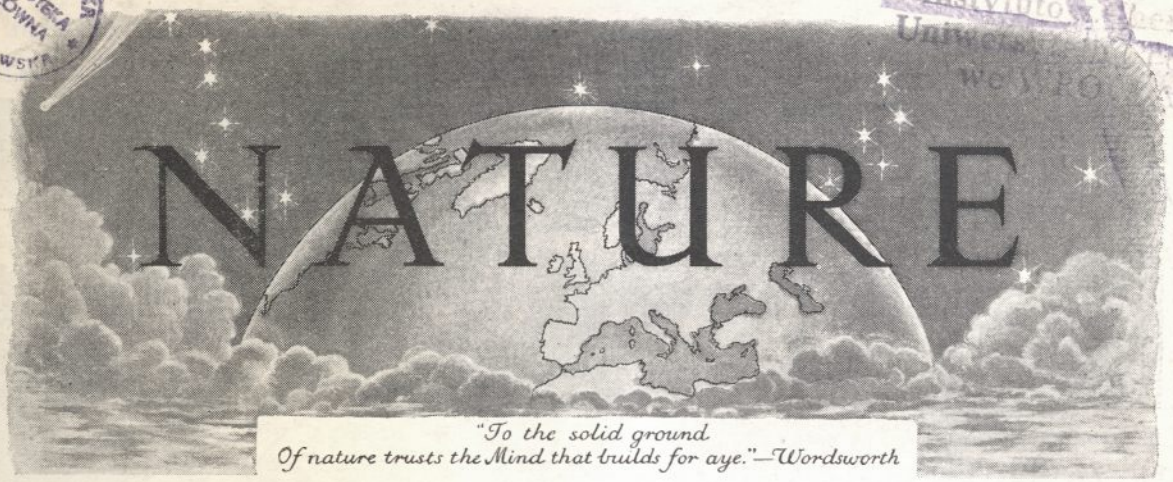

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HEALTH AND INDUSTRY

THE health and welfare of the industrial worker at all times is of vital importance to the State for many reasons. To maintain a satisfactory output and to contribute to the trade and wealth of the nation the workers must be as efficient as the machines they control. Fatigue and disease mean diminished efficiency or absence from work. Hours of work lost interfere with industrial resources, and are a source of considerable national financial loss. In order to treat the sick workers, health services and medical care have to be provided directly or indirectly at national expense, sickness benefit has to be paid out and so forth.

During the last twenty-five years much legislation has been passed dealing with factories and workshops, dangerous trades, and other industrial hazards in which the workers and especially young and female workers are protected against protracted hours of labour, and against accidents by machinery, and in which, also, the health of employees is conserved by compulsory sanitary conditions of workshops and factories. This is especially true of productive industries in which the commodity is made out of the raw material. A great impetus to progress was made in the War of 1914–18 through the Health of Munition Workers Committee, which studied especially the relation of hours of work to output, watched the relationship between hours of work and health and efficiency and issued recommendations from time to time. In 1918, on the dissolution of that Committee, a new body known as the Industrial Fatigue Research Board was formed to continue, under the auspices of the Medical Research Council, the work already begun and to extend it on more systematic and scientific lines. Its title was changed in 1928 to Industrial Health Research Board.

Research into the hazards of industry and their prevention has been conducted for many years by the Home Office, the Local Government Board and its successor the Ministry of Health, the Medical Research Council and the Industrial Fatigue Board. The results of these researches have been practically applied, and have protected the worker from diseases which formerly caused a high industrial mortality, such as lead poisoning and mule-spinner's cancer, while much has been achieved in the reduction of dust diseases, for example, silicosis and asbestosis. The problems of fatigue and monotony in work have been intensively studied.

These are the fruits of peace. In war-time new conditions prevail and new problems arise.

The British Association for Labour Legislation has issued a Report on Welfare and Health in Relation to Hours of Work and Output in War-time, which as a reasoned presentation of its subject will repay careful study.*

In the first place it considers the question of hours of work and efficiency. This subject was dealt with recently in our columns.† The report emphasizes that in the process of prolonging hours of work a point is reached at which any further extension will not only impair health, but will also lead to a fall in hourly output and a drop in total production. This lesson might well be learned by those who engage in mental as well as manual work. It is often insufficiently appreciated that muscular fatigue is associated with mental fatigue.

* Report on Welfare and Health in Relation to Hours of Work and Output in War-time. (British Association for Labour Legislation, 21, Clareville Grove, London, S.W.7.) 6*d*.

† NATURE, **145**, 108 1940).

This was shown experimentally by Gustav Mann more than forty years ago. The converse is also true, and the brain worker who engages in strenuous exercise at the week-end is thereby sapping his stores of mental energy.

Another matter discussed in the report relates to the employment of children and young persons. Here it is important to realize the strain which conditions of work and environment may throw upon the adolescent.

Next the report treats of the promotion of health and welfare. The important subjects of adequate nutrition and well-cooked food are considered, mess-rooms, canteens and communal feeding centres are reviewed, billeting of workers and ventilation and lighting during the black-out are discussed. A series of practical recommendations on all these matters closes the report.

