out of 1,014 mice classified up to the present, 554, or 54·6 per cent, have proved to be recombinations for these factors. The standard error is 1·570, so the deviation from 50 per cent exceeds the standard error in the ratio 2·952.

Of these 1,014, 354 were the progeny of males having the two factors in coupling, and 660 of males in repulsion. The coupling progenies gave 191 recombinations (54 per cent), and the repulsion progenies 363 recombinations (55 per cent).

The significance of this evidence for more than 50 per cent recombinations may be further tested by calculating χ^2 from the following 2×2 table :

	Recessive in one factor only	Recessive in both or neither	Total
Repulsion	297	363	660
Coupling	191	163	354
Total	488	526	1014

$\chi^2 = 7 \cdot 401$.

The probability of getting so great a disproportion as measured by χ^2, with one degree of freedom, is less than 1 per cent, actually about 1 chance in 150 trials.

This method of testing the significance of the results is particularly valuable, as the resulting χ^2 is independent of any deviations of the single factors from the expected 1 : 1.

The evidence for more than 50 per cent recombinations is strengthened by the uniform behaviour of the 5 different types of buck used. Two of these (α and β) have dilute and wavy in repulsion. The remaining three types were in coupling.

Type of male	No. of males	Total offspring	Recombinations	Recombinations (per cent)
α	8	375	210	56·0
β	7	285	153	53·7
γ	1	133	69	51·9
δ	1	22	14	63·6
ω	8	199	108	54·3
Total	25	1014	554	54·6

All classes of buck agree in showing more than half of their progeny as recombinations.

One inconvenient consequence of recombinations exceeding 50 per cent is that in any chromosome in which they occur there must exist regions with recombinations so close to 50 per cent that no direct test can detect the difference. Tests of linkage with chromosomes having only a single marking factor must sometimes, therefore, fail ; this consideration adds greatly to the importance of including as many factors as possible simultaneously in making linkage tests.

R. A. FISHER.
K. MATHER.

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REFERENCES :

J. Clausen, "Genetical and Cytological Investigations on *Viola tricolor* L. and *V. arvensis* Murr.", *Hereditas*, **8**, 1–156 (1926).

R. A. Emerson and M. M. Rhoades, "Relation of Chromatid crossing over to the upper limit of recombination percentages", *The American Naturalist*, **67**, 374–377 (1933).

S. J. Wellensiek, "The Occurrence of more than 50 Per Cent. Crossing Over in Pisum", *Genetics*, **11**, 509–518 (1929).

An Active Group of Sunspots and Unusual Conditions in the Ionosphere

IN NATURE of February 22, p. 311, a short account was given of an active group of sunspots which had been under observation at the Royal Observatory, Greenwich, with the Hale spectrohelioscope. The date of the central meridian passage of the centre of the group of spots was February 14·0, and some hours later a bright eruption, of major importance, visible in the hydrogen line, $H\alpha$, was observed from its first rapid development at $12^h\ 39^m$ to its termination about $13^h\ 27^m$ U.T.

It is of considerable interest that the Director of the Radio Research Station of the National Physical Laboratory has stated on inquiry from the Royal Observatory that there was a marked diminution of reflection from the ionosphere over a very wide area for a period of twenty minutes centred on $15^h\ 30^m$ on February 14.

At this time the Greenwich (Abinger) magnetic traces show general unsteadiness, but not to an unusual extent. On February $16^d\ 11^h$, however, a disturbance commenced which, although not prolonged or extensive, was characterised by some rapid movements in the horizontal force trace.

The facilities for observing solar eruptions on the disk have been greatly extended by the use of spectrohelioscopes devised by Dr. G. E. Hale, which are now installed at a number of observatories around the world. The effective use of these instruments, with respect to a daily watch kept throughout the twenty-four hours for solar eruptions, has recently been increased by a programme of observation organised by Commission 11 of the International Astronomical Union.

It may be expected that the next few years will yield a number of opportunities for testing any relationship that may exist between bright solar eruptions and distinctive conditions in the ionosphere, of which a hint is possibly given by the recent phenomena of February 14.

H. W. NEWTON.

Royal Observatory,
Greenwich.
Feb. 24.

Manufacture of Humus by the Indore Process

ON page 286 of the issue of NATURE of Feb. 15, in an article under the above title reviewing a recent lecture which was printed in full in the *Journal of the Royal Society of Arts* (Nov. 22, 1935), several sweeping statements relating to quality in plant and animal products and to immunity to disease are attributed to me. I made none of these statements. I never used the word immunity. The last section of my lecture dealt with the urgent need for the study of the factors on which quality and resistance to disease depend. My agricultural experience of nearly forty years in four continents has convinced me that quality in plant and animal products, as well as disease resistance in crops and live stock, are the natural reward of properly nourished protoplasm, and that *one of the factors* on which quality and disease resistance depend is an adequate supply of humus, prepared from vegetable and animal residues, in the soil. There are, of course, many other factors involved, such as the variety or breed, correct cultivation and management, the maintenance of the right condition of the soil, proper feeding, and suitable methods of plant and animal hygiene. This was the view set out in my lecture, and no other.

ALBERT HOWARD.

14 Liskeard Gardens,
Blackheath, S.E.3.

IN the article to which Sir Albert Howard refers I was endeavouring to give an outline of the argument put forward in his lecture ; that argument was that more humus in the soil would (in conjunction with other favourable factors) produce a quality in crops which would make animals more resistant to disease.

Thus, on p. 28, we read ". . . we as a nation are spending large sums every year on the study of the

diseases of our livestock—such as tuberculosis and foot-and-mouth disease—in the vain hope that laboratory science will find a remedy for what common sense should prevent. The microscope and the methods of Pasteur and of his successors can never hope to achieve a permanent and effective cure of such diseases. The cause lies much deeper than anything which is likely to be ascertained in the laboratory. It is in all probability malnutrition following closely in the wake of long-continued mismanagement of the land".

It is true that I introduced the word "immunity", but, remembering that it carries only a relative meaning, I feel that it was justified, though, perhaps, "resistance" would have been better.

THE WRITER OF THE ARTICLE.

Heidelberg, Spinoza and Academic Freedom

IN the issue of February 22, under the above heading, a correspondent writes that a visitor to Heidelberg on June 30 of this year may celebrate the events associated with that day (familiarly known as the 'clean up') simultaneously with the 550th anniversary of the foundation of the University. He has, however, fallen into the same error as the Rector and Senate of Germany's most ancient seat of learning. June 30, 1936, is the anniversary of the 'clean up' which established more firmly the present dictatorship in the German Reich and its dependant universities, but the academic year 1935–36 is not the 550th but the 549th from the foundation of the University of Heidelberg.

On October 23, 1385, a charter was issued to the Elector of Palatine by Pope Urban VI for a "Studium generale"—the old term for a university—at Heidelberg. The first session began on October 19, 1386, and the first academic year then opened.

Thus for purposes of celebrating a jubilee—a custom of Hebrew origin—three choices were open: (*a*) October 23, 1935, or near date, being the 550th anniversary of the issue of the Charter; (*b*) October 19, 1936, or near date, being the opening of the 550th academic year; (*c*) June 1937, or near date, being the end of the session 1936–37 and the completion of the 550th academic year.

June 27–30, 1936, has no relation to any of these dates. June 30 is, however, the anniversary of the firmer establishment of that regime on which depends the University of Heidelberg, as now constituted.

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Points from Foregoing Letters

DRS. O. R. FRISCH and G. Placzek state that they have carried out experiments with boron and cadmium in order to determine whether, as suggested by theory, the capture cross-section for slow neutrons is inversely proportional to their velocity. From their experiments it appears that cadmium, though a very efficient absorber for neutrons of thermal energies, becomes almost transparent for neutrons of energies not higher than one volt; their results, together with those recently obtained by Rasetti, indicate that the capture probability in cadmium has a maximum between 1 volt and 0·03 volt.

New and more accurate values for the atomic masses of carbon, helium and of light and heavy hydrogen are submitted by Dr. F. W. Aston. These were obtained by means of his new mass-spectrograph, from observations on doublets (atoms and groups of atoms having nearly the same mass/charge ratio).

The energy and the sign of the electrical charge of the more penetrating components of cosmic rays have been determined by L. Leprince-Ringuet from the curvature of the ionised tracks obtained in a large expansion chamber, placed in a powerful magnetic field (13,000 gauss). The results agree with the assumption that the more penetrating cosmic rays consist of both positive and negative electrons and of protons.

Objections to the thesis developed by Dr. H. H. Thomas, that the greater variety of species at high altitudes may be related to the greater intensity of cosmic rays there, are raised by Drs. M. Delbrück and N. W. Timoféeff-Ressovsky. From the known rate of mutation induced experimentally in fruit-flies by X-rays, also beta and gamma rays, they suggest that only a small percentage of the naturally-occurring mutations could be accounted for by cosmic ray action. Dr. H. H. Thomas, while not denying that other factors may be responsible for natural mutations, points out that there are essential differences between X-rays and cosmic rays (for example, the ability of the latter to produce 'showers') and consequently the effect of cosmic rays cannot be deduced quantitatively from that of X-rays.

Commenting upon the recent article on "Gases of War", Dr. H. Levinstein brings evidence showing that mustard gas was successfully manufactured in England during the War and that the British process was adopted in America in preference to the French or the German.

Dr. Norman R. Campbell analyses the meaning of 'academic freedom'; he considers that academic persons should not publicly express themselves on certain disputed matters in which a neutral judicial attitude may be expected of them.

The X-ray structure of the orthorhombic variety of the cancer producing substance 1 : 2 : 5 : 6-dibenzanthracene is described by John Iball.

Dr. J. Ferguson finds that, if the logarithms of the molar doses producing equally intense physiological responses are used as the basis of comparison, an accurate linear relationship holds between the boiling points of series of related volatile compounds and their logarithmic indexes of toxicity. The existence of this relationship in a series of substances is taken to show that the members of the series differ from each other only in 'toxic availability' and not in absolute toxicity.

Experiments with one thousand mice having inheritable characters attributed to genes of known positions in one of their chromosomes have given offspring with characters showing more than 50 per cent crossing-over (separation of characters so that they no longer occur together). The existence of such 'recombinations' in excess of 50 per cent is, according to Prof. R. A. Fisher and Dr. K. Mather, definite proof of chromatid interference.

Research Items

Ethnology and Linguistics in New Caledonia

THE first attempt to record in writing the language of Houaïllou was made some thirty-five years ago by a Loyalty islander, who wished to convert the New Caledonians to Christianity, and introduced the notation current in his own islands. The language has now been recorded and studied by M. Maurice Leenhardt ("Vocabulaires et Grammaire de la Langue Houaïllou", *Trans. et Mém. de l'Inst. d'Ethnologie, Univ. Paris*, 10, 1935, pp. 412. 125 fr.). Methods of speech have some interesting peculiarities. Tone as a rule shows little variation in pitch, this tendency being accentuated by the method of delivery. In formal oration the speaker endeavours to utter as many words as possible without taking a fresh breath. Not only does this cause a low monotonous pitch, but both in speaking, and more markedly in singing, leads to a concentration of syllables on one note. In singing, syllables and notes do not correspond; while any system of scansion becomes difficult. In conversation, on the other hand, great use is made of mimetic gesture, especially with the eyes and lips, and the words tend to follow the gesture. Thus in superlatives, the words are long drawn out, while a rising whistling sound, as it were expressing a 'parabola', is half-way between speech and gesture. To express both direction and distance the eyes and lips are brought into play. Sometimes, the words even are suppressed when the muscles of the mouth alone are used to express direction. Hands, feet and limbs are used to enforce a multitude of details. The vocabulary has been recorded very fully, not merely as a word-list but with a multitude of details relating to the sociology, religious beliefs and culture of the people. For example, *Asēcui*, "to mention in terms of respect", is used, it is explained, when a sister speaks to someone of her brother, in order that his name may not be profaned; while *Koawana*, the gift to an uncle, means "the end of a journey", because every social relation ends in a gift to the maternal uncle.

Fish Hooks from Dogs' Jaws and Teeth

THE skill with which the Maori fashioned apparently unsuitable bones into barbed fish-hooks is well shown in the Oruarangi collection in the Auckland Museum. In his description of the collection, V. F. Fisher describes and illustrates the processes by which the lower jaw of the native dog was carved to form a long point, the coronal process becoming the barbed tip (*Rec. Auckland Inst. and Mus.*, 1, 287; 1935). Shanks as well as points were made from the lower jaw-bone. The adaptation of individual teeth as points would appear to be a simpler process, and dog-tooth hooks are three times as numerous as dog-jaw hooks in the collection. The majority of these are carved from canine teeth, but there is a clever example of one worked from a premolar tooth, the two roots of which become the tip and the shaft of the hook. Remains of few other animals were used in making these Oruarangi fish-hooks; one was from the tooth of a whale, one from the margin of a shell (*Cookia sulcata*), but there was no trace of the use of the bones of Moas, although in other districts these were often made into one-piece fish-hooks.

Birds of Malaysia

THE Raffles Museum at Singapore, which is adding consistently to the knowledge of the fauna of a region of great zoological interest, has published a hand-list of Malaysian birds (Bull. No. 11, Dec. 1936, 389. 21*s*.). This systematic list, compiled by F. N. Chasen, director of the Museum, includes the birds of the Malay Peninsula, Sumatra, Borneo, Java, and the adjacent small islands, and gives scientific and English names, and, in the case of each species or variety, such synonyms as were known, and a summary of the distribution. In addition to the list, the author, in an introduction of twenty pages, gives an account of the zoogeographical relationships of the bird fauna, and suggests that instead of the usual explanation of the peculiar affinity between Java and the Indo-Chinese sub-region, namely, that it is due to complicated changes in land-surfaces, a simpler explanation should be sought in the tendency of many migratory birds to become differentiated as resident species in the southern parts of their range.

Food of Fossil Fish

THE delicacy with which fossil structures may be preserved when the preserving material and other conditions are favourable is well shown in a fossil fish in the Geology Museum of the University of Melbourne. It is a specimen of *Spaniodon elongatus*, a herring-like fish from the Upper Cretaceous chalk of Mount Lebanon. But clupeoids of the sub-family to which *Spaniodon* has been attached feed upon plankton, whereas this fossil fish has a few large teeth in the front of the mouth, and within its body (to all appearance) lie a small undigested fish and other contents of the food canal (E. S. Hills, *Proc. Roy. Soc. Victoria*, 48 (N.S.), 50, Dec. 1935). The stomach seems to have been a simple sac, the intestine relatively small and straight with only a few small loops. If the interpretation of the fossil is correct, the difference in feeding habit is sufficient to exclude *Spaniodon* from the sub-family to which Boulenger in 1907 attributed it.

Regeneration in *Sabella pavonina*

THE polychæte worm *Sabella pavonina* is fast being established as a favourite experimental animal that is likely to prove of much assistance in the elucidation of several fundamental problems of development. The comparative readiness with which it will regenerate head and tail ends from practically all levels, with often concomitant reorganisation of parapodia from abdominal to thoracic type, renders it excellent material for the investigation of regeneration phenomena. Work by Prof. N. J. Berrill had directed attention to what appeared to be a manifestation of a definite organiser action of the regenerated head end, that acting on original abdominal segments caused a change over in the form of the parapodia so that they came to resemble those of the thorax. F. Gross and J. S. Huxley have followed up this interesting observation and in an important paper (*Archiv Entwick. Organ.*, 133, 582–620; 1935)

record the manner in which numerous pieces of *Sabella*, cut from all parts of the body in a variety of ways, have developed new tissue. They describe several cases of regeneration that are of a kind not previously obtained, but which are of much importance in that they seem definitely to render the organiser theory untenable, at any rate so far as it concerns *Sabella*. They go further than this, however, and suggest that it is now advisable to reinvestigate those cases of reorganisation in invertebrates, especially planarians and cœlenterates, that have hitherto been attributed to the action of a 'distance organiser'. For *Sabella* they put forward a hypothesis based on the knowledge that in polychæte regeneration extensive migration of tissues—especially epidermis—from neighbouring segments, towards and into the regenerate, occurs. They suggest that this migration changes the physiological condition of abdominal parapodia, leading to their degeneration and initiating a process of 'alternative differentiation' whereby they are replaced by new parapodia of thoracic type.

Influence of Season on Photosynthesis

BOTH ecological and physiological considerations are raised by the investigations of Dr. B. N. Singh and Mr. K. Kumar, of the Institute of Agricultural Research, Benares Hindu University (*Proc. Indian Acad. Sci.*, 2, No. 5, November 1935). Radish plants of one selected strain were used, and the photosynthetic activity of leaves of comparable age was measured on plants of successive crops, resulting from fortnightly sowings of carefully selected seeds of standard weight. The general result was to show photosynthetic activity under these tropical Indian conditions, at a maximum during the winter conditions (April), then declining as the summer season commences, the lowest ebb of activity being in June. With the onset of the rains, the assimilatory activity rises once more to a second maximum in September–October, as the winter sets in. These interesting results are fully analysed; features of interest are a correlation of the lower summer activity with a lower water and chlorophyll content. Dry matter and total leaf area are greater in winter; possibly another factor contributing to greater carbon assimilation then may be a wider stomatal aperture associated with the higher water content.