Even as the report appears, new measures have been taken by the Ministry of Labour and National Service to promote industrial welfare. There is a scheme to cut down working time to 55 or 56 hours a week, factory inspectors have been instructed to enforce the Factories' Act in the care of women and young persons and an Order has been made by the Minister requiring the occupier of any named factory to make arrangements for part-time or whole-time medical men, nurses and officers to supervise the welfare of the persons employed. The necessity will be determined by the number of workers employed in a given factory or by special conditions such as dangerous processes or isolated position in a factory. Already some three hundred medical men and women—fifty of them in a whole-time capacity—are attached to factories and business organizations in Great Britain and there is a responsible Association of Industrial Medical Officers.

The position created by this Order is of great importance. It is State recognition of preventive medicine as a function of works management, and the extended application of the results of scientific and medical research for the benefit of the industrial workers should make a substantial contribution to national health. The Order is a beginning, but it has great possibilities. It must be remembered that workers spend only a portion of their lives in the factory, and that to safeguard their health and efficiency preventive medicine must take account of their social environment. In other words, industrial hygiene must not work in water-tight compartments but must be closely co-ordinated with the national health services provided by local authorities and the national health insurance service, all working under the auspices of the Ministry of Health. Otherwise there will be waste of effort, overlapping and duplication of health services and unnecessary expenditure.

TEACHING OF ECONOMIC BIOLOGY

THE intensification of the present conflict has brought with it many problems and none more poignant than its effects upon children. To a developing child the significance of the War is often either resolved into a singular, fervent and intense hatred of the Nazi machine that has so considerably inconvenienced its peculiar world or, very frequently with adolescent children, a confusion of ideas that leaves them groping for a clearer understanding of the deeper issues involved. The traditional and time-honoured British policy of abandoning political factions at the school portals is an admirable one that shows no sign of being relaxed despite the bitterness and mendacity of enemy propaganda. Economic factors, however, have become so paramount in importance that with daily Press references to the blockade, the repeated aerial attacks on merchant shipping and the civilian population, and the ruthlessness of the inhuman submarine warfare, their effects upon the child mind cannot be ignored. On these and related topics, further assistance from their teachers is constantly demanded by ardent youthful inquirers.

The opportunities presented here to the geography and domestic science teachers are manifold and clear. The co-operation of other teachers in illustrating this economic picture is not so frequently invoked nor even envisaged. Yet the role of the mathematics or science teachers is none the less essential in presenting a composite picture of the interlacing economic network. The biology teacher, particularly, is able to play an effective part in relating descriptions of essential commodities to their natural economy and source of origin. In times of peace, the teaching of economic biology has been adopted in surprisingly few schools in Great Britain, although in those

schools where such instruction has been given its introduction has been acclaimed as a definite acquisition to the more realistic nature of the curriculum. In war also a greater extension of the teaching of some of the economic aspects of biology would be of inestimable value in facilitating the adjustment of individual to the changing needs of our rapidly evolving society.

The argument for the teaching of applied biology with reference to the economic needs no flogging. It would serve to quicken the interest of the pupil in articles that he is constantly seeing. It should enable him to become more familiar with the interwoven relationships between all living organisms. Latex and rubber, leather, spices and condiments, perfumes, tobacco, dye-stuffs, beverages, soap and drugs could all be described in relation to their natural economy as also could certain bacteria, particularly those which are helpful to man like cheese-ripeners, tobacco-maturers, etc. References to the constantly changing methods by means of which man is making greater economic use of plants and animals should do much towards helping the child to appreciate the uniqueness of man as a successful exploiter and utilizer of many different aspects of his environment, in contrast to the circumscribed range of other living organisms. The presentation of these and related topics in a historical setting affords wide scope for the building up of attitudes which would in part enable a child to appreciate the dynamics of social change.

The present restrictions in consumption of certain food products offer special opportunities to the adaptable teacher. Rationing of staple commodities like tea, sugar, butter, and bacon could be made the basis of lessons on the place of these food-stuffs in general nutrition and economy. These might be linked up with the campaign being carried out by the Ministry of Food, which could be made use of in emphasizing the fact that suggested substitutes are not necessarily inferior in food value to articles which have been accepted as almost a part of the national heritage. (The word *Ersatz* has been partly instrumental in creating the impression that substitute foods are of lower nutritional standard than the ones they are designed to replace.) In conjunction with the geography specialists, other lessons could be used to describe the source of origin, methods of production and distribution of necessary food-stuffs, articles of clothing, footwear, etc.

Descriptions of the transport of food products like meat, fruit and fish would scarcely be complete without reference to the various methods of conditioning and preservation. Drying, smoking, salting, canning and other processes which alter the appearance and taste of the food product could be considered with reference to food substances that frequently form a part of the dietary of the child. Lessons on dried figs, bacon and ham, kippers and bloaters, fruit, vegetable and fish canning, etc., would be particularly effective in emphasizing the unique place of man as an unraveller of the—to him—tangled skeins of Nature and as one who has learned to mould her pattern to his own design. The preservation of foods in their more or less natural state by the more recently developed cold-storage devices would also form an invaluable introduction to an account of the growing interdependence of the various components of the British Empire.