Frequency of Cutting and Yield with an Australian Grass

BULLETIN No. 66 of the Council for Scientific and Industrial Research of the Commonwealth of Australia, by Messrs. A. E. V. Richardson, H. C. Trumble, and R. E. Shapter, illustrates very beautifully the delicate balance of factors that have to be considered in establishing useful permanent pasture under semi-arid conditions. In the Australian zone of winter rainfall and summer drought, *Phalaris tuberosa* has received particular attention at the Waite Institute, as it seems well adapted to form a sward where the annual rainfall is more than eighteen inches, with a winter incidence associated with a periodic summer drought. Similar climatic conditions are found in Cape Colony, portions of South America and California and in the Mediterranean countries to which this grass is indigenous. The problem is, however, to find the extent to which this grass can be cut or grazed and yet maintain a satisfactory turf. With a single cut at maturity, the nutritive value of the herbage was poor. With more frequent cuts, the nitrogen value and the phosphate in the herbage cut rose rapidly; towards maturity this was not lost but migrated towards the base of the plant, so that repeated cutting rapidly reduced the storage in the underground stolons and roots. The general result was to conclude that three cuts a year is the best system if *Phalaris* is to give a permanent sward under Australian conditions. Another point of interest in these observations is that though nitrogen and phosphorus simply migrated to the base of the plant towards maturity and were not lost, potash at this time was rapidly lost to the soil, possibly by diffusion from the root system when physiological activity ceases.

Geology of Northern Rhodesia

A CONTRIBUTION by W. C. Hatfield to the geology of the Solwezi District of Northern Rhodesia, south of the Congo-Zambezi divide, was communicated to the Geological Society at its meeting on January 29. The area described forms part of the Central African Plateau, and is composed of folded and faulted Basement to Kundelungu rocks, truncated by a late Mesozoic peneplane which is now in the early stages of a new cycle of dissection. An original consequent drainage has been rejuvenated by a change in climate, possibly accompanied by uplift, resulting in superposition and modification by piracy. The crystalline Basement rocks are intruded by basic and granitic rocks. After a period of orogeny, the younger Mine and Kundelungu sediments were deposited. Gabbroid rocks were intruded into these and were followed by late-stage solutions which scapolitised the sediments, turned the gabbro into epidiorite and chloritised the Basement schists. In addition to the marked orogeny at the end of Kundelungu times, there is evidence of diastrophism following the deposition of the Mine Series, since the Kundelungu beds lie unconformably on the latter. The Solwezi area is situated on the southern limb of the Katanga geosyncline. Thrust faulting and overturned folding have resulted in a regional west-north-west strike and a northerly dip. The area is near the nose of a mass which moved northwards, compressing the southern side of the geosyncline into an arcuate belt of folds curving east-and-west around Northern Rhodesia.

Bababudanite (a Soda Amphibole)

IN 1907 a soda amphibole was discovered by Iyengar in the banded ferruginous quartzites of the Bababudan Hills of Mysore. Smeeth considered it to be a variety of riebeckite, and gave it the name 'bababudanite'. In the *Geological Magazine* of January, C. S. Pichamuthu gives a full account of the physical, chemical and optical properties of this mineral. The new analysis corresponds to the formula $4NaFe'''(SiO_3)_2.2FeSiO_3.3MgSiO_3$. Hitherto, bababudanite has been considered as an original mineral of basic igneous rocks which by reconstitution due to metamorphism yielded the iron and silica of the banded ferruginous quartzites. As a result of his field-work, Pichamuthu finds that the mineral is confined to narrow zones which are always at the immediate contact of epidiorite dykes. It is therefore itself a product of contact metamorphism and has nothing to do with the origin of the ironstones. An analysis

of bababudanite-magnetite-schist agrees well with analyses of amphibole-magnetite rocks occurring as intercalations in the Lake Superior banded iron-stones, except that soda is present to the extent of 2·60 per cent, whereas the American examples are free from soda. Pichamuthu considers this soda to have been derived from spilitic basic rocks which he regards as one of the sources of the sediments. It is worthy of consideration, however, that the soda may have come from the epidiorite magma, since there is no indication of the occurrence of soda-bearing minerals in the banded ferruginous sediments away from the bababudanite contact zones. The latter would then constitute an interesting case of soda metasomatism.

Seasonal Variation of Daylight

THE average value of the daylight illumination to be expected at any given time of the day at different seasons of the year is of interest to the architect and to the householder. Owing to meteorological conditions, the illumination varies largely, and so the average value can only be obtained by making observations over a period of years. The average results of measurements for each month for the whole sky and for each quarter of the compass, obtained from observations taken at the National Physical Laboratory at Teddington and extending over ten years, are given in a report by the Department of Scientific and Industrial Research (Illumination, Technical Papers, 17. London: H.M. Stationery Office). The results show that the light from the whole sky is about eight times as great at 9 a.m. on a June or July morning as on a January morning. The average June noon is four to five times as bright as a December or January noon, and at 3 p.m. the illumination is nearly ten times as great in June as in December. In January the average illumination in foot-candles from the whole sky is 405 at 9 a.m., 850 at noon and 390 at 3 p.m. The report only gives the results of measurements made at Teddington, but measurements in other localities are being initiated. More detailed results are expected, as a photo-electric cell is now being used.

Measuring the Resistivity of the Earth

IN practical electrical work it is often very advisable to know the electrical resistivity of the earth in the neighbourhood of electric stations, cables, etc. Various methods of doing this are used, but the 'search coil' method used by Dr. J. Collard (*J. Inst. Elec. Eng.*, Jan.) is novel, and as it agrees roughly with other methods and can be used over a wide area, will be of value. The method consists in the measurement of the E.M.F.'s induced in a search coil placed at various distances from an earth-return circuit carrying alternating current. A set of curves is computed by theory for various values of the resistivity, and the one which passes through the experimental points gives the average resistivity. When a power transmission line exists in the neighbourhood of the site where the resistivity is to be measured, one of the harmonics of the line can be used as the inducing current. The method has been used to measure the resistivity of the earth at various places in England and Italy. The results obtained are given, together with particulars of the geological formation of the sites that have been measured. The resistivity is least for alluvial soils, varying between 200 ohms and 400 ohms per cm. cube; that of clay is about three times as much, while the value for coal-bearing measures and chalk is about fifteen times as much. Sandstone varied between 6,000 ohms and 10,000 ohms per cm. cube and igneous rocks between 50,000 ohms and 100,000 ohms. A map is given showing how the resistivity varies in different parts of England.

The Corona Loss on Overhead Wires

IN very high tension systems for the electric transmission of power, the overhead wires are sometimes surrounded with brush discharges, generally called coronæ, which appreciably increase the transmission losses. To prevent this loss, the overhead wires might be insulated with insulating material of high electric strength. Provided the thickness of the covering is very small and its thermal conductivity sufficiently high, the wires may actually carry a greater current for the same rise in temperature. In addition, a higher voltage can be applied without any appreciable corona forming. In *World Power* of January, the effect of the humidity of the air on the corona loss on wires is considered. It was found experimentally that the corona loss increases slowly until the humidity exceeds 80 per cent, when it increases rapidly, and very rapidly when it approaches the dew point. With pressures of 100 kv. and 120 kv., the losses were found to be 3·6 kw. per km. and 11 kw. per km. respectively. When the surface was coated with shellac or paraffin, the loss increased very slowly at first as the voltage was increased, and then in the region of 132 kv. it increased rapidly and seemed to be almost independent of the humidity. It was found that the effect of the humidity on the corona losses of a conductor was less after the wire had been left to 'age' in the open air for some time. When the surface was treated with shellac and the humidity was 89 per cent, it was found that the losses at 120, 130 and 135 kv. were 0·6, 2·2 and 5·1 kw. per km. respectively.

Observations of Nova Herculis

RESULTS of observations of Nova Herculis 1934 are still appearing. In No. 4 of the *Mitteilungen der Wiener Sternwarte*, K. Graff publishes observations of brightness from December 1934 up to April 1935. More than 800 photometric observations, together with about a hundred visual observations, made both with optical apparatus and with the naked eye, were secured at the Vienna station in Mallorca. Magnitudes are reduced to the Revised Harvard scale. In the same volume, H. Krumpholz gives a reduction of the results of sixty-five observers to Graff's scale. This discussion embraces a great wealth of observational material. Again, in the same volume, K. Graff describes measurements of the colour of the Nova from over the same period (December to April). Measurements were made on a colour-wedge. The observed colour ranged from that of stars of type *A*0 to that of stars of type *G*0. The colour curve so obtained is complete, but, as the author points out, the presence of strong emission lines in the Nova spectrum deprives the observations of the simple physical meaning enjoyed by the colour temperatures of the continuous spectrum of the star apart from the emission lines.