The limitations of ice as a natural preservative —although the caviare taken to ancient Egypt embedded in the snow of the Caucasus apparently had lost little of its appeal to the recipients—and the introduction of machinery to produce cold artificially could be used to show how, some fifty years ago, mechanical refrigeration was first applied to the storage of food. The growing scarcity of meat in Great Britain in the seventies of the last century, due largely to the rise of industrialism, coupled with the urgent need to find a profitable outlet for the large quantities of food materials in the producing countries like Australia, New Zealand and South America, could demonstrate how the economic problems led to the first attempts at installing refrigerating machinery in ships to bring frozen meat from overseas. The necessity of refrigeration assumes added importance to-day with the diversion of merchant ships from their customary trade-routes.

The excellent series of posters now widely distributed throughout the country in which attention is directed to the raw materials produced by various parts of the British Empire would be useful starting points in lessons that would foster a better understanding of the vital inter-relations between Dominions, Colonies, Dependencies and the mother country.

In teaching children about articles they eat and drink and in which they clothe themselves, a valuable link is made in introducing them to a wider appreciation of the lives lived by other people in different climatic regions. The absolute necessity

of the reindeer to Laplanders as a provider of food, clothing, utensils and fuel, and the complete dependence of natives of Papua upon shellfish and yams are examples of how the story of civilization might be re-lived in the classroom.

Greater attention might also profitably be paid to the economic aspects of biological control. The late Mr. Frederick Muir's estimation that the introduction of the Tachinid parasite of the weevil borer of sugar cane into the Hawaiian Islands saved the cane growers about one million pounds a year is a spectacular example of the inscriptions that might be given to illustrate the potentialities of control of pests by biological methods. This could be adequately supplemented by discussions more prosaic, but none the less important and effective, of the methods of control which have been originated and which are being constantly extended at the Laboratory of the Imperial Institute of Entomology at Farnham Royal. The value of the film in augmenting the learning process by providing visual experiences beyond the concept of words springs readily to mind in considering this issue. An outstanding film on prickly pear control produced by Australia Trade Publicity would be invaluable in presenting a picture of man's ceaseless fight against natural forces in his march towards civilization.

The remarkable plagues of insects which occur from time to time, as instanced by the appearance of flying ants in amazing numbers in the streets of Croydon recently, and other cyclical fluctuations of animal populations would be useful in bringing out the importance of the effects of the alternate abundance and scarcity of organisms upon which human life is dependent. Price variations, together with the need for investigating the causes of scarcity and the introduction of corrective and ameliorative methods, could be considered in connexion with lessons on the fickleness of Nature in providing a dearth of life-giving crops interspersed with seasons of plenteous bounty.

The introduction of a more liberal use of economic biology in the school syllabus would have a further advantage in dispelling the unfortunately too prevalent belief that practical biological experiments and demonstrations can only be taught by using stock equipment and apparatus which are usually of an expensive type. Discussion of topics concerning articles that form part of our everyday habitat could be illustrated quite adequately by practical observations making use of the articles themselves. The question often debated as to whether the teaching of science should either focus upon the inculcation of mental discipline or should play a more considerable part in introducing the student to the wider human and social aspects of science need scarcely arise in a course centred round economic products. Formal training could be given using the commodity under consideration as experimental material, while the human implications would inevitably be developed both in the classroom itself and by visits to local museums, botanic gardens and, where possible, to shops and stores which often display models and exhibitions depicting the derivation of their products from the raw materials. It might be argued by reactionary observers that this type of teaching would introduce too much of the utilitarian aspects of science and might even approximate towards totalitarian methods of imparting information. Further reflection, however, would show that this tendency is scarcely likely to develop even with those enthusiasts who are considered to be extremists in their method of propounding a more everyday outlook in their science teaching. Where knowledge is freely administered and where information is never withheld there also is the mainspring of freedom of thought ; and where the imparted information is made to link up with the problems of daily life, there, also, must be a better understanding and a more resolute confronting of our own difficulties and, equally important, those of our neighbours in other lands.

For the previous neglect in schools of the teaching of biological questions verging upon the economic, the universities must be held responsible in great part. The recruit to the school teaching profession attempts little during his first years except a repetition of factual material that he has assiduously collected in his Alma Mater. Although there are notable exceptions, in many of the universities little or no instruction is provided in economic biology even for students of honours degree standard. It is almost inevitable that this deficiency in the equipment of potential teachers must have an adverse effect upon the liberality of their early teaching at least. Even for students who are not contemplating entry to the teaching profession, the introduction of lecture courses and practical demonstrations relating to economic products would add both to the attractiveness of the syllabus and the usefulness of their training as a preparation for the rigours of modern life.

THE TAXONOMY OF TULIPA

The Genus Tulipa

By Sir A. Daniel Hall. Pp. viii + 171 + 52 plates. (London: Royal Horticultural Society, 1940.) 21*s*.

THIS book on the genus Tulipa does not profess to be a monograph. The imperfection of the record makes a completely satisfactory monograph impossible at the present time, but the book must serve as such until many problems concerned with the tulip flora of Central Asia are solved by the collection of further living material. Sir Daniel Hall has devoted many years to the study and cultivation of the genus. While director of the John Innes Horticultural Institution and afterwards, he has been indefatigable in securing living material from every available centre. The genus presents very serious difficulties to the analyst. The number of criteria available for discrimination of the species is comparatively small, as happens often among the Monocotyledons. A second obstacle lies in the quality of herbarium material—even at the best affording inadequate evidence of the floral details. Consequently many species have been described on imperfect material which defies even the expert. Interpretation is also impeded by the excessive number of species described, the great majority of which are invalid. Accordingly Sir Daniel has restricted his review chiefly to those members of the genus which he has been able to grow in Great Britain.

If this book contained simply descriptions of the valid species it would perhaps appeal only to systematists and to keen growers of tulips. But the scope of the work is much wider than that. Apart from the workmanlike execution of the task, botanists, whether systematic or not, will be interested in Sir Daniel's methods of analysis. We hear a great deal in these days of the new systematics. Here in this volume we have a fine example of the new method and in a field well adapted for its exposition. It may be admitted forthwith that the ordinary macroscopic criteria would fail to disentangle the many systematic difficulties which occur in this perplexing genus. All the tulips which come under review have been subjected to genetical and cytological examination. The author, therefore, approaches this problem from several angles, and the genus itself proves to be one particularly suitable for such a combined attack. The various factors derived from more than one type of investigation are all happily blended. To the reviewer the chief pleasure has been not in the unravelling of a difficult series of plants but an appreciation of the methods employed by the author, for these he feels have a very wide significance and are bound to have a decided influence on future systematic work.

Adequate descriptions are given of all the species investigated, and of these certain ones can be picked out as eu-species, while the others must be relegated to subordinate positions. This is usually done by calling them subspecies, but in that case a trinomial term would be required. Such trinomials are never welcome to the horticulturist. Sir Daniel has not committed himself to the difficult task of proving that these subordinate species are really subspecies but has avoided the issue by calling them subsidiary species, by which action he is perhaps entitled to keep the binomial terms. The choice of the eu-species may lead to another problem. Certain species which are of older date and therefore hold priority are in some cases subordinated to species described later. It may well be that in certain cases the Procrustean rules of botanical nomenclature must be loosened.

It is recorded that the word 'tulip' itself has a comparatively recent origin and is, moreover, the result of an error. The earliest reference is in a letter by one Busbequius, who had specimens given him in Turkey and referred to them in a letter written in 1554. He says that the Turks call it 'tulipam' and cultivate flowers with extreme zeal. But the word used by the Persians and also by the Turks was 'lalé', and when Busbequius was presented with the flower he was told that it was very like a 'tulband' or 'turban'. Busbequius thought this was its name, wrote it 'tulipam' and so we have the word 'tulip'.

The origin of the race of garden tulips is still obscure, and the author does not find that the new methods throw much light on this long-standing problem. Evidently there is a considerable period of cultivation in Persia and Turkey behind these garden tulips, and no wild species can be indicated with any conviction as their progenitors.

Near the beginning of the text is a key to the species investigated. Except for the primary division into Eriostemones and Leiostemones, no further divisions are indicated. But in the body of the text certain apparently definite sections are mentioned in each of the two main groups. The

key would be more workable if these sections could be incorporated.

The text itself, the forty coloured plates, as also the figures and line drawings, are of high standard. The passages on the history and distribution of the genus, on the general morphology with a wealth of observations on the living material, as well as on the pigmentation and cytology, eminently repay perusal.

W. WRIGHT SMITH.

ANTHROPOLOGY AND ADMINISTRATION

(1) Drama of Orokolo

The Social and Ceremonial Life of the Elema. By F. E. Williams. Pp. xxvi+464+62 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 30*s*. net.

(2) The Swazi

An Ethnographic Account of the Natives of the Swaziland Protectorate. By Brian Allan Marwick. Pp. xvii+320+8 plates. (Cambridge: At the University Press, 1940.) 18*s*. net.

(1) THIS book is dedicated to the late Sir Hubert Murray, fittingly enough. Not only does the author, the Government anthropologist of Papua, owe his existence, in an official sense, to that great administrator, but also the science of anthropology is indebted to him for his practical demonstration of its value in promoting the joint interests of people of different cultures and varied grades of civilization in the great administrative system which he built up by its aid in Papua in the course of more than thirty years of governorship.

The remarkable series of ceremonies of which this volume is a record is a striking example of the long and patient investigation which has been necessary before even the trained official has been able to arrive at a comprehensive view of the main integrating force in the social life of a group of people. The account of the *Hevehe* ceremony of the Elema peoples of Orokolo district on the Gulf division coast of Papua, forming the eighteenth in the series of anthropological reports published by the Government of Papua, embodies the results of eight working-periods totalling in all more than twenty-one months. How far so protracted an inquiry may be regarded as having contributed to, or have been an essential of, efficient administration to some may seem open to question. In the judgment of the anthropologist there can be no doubt.