Racial History in India

FOR the first time since 1901, the report on the Census of India includes a volume of ethnographic appendixes*. It is a welcome, and as those who are familiar with the earlier volumes of the report will agree, a very necessary addition, at least in so far as it deals with the question of racial distributions.

Of the two parts into which the volume is divided, the first contains the report on the somatic affinities of the tribes and castes of India as shown in the series of measurements which have been taken from time to time by Dr. B. S. Guha, anthropologist of the Zoological Survey. This report is of no little moment to the anthropologist. It restates the racial problem of India in the light of the most recent research; and not only does it review the evidence afforded by recent investigation in the prehistory of India, especially with reference to the composition of the calcholithic population of the Indus valley, but it also advances evidence against certain of the racial theories put forward by Sir H. H. Risley a generation ago, which, in a general sense, have held the field ever since.

Dr. Guha's investigations occupied from 1930 until 1933, during which period he toured the greater part of Central, Western and Southern India, and visited selected areas in the north and east, covering in all some ten thousand miles. Thirty-four racial groups were examined, of which fourteen were Brahmin, sixteen belonged to various Hindu castes, and four groups were tribal. The objective of the examination was to obtain particulars of the somatic characters of the Brahmins with the castes next in order of precedence, and of the so-called lowest castes and the major aboriginal groups in the survey. This distribution of inquiry, it was thought, would reveal the racial types present among the highest and the lowest classes of the Indian population, and the extent of intermixture between (*a*) Brahmins and the upper classes of the rest of the population, and (*b*) between the latter and the aboriginal tribes. The method of investigation followed has been by extraction of the reduced coefficients of racial likeness.

Dr. Guha discusses his material in detail in groups constituted on the basis of topography and the known history of the country. This analysis contains much material in highly condensed form bearing on the special problems of the inquiry. For details reference must be made to the original. Here it is not proposed to do more than mention briefly the main conclusions relating to racial classification and racial history.

Three elements are discerned in the racial composition of the peoples of India:

(*A*) A short-statured, long-headed element, with high cranial vault, faintly marked orbital ridges, and broad, short, orthognathous face, with medium lips and a prominent, long nose, having moderately spread alæ, the skin-colour varying from light brown to dark tawny, the hair being black, straight inclined to wavy, and moderate in amount on both face and body. This is the predominant type in the greater part of the lower stratum of the population of Northern India, including to some extent the Punjab.

On this basic substratum there appears to have been imposed the two following:

(*B*) In the western littoral and Bengal, a brachycephalic element of medium stature, with flattened occiput, but having also a high head and, not infrequently, a receding forehead. The face is short and orthognathous, but broader than in (*A*). The nose is long and highly pitched, but quite often arched and convex. The skin-colour varies from pale white to light brown. A small percentage has light eyes and a small proportion has dark brown hair. The hair is generally straight and the pilous system well developed.

(*C*) In Northern India, a long-headed strain with a comparatively lower but longer head, and tall stature. It has a long face and long prominent narrow nose. In its purest form it is found among Kaffirs and Pathans, where the skin-colour is predominantly rosy white, and an appreciable number have grey-blue eyes. In the plains of Northern India, among Sikhs of the Punjab and Brahmins of the United Provinces, the skin-colour changes to a transparent light brown. Here too a few have light eyes and brown hair. The pilous system is well developed.

Type *A* may be a south-eastward drift of a very early type of modern man, which reached India in very early times, while *C* may be a late drift from the north-west.

In addition to these three types, the aboriginal population discloses four types:

(*D*) A short, long- and moderately high-headed strain, with strongly marked eyebrow ridges, hair that varies from wavy to curly, and a skin that is dark chocolate brown, approaching black. This is predominant among the aboriginal tribes of central and southern India, and is closely allied to the Veddas of Ceylon, Toala of Celebes, Semang of the Malay Peninsula, and the Australian aborigines.

(*E*) A dark pygmy type having spirally curved hair, which is mostly submerged in India at the present time.

(*F*) A brachycephalic mongolid type, constituting the main population of the sub-Himalayan region. What is probably a sub-type (F^1) is the dominant element in Burma, but it has strong affinities with Siamese, Malays and Cochin Chinese.

(*G*) In Assam and Northern Burma there seems to have entered a second Mongolid strain of medium stature, longish head and medium nose. The Angami Nagas may be considered the best representatives of this type.

The evidence of anthropometry, it is noted, does not show that the mongolid racial strain entered in any considerable degree into the population of the mainlands of India. The true Mongol element remains outside the Indian frontiers.

There is a lack of the skeletal material which would make it possible to trace the history of these types. Dr. Guha, who ably summarises the archæological evidence, argues for the essential continuity in geographical distribution of the megalithic culture from neolithic Sind to Southern India, dating it in the

* Census of India, 1931. Vol. 1: India. Part 3: Ethnographical. A: Racial Affinities of the Peoples of India, by Dr. B. S. Guha; B: Ethnographic Notes, by various Authors, edited by J. H. Hutton. Pp. lxii+245+39 plates. (Delhi: Manager of Publications, 1935.) 7.10 rupees; 13*s*.

latter area in the Iron Age. Iron was introduced into Northern India by the Vedic Arya about 1500 B.C., who drove the previous inhabitants towards Central and Southern India, where the 'black' metal and the horse are associated with invaders from the north.

Prehistoric skeletal remains fall into two groups, (*a*) the calcholithic, from the Indus Valley, especially Mohenjo-daro and Harappa; and (*b*) Iron Age.

The majority of the skeletal remains of the calcholithic Indus valley civilisation are dolichocranial, but show evidence of two long-headed races, of which one has a much larger skull, but with lower cranial vault and marked post auricular development. At first classed as Proto-Australoid, it is now regarded as 'Caucasic'. A third race, most strongly represented at Harappa, is brachycephalic, showing Armenoid affinities.

The skulls of the scanty Iron Age remains show Australoid, Mediterranean and Armenoid affinities. It is suggested that late in the Iron Age the Peninsula was occupied by a long-headed high-skulled race with a low broad face, comparable to the Combe Capelle type, and further that this type is to be associated with the megalithic culture. Apparently it absorbed a negrito element and later had superimposed on it a race with Armenoid affinities.

The racial history of the Indian peoples may then be summarised as follows:

At the beginning of the fourth millennium B.C., Northern India was occupied by a long-headed race with high cranial vault and long narrow face, by its side being a second, powerfully built, race, also long-headed, but with distinctive peculiarities. With these was a third race showing Armenoid affinities, probably a later influx. None of these had as yet penetrated Southern India. Possibly as early as the neolithic age the megalithic culture had been introduced by people of the Combe Capelle type, who afterwards in the Iron Age reached Southern India, where they subdued the aborigines, but themselves were overrun later by people of Armenoid affinities. In the north they mingled with the Mediterraneans of the Indus Valley to form the bulk of the population of Peninsular and Northern India of to-day. In the upper classes of Northern India another strain, with undoubted northern affinities, is clearly to be distinguished, which, as E. Fischer says, retains the Nordic characters, but without the fair tint of the skin. This strain in fact is also retained slightly among Tamil Brahmins in the south; but it is especially evident among the Chitpavan, or Maharashtra, Brahmins, who constitute one of the fairest groups in India. It is probable that the powerfully built large-headed strain at Mohenjo-daro forms one of the constituents of this race, whose advent to India appears to synchronise with the 'Aryan' invasion.

The brachycephalic element dominant in the west and south-west of India and also in Bengal to-day, which is definitely non-Mongolic in character, possibly drifted into Bengal before it reached Southern India. Its occurrence at Mohenjo-daro and Harappa is definitely against the view that it is a Tokharian-speaking race from the Pamirs. It is comparable to the brachycephalic element in southern Arabia, which Keith identified in the records of Bertram Thomas.

The Upper Atmosphere

IN the Joule Memorial Lecture delivered to the Literary and Philosophical Society of Manchester on February 11, Prof. E. V. Appleton said that it was perhaps not inappropriate, in a lecture associated with a great pioneer in thermal measurements, to survey recent advances in our knowledge concerning the temperature of the upper air. Frictional work produces heat, as is well known, and Joule was the first to state the exact nature of this equivalence. An example of the heating process studied by Joule is the flight of a meteor through the atmosphere, in which case the energy of its speed is ultimately transformed into heat and light. But it has been found that electric waves can also heat the atmosphere when they travel through it. Ultra-violet light from the sun, for example, produces a belt of hot air at about the level in the ionosphere (300 km. high) where short wireless waves are reflected. It has also been found that a powerful long-wave wireless station can warm up the Kennelly-Heaviside layer to a very small but still detectable extent. The so-called 'Luxembourg effect' noticed by long-distance listeners, who find that they receive a long-wave programme when their receiver is tuned to the medium waves, can be traced to the influence of such a process.