It is, for example, to be noted that the great Vailala madness, the hysterical outburst which in 1919 and the succeeding years troubled the administration and led to the sacrifice of much of the more ornamental parts of Elema culture, though rampant in the adjacent regions, failed to touch Orokolo. The madness is attributed by Mr. Williams to the impact of a host of new ideas on a culture insufficiently stable to withstand them. In Orokolo the *Hevehe* ceremonial provided the stabilizing element which preserved its social organization from disintegration. In this connexion, however, the author makes some interesting comments on the functional element in social anthropology. He admits certain modifications in his earlier views on the effects of cultural change in the habits and outlook of peoples of backward civilization, which *mutatis mutandis* may be commended to the attention of those who are concerned with problems of cultural disintegration and their relation to administration in other parts of the world. Yet in noting the importance of pig culture in Papuan economy, virtually he allows the major contention that in cultural integration, certain elements are pivotal.

The ceremonial or cycle of ceremonies called *Hevehe* is carried through with much primitive magnificence. In fact, Mr. Williams says that it is "a finer thing than I imagined any Papuans could do". In its many stages it is a vast drama, of which the acts may spread over a period of so long as fifteen years. Until a quarter of a century ago it dominated the ceremonial and artistic life of the Elema people. It has now disappeared from the life of most of the Gulf villages, and even at Orokolo, the village in which the ceremony here described took place, features have dropped out.

Sorcery plays a great part in the Elema culture; and the religion is a species of combination of animism and cult of the dead. In the *Hevehe* ceremonial, however, it is the non-human spirits rather than the dead who are primarily affected.

The author divides his account of the Orokolo drama into three parts. In the first he provides a social and cultural background in a general description of the natural and social settings, a condensed monograph on the Elema peoples of 138 pages. In the second is an extended and detailed account of the *Hevehe* ceremony itself in all its stages; and finally, in a third part, is a critical study of the pragmatic value of the ceremonial. In this, as Prof. Seligman points out in his introduction, is "one outstanding remark, which has

not perhaps been made so explicitly before", namely, that *Hevehe* rises high above everyday needs and provides active recreation which is so conspicuously absent in native life. It is this, Prof. Seligman points out, which W. H. R. Rivers had very much in mind when he spoke of the causes underlying the decay of Melanesian populations.

(2) For many years Swaziland has been 'news'. The long minority of the king, or paramount chief as he is now termed, and the strong individuality and astuteness of the queen mother which found abundant opportunity for exercise during her regency, frequently directed attention to anomalies latent in native institutions under white administration; while more recently, as one of the Protectorates affected by the proposed transfer to the Union of South Africa, the future of Swaziland has been under close examination and discussion.

Nevertheless, the people of Swaziland and their institutions have received comparatively little attention from the anthropologists; while the missionaries, having retained an even more strongly coloured view of native institutions than usual, have not, as elsewhere, provided any considerable store of information. Mr. Marwick, who has the advantage not only of some years experience as an administrative official, but also has spent some time in the field in intensive inquiry among native informants, has thus produced the first account of Swazi ethnography to approach anything like completeness. Since the close of his field-work, a research fellow of the International Institute of African Languages and Cultures has published a valuable study of the Swazi military organization, of which the main points are summarized in an appendix.

Swazi social organization, as is commonly found among the Bantu peoples of the southern region of the African continent, is of a highly complex character, closely interrelated as between its constituent elements. While following on broad lines what might be regarded as a general cultural pattern like other conformists to the general type, it exhibits innumerable local individualities and peculiarities which would make any attempt here at a summary account misleading. It is described with complete lucidity by the author. Among the people as a whole, the military system with its regimental organization is the predominant element, constituting a life-long bond—unfortunately now impaired by the necessity imposed on the younger men to meet taxation. On the spiritual side, however, the soul of the nation is embodied in the king or paramount chief, whose ritual character appears more especially in his function of rain-maker and in connexion with first-fruit ceremonies. This is not unfamiliar to students of the institutions of African kingship. More remarkable are the functions of the queen mother, who not only acts as regent during a minority of the king, but also even when he is paramount with full authority, has her own council and wields an influence scarcely if at all inferior to the authority of the chief.

Mr. Marwick dwells on the changes which have been introduced by the intrusion of white influence, especially the suppression of 'smelling out' witches by the administration and of polygamy by the missionary. In neither instance does he consider the changes beneficial. In native opinion the crimes witch-hunting kept in check have increased; monogamy has introduced or increased prostitution.

Experience as an administrator, whose knowledge of anthropology at first was purely academic but was vitalized by investigation in the field, has convinced Mr. Marwick that anthropology as applied to the institutions of the specific people affected is the most vital necessity in the equipment of an administrative official. Though he touches on this aspect of his work both as administrator and observer only briefly, his conclusions deserve the most careful consideration.

FAMILY ALLOWANCES

Population

Policies and Movements in Europe. By D. V. Glass. Pp. viii + 490. (Oxford: Clarendon Press; London: Oxford University Press, 1940.) 25*s*. net.

MR. D. V. GLASS is the research secretary of the Population Investigation Committee which was formed on the suggestion of Prof. A. M. Carr-Saunders, and has been partly financed by the Eugenics Society. He states in his preface that he does not deal with the question of planning, but has tried, by summarizing his work as research secretary, to give a general background against which we may set our ideas for the future.

The author begins by laying a useful foundation of population statistics, and notes the uselessness of crude birth-rates and death-rates for comparative purposes. For example, a crude death-rate of 11·9, in England and Wales, for 1930–32, by no means implies that the average age at death will be eighty-four. Actually, the expectation of life at birth, in those years, was 60·76, and this

gives a 'life-table' death-rate of 16·46, which is the correct figure to take. He then explains the 'net reproduction-rate', after the method of Dr. Kuczynski, that is, the average number of girl babies that each newly born girl will have in the next generation. The first chapter ends with a reference to the estimates of the future population of England and Wales, as calculated by Dr. G. G. Leybourne (28·7 millions in 1976), and Dr. Enid Charles (31·4 millions in 1975)—on certain assumptions, which may well be falsified by the War. The population of England and Wales in April 1931 was almost exactly 40 millions.

In the second chapter we are given a historical summary of early population legislation, from the time of Augustus, including the laws of Trajan, who was responsible for "the earliest example of a family allowance fund". The last remaining vestiges of such ancient laws were swept away by Justinian in the sixth century. For more than a thousand years after this there are no definite population policies until we come to certain seventeenth century legislation in Spain and France.

Now we come to the core of the book, namely, population policies and family allowances in France, Belgium, Italy, Germany, and Scandinavia. For the rest of this review, we shall concentrate on the question of family allowances.

The author thus defines the term 'family allowance': "A cash grant, quite separate from, and in addition to, a man's wage or salary, given to help to cover the costs . . . of raising a family. . . . The grant generally varies . . . with the number of children, and is given only while the children are dependent."

Here we should note that there are two reasons for the introduction of a system of family allowances; first, the relief of poverty due to the expenses of a family; and, second, the arrest of the tendency towards depopulation.

We learn that the real beginning of the system was the scheme of E. Romanet, of a firm of engineers, at Grenoble, in 1916. Equalization funds were started in 1918, to avoid the result that employers might refuse to employ married men. Engineering firms were grouped together and each employer's contribution varied with the number of his workers and disregarded the number of married men, so that there was no incentive to discriminate against them. There were two kinds of funds, the professional and the regional. So much for the beginning. In 1932–33 and in 1936–37 the French Government introduced legislation by which all employers were ultimately to join equalization funds, in their region or industry.

Mr. Glass analyses for 1938 the position of French families with four dependent children, and finds that, in that year, "each child received an allowance equal to between 4·7 and 8·2 per cent of the basic earnings". In Belgium, in 1938, the average allowance for one child was 1·7 per cent of the basic earnings, rising to 17 per cent for a family of four children.

The author quotes an investigation by Prof. R. A. Fisher into the results of the equalization fund in Haut Rhin. There was, apparently, a slight success, but the material was not sufficiently detailed to justify a definite conclusion. Mr. Glass notes that family allowances would, at least, raise the level of nutrition and tend to lower mortality. He has made the approximate calculation that the increase necessary to maintain the standard of living of a working-class couple would be about 22 per cent of the basic wage per child. He shows that, in France, the family allowances were much below this level. He gives an account of the *Code de la Famille* of 1939, which allowed, in the case of an urban family, some 15 per cent per child. But France is now derelict, and all this is in the region of the might-have-been.

It may be as well to mention the views of a well-known worker in the same field, Mr. Fernand Boverat, who is sometimes referred to in this book. Mr. Boverat suggests the possible application of the principle to men serving with the forces, in the form of a reduction of the military obligations of fathers of large families.

The reviewer would like to note here an important scheme of family allowances which is in operation in Great Britain. Mr. L. J. Cadbury, in an address to the Liberal Summer School, at Cambridge in August 1939, said, "We have recently adopted a Family Allowance Scheme at Bournville. We employ between 10,000 and 11,000 people, about equally divided between men and women. An allowance of five shillings a week is paid for every child over two, where more than two are of school age. We have 410 children qualifying under the scheme". He remarked that investigation showed that the extra money was mainly spent on the children's food and clothing, and he made the interesting point that, since the introduction of the system, the attitude of the community has become more favourable to parenthood and the bringing up of larger families.

The chief reasons for the widespread custom of extreme family limitation are economic, and it is to combat these reasons that the system of family allowances has been devised. We may expect that, in the post-War world, some such general scheme will find its proper part in the reconstruction of society. Mr. Glass's book will serve admirably as a sound introduction to the study of this important matter.

PLANNING IN HUMAN SOCIETY

The Plans of Men

By Prof. Leonard W. Doob. (Published for the Institute of Human Relations.) Pp. xiii+411. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1940.) 18*s.* 6*d.* net.