It is a familiar fact that the temperature of the air falls as we go upwards from sea-level. But the temperature does not go on decreasing, as Teisserenc de Bort first showed by experiments with free balloons. At a height which varies from 16 km. at the equator to 6 km. at the poles, the fall of temperature is arrested. It is at this level that the stratosphere begins, the underlying stratum being called the troposphere.

At first it was assumed that the stratospheric temperature of − 53° C. is maintained up to the highest levels, and it came as quite a shock when Lindemann and Dobson announced, in 1922, that their study of the tracks of meteors in the atmosphere had led them to conclude that the air at 60 km. in height must be 30° C.—a temperature higher even than that obtaining at ground-level. Experiments on the anomalous propagation of sound from explosions and gunfire had shown that sound waves were reflected at this warm level. The sound of a gun at Shoeburyness, for example, would be expected to travel to Birmingham in a little more than ten minutes and yet the measured time, due to the upper-air trajectory pursued by the waves, was found to be twelve minutes.

In the electrically conducting region of the atmosphere, the daily sequence of events has been studied by means of radio-wave exploration. Conditions do not change much from summer to winter at the 100 km. level, but there appears to be a very pronounced seasonal variation of temperature at 300 km. In summer the ionisation at that level is abnormally low, whereas theory would suggest that it should be

twice the winter value. The discrepancy has been traced to the effect of solar heating which causes the air to expand. The expansion, in turn, dilutes the electrical concentration proportionally with the reduction of air density.

It may, at first sight, seem impossible for human beings to be able to affect conditions at high levels, and yet it has recently been found that powerful wireless stations can increase to a very small extent the temperature of the Kennelly-Heaviside layer. Due to the modulation of such a station, the slight heating varies rhythmically with the speech or music being transmitted and the programme is, as it were, stored up in the absorptive properties of the layer. The effect of this is most unfortunate, for any other waves reflected at the affected patch acquire the modulation of the unwanted programme. The result is that listeners may find an undesired programme obtruding when they are listening to a station on quite a different wave-length. The practical consequence of this so-called 'Luxembourg effect' appears to be that until it is possible to reduce the upward radiation towards the Kennelly-Heaviside layer, there is a certain amount of danger in increasing the power of long-wave broadcasting stations beyond a certain limit.

Effect of Fog upon Plant Growth

OWING to the severe damage caused by London fogs to orchid flowers, begonias and other plants at the Royal Botanic Gardens, Kew, experiments have been carried out at Kew during the past few months with (1) ammonia, (2) electric fans. These experiments were described by Sir Arthur Hill at the Linnean Society on January 30. A 2 per cent solution of ammonia was placed in trays on the floor of the house where begonias, "Gloire de Lorraine", etc., were in flower, with the object of neutralising the sulphuric acid present in the fogs. Very little shedding of flowers or leaves took place beyond what is normal at this season. Electric fans were installed in the Tropical Begonia and Tropical Orchid Houses, and proved quite successful during the bad fogs in December 1935. *Calanthe* flowers remained uninjured, whereas in an adjoining similar house without fans all the flower spikes were seriously damaged and blackened.

During the bad fogs in mid-January, however, when snow fell at the same time, the fans were not so effective, and it seems probable that the humidity of the houses was unduly high at the time and the fans ceased to lower the humidity, so that the injurious matters in the fog were able to be effective. It seems clear from the experiments carried out so far that the fog damage is closely linked with temperature and moisture conditions, and immunity can only be effected by careful adjustment of these two factors.

Specimens of *Calanthe* influorescence were shown at the meeting, some entirely blackened and wholly spoilt, some with the older buds injured, others fairly normal.

Dr. C. R. Metcalfe made microscopical examinations of the leaves which fell in the houses unprovided with fans or ammonia. He finds that when leaves of begonias and other plants fall off during foggy weather, the petioles sometimes break where an abscis layer is present, but in other instances an irregular fracture occurs. No evidence has been found that foggy weather stimulates the formation of abscis layers. Granular material, which stains readily with alkannin, tends to accumulate at the points where the leaves break off.

Bicyclic Terpenes

IN his presidential address to the Chemistry Section of the twenty-third Indian Science Congress held at Indore on January 2–8, Dr. P. C. Guha reviewed at length recent developments in the chemistry of the bicyclic terpenes, derivatives of camphane, santane, pinane, thujane and carane being reviewed in turn.

Apart from the very obvious importance of a detailed study of natural products, one of the most interesting developments in recent years has been to widen the scope of stereochemical problems. Thus the study of decalin (decahydronaphthalene), the parent hydrocarbon of the sesquiterpenes, led Hückel to the discovery of a new type of stereoisomerism arising out of the *cis* and *trans* interlockings of two monocyclic structures to multiplanar molecules. This work and that of Ruzicka on the stability of polymembered carbon rings have provided strong arguments against Baeyer's uniplanar models for cyclohexane and higher carbon rings; but in discussing the work of Linstead and Barrett on the bicyclooctanes, the author has overlooked the fact that the multiplanar configurations assigned by Hückel to the decalins and hydrindanes have been conclusively confirmed recently by the discovery of the existence of optical isomerism in certain of their derivatives.

The interesting reaction described by Diels and Adler in 1928, in which a conjugated system of double bonds is caused to combine additively in the 1·4 positions with compounds containing the grouping —CH=CH—CO—, has opened the way to the synthesis of many bicyclic terpene derivatives, including camphor compounds, and the systematic study of the degradation products in the fenchane and camphane series has progressed steadily. A new type of intramolecular rearrangement has been described by Nametkin in which α-methylcamphene on hydration yields 4-methylisoborneol instead of the 6-methylisomer which would be expected from the usual Wagner mechanism. The published address (Calcutta: Asiatic Society of Bengal) includes a useful classified bibliography.

Educational Topics and Events

CAMBRIDGE.—Dr. T. S. Hele, Master of Emmanuel College, Prof. J. H. Clapham, Sir F. G. Hopkins, Sir A. S. Eddington and Prof. E. J. Dent have been appointed delegates from the University to the tercentenary of Harvard College on September 16–18.

Prof. A. C. Seward, Master of Downing College, has been elected into an honorary fellowship at St. John's College.

Prof. E. V. Appleton, Jacksonian professor of natural philosophy, has been elected into a professorial fellowship at St. John's College. At King's College, Leslie Howarth, formerly scholar of Gonville and Caius College, has been elected Berry-Ramsay fellow of the College. Mr. Howarth was a Wrangler in Part II of the Mathematical Tripos 1933, and was awarded a Smith's Prize and the Amy Mary Preston Read Scholarship in 1935.

PROF. A. R. WADIA, secretary of the Inter-University Board, India, has sent us a copy of a pamphlet containing a "Bibliography of Doctorate Theses in Science and Arts accepted by Indian Universities from January, 1930" (The Bangalore Press, Bangalore City). It is not always realised that the D.Sc. and D.Litt. degrees of Indian universities are equal in standing to those of most universities in Great Britain and demand equal attainment or original work. In the chief universities, the D.Sc. may be taken by M.Sc.'s (in some cases, by M.A.'s in science) of three years' standing, by thesis; and similarly the D.Litt. may be taken by M.A.'s. Usually, there is a European, or other leading authority, who acts as one of the assessors of a thesis for such a higher degree. The Ph.D. degree may also be taken by thesis by M.A.'s of three years' standing. The number of theses of which the titles are given in the list just issued is as follows: Aligarh, Ph.D., 3. Allahabad, D.Sc., 7; D.Litt., 4. Benares, D.Litt., 4. Bombay, D.Sc., 1. Calcutta, Ph.D., 25; D.Sc., 13. Dacca, Ph.D., 5; D.Sc., 7. Lucknow, Ph.D., 6; D.Sc., 1. Madras, Ph.D., 4; D.Sc., 6. Nagpur, D.Sc., 2. Panjab, D.Sc., 7; D.Litt., 2.

Science News a Century Ago

Brunel's Shields for the Thames Tunnel

THOUGH the shields used to-day for tunnelling through loose ground or water-bearing strata are mainly developed from the shield designed by James Henry Greathead (1844–96) for the construction in 1869 of the Tower Subway beneath the Thames, the original inventor of such a shield was the elder Brunel, who had two built during the construction of the Thames Tunnel begun in 1825 and finished in 1843. The first shield was made by Maudslay, Sons and Field in 1825. It consisted of twelve separate cast-iron frames each divided into three cells in which the miners worked. The frames could be forced forward by screw jacks as the lining of the tunnel with brickwork proceeded. The entire shield weighed 80 tons. Owing to the irruption of the river into the tunnel in 1828, work was suspended for seven years, and the shield remained submerged. On work being resumed in 1835, an improved shield weighing 140 tons was made by Messrs. Rennie, and this was in place by March 1, 1836, when the directors in a report to the proprietors said "that, from the first removal of the old machinery to the erection in its place of the last portion of the new shield, under, at all times, a vertical and lateral pressure of about three thousand tons, and under other circumstances of great difficulty and danger, with which the proprietors are familiar, *not only had no life been lost, but not an accident worth recording had occurred*".

Biot on Tartaric Acid

IN its column of *Miscellanea* of March 5, 1836, the *Athenæum* said: "M. Biot has read a notice to the French Academy of Sciences, on the molecular properties of tartaric acid. The following are the heads of his memoir:—If we dissolve an equal weight of crystallized tartaric acid in different proportions of distilled water, at a temperature of from 22 to 26 centensimal degrees, and make a ray of polarized light, of fixed refrangibility, traverse the solutions, the following phenomena will be manifested. 1st In each solution at different depths, the primitive plane of the polarized ray will be found to deviate to the right, in an angular quantity, proportional to the weight of the acid traversed by the ray. 2nd The absolute extent of this deviation, for the same weight of acid, varies according to the quantity of water in the solution which shows, that in each, the total deviation of the ray is the source of the deviations successively performed by the atomic groups of acid traversed by the ray. 3rd The deviation which the ray undergoes with an equal weight of acid, increases with the quantity of water in nearly an equal proportion; which proves that the power of the molecular rotation of the acid augments with the quantity of water in the solution, and that this water has an influence on the different atomic groups which produce the rotation; consequently it is not a simple mixture, but a true combination."

It was twelve years after Biot's observations that Pasteur, in 1848, made his brilliant discovery of the true nature of tartaric acid (see NATURE of December 23, 1922. Supplement p. viii).

Rapson's Improvements in Steering Gears

THE ease with which large vessels are steered to-day in any weather is due to the successive improvements in steering gears made by a large number of inventors, among whom one of the most notable was John Rapson of Penrhyn. At a time when tillers were controlled by chains or ropes led over a winch barrel attached to the steering wheel, he brought out both the 'double screw' gear and the 'Rapson's slide', which rendered steering easier and a far less dangerous operation in a heavy sea than it had been hitherto. His double screw gear was fully described in the *Mechanics' Magazine* of March 5, 1836. The writer of the article concluded his description by saying: "The only objection to this steering apparatus which at present occurs to us, is that it may cause the rudder to give a too stubborn resistance to the sea, so that a heavy wave would break away the patent steered rudder, while one with the common tiller, rope and drum, would yield a little to the opposing force and we need not mention that the safety of the rudder is of paramount importance to the ship." More than twenty years after Rapson had made his invention, the older methods continued to be used, as many as a hundred men sometimes being needed to steer a big armoured cruiser.

Societies and Academies

LONDON

Royal Society, February 20. N. THOMPSON: The electrical resistance of bismuth alloys. The electrical resistance of single crystals of bismuth containing small amounts of lead, tin, germanium, selenium, tellurium and other elements has been measured over a temperature range 14°–400° abs. The first three elements dissolve in the bismuth lattice and produce an alloy which has a large negative temperature coefficient of resistance parallel to the principal axis of the crystal Perpendicular to the axis the effect is similar but less marked. Selenium and tellurium both dissolve in bismuth, thereby reducing its specific resistance, both parallel and perpendicular to the axis, except at low temperatures. There is no negative temperature coefficient. A qualitative explanation of these results is suggested on the basis of Jones's theory of bismuth. E. G. WILLIAMS, M. W. PERRIN and R. O. GIBSON: The effect of pressure up to 12,000 kgm./cm.^{2} on reactions in solution. Velocity constants have been measured for various reactions in solution. The constants A and E of the Arrhenius equation have been calculated wherever possible. The reactions fall into three main classes: (*a*) 'Normal' reactions—where pressure has a small accelerating influence which falls off at high pressures, the increase in velocity being of the order of 5 times at 12,000 kgm./cm.^{2}. The acceleration in this class appears to be due mainly to a decrease in the activation energy. (*b*) 'Slow reactions—where pressure has a much greater accelerating influence, which increases with increasing pressure, the increase in velocity being of the order of 10 times at 5,000 kgm./cm.^{2}, and 45 times at 8,500 kgm./cm.^{2}. In this class the constants A and E of the Arrhenius equation both increase with increasing pressure. (*c*) Unimolecular decompositions—the decomposition of phenyl-benzyl-methyl-allyl ammonium bromide in chloroform solution is retarded 1·5 times at 3,000 kgm./cm.^{2}. The results are in good agreement with the predictions given by the transition state method of calculating reaction velocities.

PARIS

Academy of Sciences, January 20 (*C.R.*, **202**, 177–256). I. VINOGRADOFF: New results of the analytical theory of numbers. ABRAHAM WALD: The idea of the *collectif* in the calculus of probabilities. GUSTAVE JUVET: Clifford's numbers and the equation of Dirac. GEORGES KUREPA: The hypothesis of ramification. KAROL BORSUK: Spaces possessing the (Δ) property. JACQUES DEVISME: A method of colouring maps showing the dispersion of the rural habitat. N. TCHUDAKOFF: The zeros of the $\zeta(s)$ function. DANIEL DUGUÉ: The maximum of precision of Gaussian estimations at the limit. CATHERINE NERSESSIAN: The multiplicity of trigonometric development. PIERRE BOOS: Certain functions of two variables connected with arcs of a curve. NICOLAS KRYLOFF and NICOLAS BOGOLIOUBOFF: General stationary movements in dynamical systems of non-linear mechanics. ALBERT TOUSSAINT and MIROSLAV NÉNADOVITCH: Contribution to the experimental study of infinite multiplanes in a plane current. ERNEST BAUMGARDT: Variation with temperature of the absorption of ultra-sonic waves by liquids. The results obtained by a modification of Biquard's method can be expressed by a formula of the type $A\eta/\rho_0.V_0^3$, where η is viscosity, ρ_0 density and V_0 the velocity of sound. JACQUES SOLOMON: The absorption in matter of protons of great energy. ARKADJUSZ PIEKARA: Research on the magnetic change of the dielectric of liquids in a field of 20·4 kilogauss. No appreciable effect could be proved for hexane, carbon disulphide, benzene or nitrobenzene. MAURICE BAYEN: Measurements of dispersion in the ultra-violet. Results are given for heptane, heptene and heptine. MICHEL KANTZER: The existence of chlorous anhydride, Cl_2O_3. The author concludes that Cl_2O_3 exists, and that the spectrum obtained by Gernez and subsequent workers represents the superposed spectra of ClO_2 and Cl_2O_3. JEAN TERRIEN: Some properties of photographic plates, treated with solutions of sodium salicylate, between 2500 A. and 1600 A. Tien Kiu has shown that the factor of contrast of plates treated with an aqueous solution of sodium salicylate is independent of the wavelength between 2967 A. and 2482 A. This property is shown to hold to 1600 A. JACQUES YVON: The kinetic theory of liquids and diffusion of light. JEAN HERBERT: The disappearance of a cause of anisotropy of glass by reheating. Glass can be rendered homogeneous by prolonged reheating: this is proved both by examination in polarised light and by etching with hydrofluoric acid. MARCEL CHÂTELET: The system cobalt chloride, ammonium chloride, ammonia, water. The results of a calorimetric study. MLLE. SUZANNE ESTRADÈRE: The thermal study of the oxidation of hydrocarbons. A mixture of hydrocarbon and oxygen is passed through a heated tube under fixed conditions. The temperature at which an exothermic reaction commences is shown to be in direct relation with the Boyd number for the same hydrocarbon. JEAN CHÉDIN: The Raman effect of mixtures of fuming sulphuric acid and nitric acid. There is evidence of an association between N_2O_5 and SO_3: this association is quite different from the formation of $H_2S_2O_7$. MARCEL BALLAY: The plastic deformation and the hardness of lead. VICTOR AUGER and MLLE. MARIE GALLISSOT: A carbonate of ferric iron and ammonia. The crystalline compound isolated has the composition $Fe(OH)_2$, NH_4CO_3, H_2O. HENRI GUÉRIN: The barium arsenates. The characterisation of a new arsenate, $3BaO.2As_2O_5$. CHARLES DUFRAISSE and JEAN LE BRAS: Study of the extinguishing mechanism of carbon tetrachloride towards flames. NICOLAS MENCHIKOFF and THÉODORE MONOD: Geological section of the Hank at Taoudeni (western Sahara). FERNAND BLANCHET: The extension of the Bathonian in the intra-alpine zones to the south of the Guisane. MAURICE HOCQUETTE: The chondriome in the excreting cells of *Primula obconica* and its modifications. WILLIAM HENRI SCHOPFER: Study of the auxogene action of extracts of normal and pathogenic tissues of animals on the development of *Phycomyces*. (The late) MARCEL MIRANDE: New researches on the presence of sterinic enclosures in the leaves and flowers of the lily. RENÉ SOUÈGES: The embryogeny of the Saxifragaceæ. The development of the embryo in *Saxifraga granulata*. TCHOU SU: Hybridation of Anurians of Canton (China). PIERRE CARRÈRE: The evolutive cycle of a *Maritrema* (Trematoda). RAOUL MICHEL MAY: Hexachlorethane in the fight against the mosquito larvæ. A mixture of talc powder and hexachlorethane, spread on the surface of water containing larvæ or nymphs of the mosquito, is