PROF. DOOB, of Yale University, has in this volume attempted a comprehensive treatment of the subject of planning. It perhaps suffers from being too comprehensive, nearly half the book consisting of prolegomena in the shape of a general discussion of the main types of human activity, biological, social, political and economic. Prof. Doob also suffers from the common failure of sociologists to reconcile their conscience as pure scientists with a firm and constructive handling of the problem of values. In especial, no adequate attention is given to the question of the hierarchy of values—in fact, the author goes so far as to assert that "no man can say whether the gratification secured from beer is or is not different qualitatively from that obtained by reading a sonnet"—a statement which to the reviewer appears plain nonsense, on a par with saying that no one can say whether the sensation of red is qualitatively different from that of green.

In another place, in an effort to escape from his dilemma, Prof. Doob claims that to demonstrate a *qualitative* differentiation among gratifications is impossible unless one can prove that some are *more gratifying* than others (italics mine). But surely all attempts to interpret quality in terms of quantity are logically inadmissible?

Passing from criticism to appreciation, the reader can find much of interest in Prof. Doob's book. In the first place, he rightly stresses the fact that planning is not some mysterious new type of activity which has emerged since the War of 1914–18 as a product of the U.S.S.R. or the New Deal, but a universal attribute of all human activity, both individual and social. Its scope and the degree of its organization vary enormously, and the problem of the present is to determine, not whether planning in the abstract is or is not a good thing, but on what scale and by what machinery planning should operate. On this subject, Prof. Doob has some valuable comments. He is in general opposed to what he calls "master planning", in which an attempt is made to provide big plans for an entire social economy; and he produces a number of arguments for the adoption wherever possible of regional planning, as exemplified already in the Tennessee Valley Authority. This gives more flexibility and makes better provision for "cultural self-determination". (In this connexion, it is perhaps of interest to point out that Prof. Sewall Wright, of Chicago, has demonstrated that in biology the most favourable opportunity for evolutionary change is afforded by large species subdivided into subspecies which are partially but not wholly isolated from each other.)

"The Plans of Men" is perhaps not a book for the layman, however inquiring and intelligent; but it deserves serious study by sociologists and all those who may be concerned with the theory or practice of planning. J. S. H.

PROGRESS IN BIOCHEMISTRY

Annual Review of Biochemistry

James Murray Luck, Editor; James H. C. Smith, Associate Editor. Vol. 9. Pp. ix+744. (Stanford University P.O., Calif.: Annual Reviews, Inc., 1940.) 5 dollars.

SCIENTIFIC workers cannot escape the welter of events, the horrors and anxieties of the moment. It is well, therefore, to be reminded occasionally that there is a normal side, that peaceful creative life exists. Such demonstration is welcome: it comes from across the Atlantic in the form of 743 pages of biochemical abstracts. True, the work described was done before war began, and the summaries, two of which are from Danish contributors, were written before April 1939. Everywhere there is progress, whilst some of the work will have practical application at a time when knowledge of food values and of much else in biochemistry will play a part in saving lives and in contributing to health in Great Britain.

Food is rationed. In twenty-five years the consideration of calories has given way to that of quality. The Minister of Food, acting under scientific

advice, has the courage to tell the people that they must eat what is good for them and not what they individually fancy. Perhaps our national habits are about to be changed under scientific guidance. The work has been done in many laboratories; its interpretation has been the subject of much discussion and often controversy. Such problems have many angles, wide reading is required to appreciate them, and, since the number of papers has increased beyond our powers of study, summaries have become essential.

Murray Luck and his helpers realize that the pursuit of learning is in peril: it is for them in the Pacific and us in beleaguered Britain to prevent the eclipse.

Comment in detail on such a wide subject is more than usually difficult. It is of interest to read the statement that a protein is now being regarded by many workers as a pattern rather than as a thing—a molecule of definite composition but of dubious size. Analytical work is now once more considered of importance in establishing protein structure. The proteinase enzymes are regarded as consisting of two proteins at once.

Though viruses were discovered in 1892 it was not until 1935 that a tangible characteristic material carrying virus activity became available for biochemical study. They now form a fashionable subject for intense research, and a large number of general reviews, five books, and a new journal dealing with them have appeared during 1939. Another subject which is largely novel is insect biochemistry: here the biochemist is beginning to encounter many surprising phenomena.

The bulk of the essays bear well-known American names, but there are several British contributors, notably Heilbron and Jones, Channon, Raistrick, J. A. B. Smith, Dodds and Dickens.

E. F. ARMSTRONG.

INDIAN SPOROZOA

The Fauna of British India, including Ceylon and Burma

Protozoa: Sporozoa. By Dr. B. L. Bhatia. Pp. xx+498+2 plates. (London: Taylor and Francis, Ltd., 1938.) 30*s*.

THIS volume, dealing with the Sporozoa, is the author's second publication on the Protozoa in "The Fauna of British India", and follows the plan adopted in the preceding volume on the Ciliophora. Though a number of text-books on general protozoology have appeared in the last decade the treatment of the Sporozoa in them is very inadequate, while the more specialized publications devoted to the parasitic protozoa are already out of date. Dr. Bhatia has rendered a useful service by producing a comprehensive and modern work on the Sporozoa which, though limited to the description of those species which have been recorded from India and adjoining countries, will be of undoubted value to zoologists in all other parts of the world, since most of the genera belonging to this group have a cosmopolitan distribution. With the help of the keys provided, it should be possible to identify the genus of almost any sporozoon.