very effective, and does not prevent the use of the water for domestic purposes or for watering plants. ANDRÉ LWOFF and HISATAKE DUSI : The nutrition of the euglenian, *Astasia Chattoni*. MARCEL PAUTHENIER and HENRI VOLKRINGER : An electrical method for the destruction of micro-organisms in suspension in a gas. The application of the electrical method for removal of dust in suspension in air not only removes, but also kills, any micro-organisms present in the dust. ALFRED BOQUET and ROGER LAPORTE : Experimental osseous and osteo-articular tuberculosis in the rabbit. ANDRÉ PAILLOT : A new type of polyhedral diseases observed in the caterpillars of *Euxoa* (*Agrotis*) *segetum*.

BRUSSELS

Royal Academy (*Bull. Classe Sci.*, 21, No. 11, November 9, 1935). L. GODEAUX : Surfaces on which certain matrices of linear forms vanish. E. ASSELBERGHS and W. HENKE : Contribution to the tectonic of Hunsrück and Soonwald. E. LAHAYE : Representation of functions of several variables which are the roots of an algebraic equation. L. LONG : Surfaces (S) and the surfaces (Σ) (2). Degree of generality and general properties of the surfaces (S) and (Σ). M. LINSMAN : Certain singular points of surfaces in finite geometry.

GENEVA

Society of Physics and Natural History, December 19. E. JOUKOWSKY : The presence, in the Genevan glacio-lacustral deposits, of organisms hitherto considered as marine (Coccoliths and *Actiniscus*). A. JAYET : A subterranean shelter with palæolithic microfauna near Sergy. C. METTETAL : The precocious determination of regenerates in the salamander. C. METTETAL : Regenerates of grafted claws on the tail region in the salamander. E. PAREJAS and A. LILLIE : Some micrographical data on the upper Cretaceous of Vormy. E. PAREJAS and A. LILLIE : Some micrographical data on the upper Cretaceous of Châtelard en Bauges. R. VERNIORY : The tectonic of the Faucigny hills (Hte. Savoie). A. LILLIE and W. SCHROEDER : The Nummulitic of Chantemerle. E. BRINER and E. PERROTTET : Raman spectra and the constitution of the ozonides. K. H. MEYER and W. LOTMAR : The structure of the chitin of fungi. A. WEINSTEIN : On the demonstration given by Schäfli of the Schwarz-Christoffel formula.

WASHINGTON, D.C.

National Academy of Sciences (*Proc.*, 21, 633–684, Dec. 15). EDWIN B. WILSON : Heights and weights of 275 public school girls for consecutive ages 7 to 16 years, inclusive. Correlation of height with weight falls from 0·77 at seven years to 0·42 at sixteen years ; weight-weight correlations are generally less than height-height correlations for corresponding years. Variance of height at sixteen years is 66 per cent 'controlled' by knowledge of the height at seven years ; the corresponding figure for sixteen and eleven years is 56 per cent. A. J. WATERMAN : Transplantation of fœtal tissues between rabbits and rats. Fœtal tissue of the rabbit was placed beneath the capsule of the adult rat kidney, and that of rat in the adult kidney and omental bursa of the rabbit. Few grafts were recovered. Occasionally a little differentiation was observed, particularly of harder tissues in older embryos. R. F. DEIMEL : The torsion of a circular cylinder. Saint-Venant assumed that a transverse section suffers no distortion in its own plane if it is not near the ends of a long cylinder. Consideration of the effect of boundary conditions at the ends does not change the linear relation derived by Saint-Venant and assumed by engineers. G. W. BEADLE and BORIS EPHRUSSI : Transplantation in *Drosophila*. The desired organ was injected into the body cavity of the host by a specially designed micropipette. Larval ovaries, imaginal disks of eyes, antennæ, wings and legs have thus been transplanted successfully into flies in the larval stages. Host and transplant of different genetic constitution and even of different species have been used. PHILIP TRUMAN IVES : The temperature-effective period of the scute-1 phenotype. Bristle counts of experimental cultures of *Drosophila* show that exposure to a temperature of 40°–41° C., at any period from the laying of the egg to the early pupal stages, has an effect on development. This result is opposed to that of other workers, who find that the insect is effected only when such exposure occurs during a definite but very limited stage of development. J. T. BUCHHOLZ, L. F. WILLIAMS and A. F. BLAKESLEE : Pollen-tube growth of ten species of *Datura* in interspecific pollinations. A chart is given showing distribution of pollen-tube lengths of all possible crosses between these species. The results show the possibilities of hybridisation and also suggest a new morphological phylogenetic character. REGINALD A. DALY : Densities of rocks calculated from their chemical analyses. In 1920, J. P. Iddings published a method of doing this. Further tests justify the use of the method, which can be of service in calculating densities of vesicular material and partly glassy material where immersion methods are untrustworthy. SAUNDERS MACLANE : The ideal-decomposition of rational primes in terms of absolute values. N. JACOBSON : On pseudo-linear transformations. G. A. MILLER : Formulas giving the number of the groups determined by squares. I. J. SCHOENBERG : On the zeros of the successive derivatives of integral functions. A. A. ABRAMOWITZ : Colour changes in cancroid crabs of Bermuda. Crabs of two species of *Portunus*, which appear white and red respectively, were used. On coloured backgrounds, the responses were very varied but never sufficient to affect the colour of the animal as a whole. In blinded white crabs, the black pigment became concentrated whatever the background colour, contrary to the effect in most crustaceans, but exactly as occurs on removal of the pituitary gland in amphibians. W. G. CLARK : Note on the effect of light on the bio-electric potentials in the *Avena* coleoptile. Seedlings 30–40 mm. in length and devoid of chlorophyll were mounted in a dark chamber so that they passed through four glass loops carrying water meniscuses to provide electrical contact at four points of the growing coleoptile. When the system reached a steady electrical state, the plant was illuminated for 5, 10, 30, etc., minutes. Electrical response occurs after the light is turned off. The tip, which is normally negative to the base, shows decreased negativity, followed by increase to a maximum and finally decrease to original level ; the curve is very similar to the light-growth curve. Maximum reaction occurs in the subapical region.

Forthcoming Events

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

Monday, March 2

UNIVERSITY OF LEEDS, at 5.15.—Prof. C. G. Darwin, F.R.S.: "Some Properties of Metals".*

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.—A. Courtauld: "A Journey in Rasmussen Land".

Tuesday, March 3

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. R. Kuczynski: "Recent Population Trends" (succeeding lectures on March 6 and 10).*

Wednesday, March 4

SCIENCE MUSEUM, SOUTH KENSINGTON, at 3.—Opening of the Very Low Temperatures Exhibition by Sir William Bragg, F.R.S.

CHADWICK PUBLIC LECTURE, at 5.30.—(at Manson House, 26 Portland Place, London, W.1).—Prof. M. T. M. Ormsby and Prof. H. J. Collins: "The 'Edwin Chadwick' Laboratory"*.

ROYAL SOCIETY OF ARTS, at 8.—G. G. Blake: "Electrically Produced Music".

Thursday, March 5

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. August Krogh: "The Economy of Some Animal Communities".*

Friday, March 6

INSTITUTION OF CHEMICAL ENGINEERS.—Annual Corporate Meeting to be held at the Hotel Victoria, Northumberland Avenue, W.C.2.

Dr. H. Levinstein, at 11.45: "The Grant of Trading Monopolies—Then and Now" (Presidential Address).

M. Novomeysky: "The Dead Sea—A Storehouse of Chemicals".

SOCIETY OF PUBLIC ANALYSTS, at 3.15.—(at the Chemical Society's Rooms, Burlington House, Piccadilly, W.1).—Annual General Meeting.

UNIVERSITY COLLEGE, LONDON, at 5.30.—Prof. August Krogh: "The Osmotic Regulation in Aquatic Vertebrates".*

QUEEN MARY COLLEGE, LONDON (CHEMICAL COLLOQUIUM), at 5.30.—Prof. J. B. S. Haldane, F.R.S.: "The Action of Enzymes".

GEOLOGISTS' ASSOCIATION, at 7.30.—(at University College, London, W.C.1).—Annual General Meeting.

Sir Albert Kitson: "Outlines of the Geology of Victoria, Australia" (Presidential Address).

ROYAL INSTITUTION, at 9.—Sir William Bragg, F.R.S.: "The Electric Properties of Crystals".

Official Publications Received

Great Britain and Ireland

The Royal Society of Arts. Cantor Lectures, 1936: Nutrition and National Health. Three Lectures delivered before the Royal Society of Arts on February 10th, 17th and 24th, 1936, by Major General Sir Robert McCarrison. Pp. 56. (London: Royal Society of Arts.) 2*s*. 6*d*. [102

Technical Publications of the International Tin Research and Development Council. Series A, No. 30: The Corrosion of Tinplate. By Dr. T. P. Hoar. Pp. 11. (London: International Tin Research and Development Council.) Free. [122

Ministry of Health. Report on the Work of the Central Midwives Board for the Year ended 31st March 1935. Pp. 15. (London: H.M. Stationery Office.) 3*d*. net. [132

University of Leeds. Thirty-first Report, 1934–35. Pp. 160. Publications and Abstracts of Theses by Members of the University during Session 1934–35. Pp. 34. (Leeds: The University.) [132

The University of Sheffield. Report on Research Work carried out in the Departments of Mining and Fuel Technology during the Session 1934–1935. Pp. 18. (Sheffield: The University.) [132

The Imperial Forestry Institute: University of Oxford. Eleventh Annual Report, 1934–35, and Prospectus. Pp. 34. (Oxford: Imperial Forestry Institute.) [172

Empire Cotton Growing Corporation. A Review of the Work of the Experiment Stations, Season 1934–35. By Dr. J. C. Willis. Pp. 32. (London: Empire Cotton Growing Corporation.) 1*s*. 6*d*. [172

Report by the Board of Trade on the Comparisons of the Parliamentary Copies of the Imperial Standards deposited at the Royal Mint, with the Royal Society, in the Royal Observatory, Greenwich, and at the Standards Department of the Board of Trade, with the Imperial Standard Yard and the Imperial Standard Pound and with each other, together with a Report on the Re-Verification of the British National Copies of the Metre and Kilogram and an Account of a Re-Determination of the Ratio of the Pound to the Kilogram made during the Years 1932 to 1933. Pp. 56. (London: H.M. Stationery Office.) 1*s*. net. [172

The Carnegie Trust for the Universities of Scotland. Thirty-fourth Annual Report (for the Year 1934–35) submitted by the Executive Committee to the Trustees on 12th February 1936. Pp. iv+102. (Edinburgh: Carnegie Trust for the Universities of Scotland.) [172

Second Report of the Commissioner for the Special Areas (England and Wales). (Cmd. 5090.) Pp. vi+120. (London: H.M. Stationery Office.) 2*s*. net. [172

P E P (Political and Economic Planning): Industries Group. Report on the British Coal Industry: a Survey of the Current Problems of the British Coal-Mining Industry and of the Distribution of Coal, with Proposals for Reorganisation. Pp. vi+214. (London: P E P). 7*s*. 6*d*. net. [182

Ministry of Agriculture and Fisheries. Agricultural Statistics, 1934. Vol. 69, Part 2: Prices and Supplies of Agricultural Produce and Requirements in England and Wales. Pp. ii+95–190. (London: H.M. Stationery Office.) 2*s*. net. [202

Other Countries

Journal of the Indian Institute of Science. Vol. 18A, Part 17: Studies in Indian Essential Oils. 7: Essential Oil from the Flowerheads and Stalks of *Cymbopogon polyneuros*, Stapf, by M. S. Kotnis and B. Sanjiva Rao; A Note on the Essential Oil from the Rhizomes of *Rheum Emodi*, Wall, by M. Ghouse Mohiuddin. Pp. 129–135. (Bangalore: Indian Institute of Science.) 10 annas. [102

Verhandlungen der Schweizerischen Naturforschenden Gesellschaft. 116 Jahresversammlung vom 17 bis 20 August 1935 in Einsiedeln. Pp. 491+8 plates. (Aarau: H. R. Sauerländer et Cie.) [102

Publications de l'Observatoire Astronomique de l'Université de Belgrade. Nouvelles tables de précession. Par V. V. Michkovitch. Pp. 39. (Belgrade: Observatoire Astronomique.) [112

Union of South Africa: Department of Mines: Geological Survey. The Geology of the Klerksdorp—Ventersdorp Area; an Explanation of the Geological Map. By Dr. Louis T. Nel. Pp. 168. (Pretoria: Government Printer.) 10*s*. 6*d*., including Map. [112

Journal of the Faculty of Agriculture, Hokkaido Imperial University. Vol. 38, Part 1: Chemical and Physico-Chemical Studies on the Starches. By Yukihiko Nakamura. Pp. 109. (Tokyo: Maruzen Co., Ltd.) [112

Imperial College of Tropical Agriculture. Studies in West Indian Soils, 9: Some Soil-Types of British Honduras, Central America. By F. Hardy, H. P. Smart and G. Rodriguez. Pp. 56. (Trinidad: Government Printing Office.) 2*s*. [112

Nutritional Charts: Prepared expressly for Medical, Dental and Dietetic Specialists by the Staff of the Research Department of H. J. Heinz Company. Second edition. Pp. 32. (Pittsburg, Pa.: H. J. Heinz Co.) Free. [142

Carnegie Institution of Washington. Report of the Editor of the Division of Publications. (Reprinted from Year Book No. 34, for the Year 1934–35.) Pp. 371–401. (Washington, D.C.: Carnegie Institution.) [142

The Imperial Council of Agricultural Research. Miscellaneous Bulletin No. 7: List of Publications on Indian Entomology, 1934. Pp. ii+38. (Delhi: Manager of Publications.) 1.2 rupees; 2*s*. [172

Transactions of the National Institute of Sciences of India. Vol. 1, No. 6: *Nappe* Structure in the Archaean Rocks of the Nagpur District. By W. D. West. Pp. 93–102+1 plate. (Calcutta: National Institute of Sciences of India.) 1.8 rupees. [172

Havsforskningsinstitutets Skrift. No. 97: Översikt av isarna vintern 1933–34. Av Risto Jurva. Pp. 70. No. 101: Havsforskningsinstitutets verksamhet år 1934. Av Gunnar Granquist. Pp. 15. No. 103: The Thalassological Summer Cruise in 1935. By Gunnar Granquist. Pp. 17. No. 104: Vedenkorkeusarvoja 1934. Av S. E. Stenij. Pp. 52. No. 105: Regular Observations of Temperature and Salinity in the Seas around Finland, July 1934–June 1935. By Gunnar Granquist. Pp. 42. (Helsingfors: Havsforskningsinstitutet.) [182

Department of Agriculture, Mauritius: Sugarcane Research Station. Bulletin No. 9: Base Exchange Relationships in Mauritius Soils. By N. Craig. Pp. 25. (Port Louis: Government Printer.) [182

Ministry of Public Works, Egypt: Physical Department. The Nile Basin. By Dr. H. E. Hurst and Dr. P. Phillips. Supplement to Vol. 3: Ten-day Mean and Monthly Mean Gauge Readings of the Nile and its Tributaries up to 1932. (Physical Department Paper No. 32.) Pp. vii+565. (Cairo: Government Press.) 50 P.T.; 10*s*. [192

Catalogues

Movable, Focussing Self-Sustaining Fittings. (Abridged List No. 3.) Pp. 10. (Stockport: John Dugdill and Co., Ltd., Hazel Grove.)

Vitamin C (Ascorbic Acid B.D.H.). Pp. 11. (London: The British Drug Houses, Ltd.)

Catalogue of Books on History and Archaeology: Castles, Domesday Book, Topography, etc., with a Fine Collection of Publications of the Public Record Office. (Catalogue No. 596.) Pp. 80. (London: Francis Edwards, Ltd.)