In the introduction the author reviews the position of the Sporozoa in the animal kingdom, their structure, phylogeny and classification. Lists are given of the parasites and their hosts, and vice versa, and there is a useful section on technique, dealing with the methods for the examination and study of these parasites. The greater part of the book is devoted to a systematic account of the Sporozoa. The description of each subdivision is accompanied by dichotomous keys for the identification of the lower units, down to genera and species. A separate description is given of each species recorded from India (total 320), usually with illustrations, and including the relevant references and synonyms. The classification adopted can be seen at a glance in the "Systematic Index" which contains the names of all the organisms recorded in the book, arranged in their systematic order. There is also a useful glossary of technical terms and an extensive bibliography occupying more than one hundred pages. The monograph is abundantly illustrated by text figures and by two coloured plates depicting human and simian malarial parasites.

There are several instances in which the nomenclature differs from that accepted by the majority of protozoologists (for example, *Laverania malariæ* for the parasite of malignant tertian malaria), but this is a controversial subject where difference of opinion is justifiable. Dr. Bhatia can be congratulated on the production of a book which will be of great assistance to zoologists—especially parasitologists and protozoologists, including medical and veterinary workers—in need of an authoritative and up-to-date guide to the systematics of the Sporozoa.

C. A. HOARE.

A Treatise on Quantitative Inorganic Analysis

With Special Reference to the Analysis of Clays, Silicates and Related Minerals. By Dr. J. W. Mellor and H. V. Thompson. Second edition, completely revised and re-set. Pp. xxxi+784. (London: Charles Griffin and Co., Ltd., 1938.) 45*s*. net.

IN view of the excellent reception of the first edition of this book, it is surprising that so many years have been allowed to elapse before the issue of a second one. This was due, no doubt, to the many other calls on the time of the late Dr. Mellor, who finally entrusted to Mr. H. V. Thompson the task of producing a new edition. This task has been efficiently performed, the original text having been thoroughly revised and brought up to date by the incorporation of many of the newer methods and reagents introduced in recent times. Although written primarily from the point of view of analytical practice in the ceramic industry, the work covers practically all the elements and combinations of them which are met with in other analytical fields, so that it can rightly be regarded as a general treatise on quantitative analysis and one of great value to all who carry out complicated analyses.

The subject-matter is arranged according to the plan adopted in the earlier edition, being divided into five sections. These deal respectively with general analytical procedures, typical silicate analysis of glasses, glazes, colours and complex silicates, special methods including procedures for many of the rarer metals and, finally, the analysis of acids and non-metals. All these are treated in a most detailed and thorough manner, while additional information is often given in footnotes which also contain an excellent and wide selection of references from the literature. Those who have used the first edition will need no recommendation to this revised work, while those who have not, will find it one of the best text-books on its subject.

Rural Community Organization

By Prof. Dwight Sanderson and Prof. Robert A. Polson. Pp. ix+448. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 18*s*. net.

THIS book is a contribution to the solution of the old question whether man can control his social relations by taking thought as he does control the world of things. Organization of social relations must be based on an understanding of the facts. The authors state that to aim at organizing a rural community in a mechanical way such as is implied in 'social engineering' is vain, and they assert that "rural social organization is the art of planning social relationships in the rural environment by use of the methods of science". They do not, however, give more than passing reference to possible scientific methods of approach to the problems they discuss: the science they have in mind is the rather vague one of sociology, and it appears as if they had no conception of the possibilities of modern statistical reasoning. The book is an able exposition of applied psychology, illustrated with many well-documented examples of what has been done in the field of rural community organization in the United States. However empirically this has been performed, it is a beginning which offers useful lessons and can be developed. The chapter analysing community conflict and clashes of interest is novel and is particularly trenchant. The book presupposes that the student will have had a course in general sociology or rural sociology, but this is said not to be essential for mature students who have had personal experience in rural life.

Food Control, its Public-Health Aspects

A Manual for Regulatory Officers, Food Technologists and Students of the Food Industry. By Dr. James Houston Shrader. Pp. ix+513. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1939.) 24*s*. net.

ALTHOUGH Dr. Shrader's volume is written primarily for the American reader and is concerned mainly with United States public health administration, it will be welcomed by many in Great Britain as a valuable and concise manual. The author surveys a very wide field and, on the whole, does so with commendable balance and sense of proportion. In most respects his treatment is up to date. This is particularly true of his descriptions of the technical side of food preparation and manufacture. By contrast one comes now and again to sections where his knowledge is curiously behind what we should expect. Thus, for example, although compiled in the early part of last year, the section on the vitamins is far from adequate. There is merely passing reference to nicotinic acid, B_6 is not mentioned, and attention is not directed to the important differentiation between D_2 and D_3. However, any small disappointment these minor faults may provoke is soon dispelled by appreciation of the merits of the book as a whole. They are many and they far outweigh the defects, not the least of which is the use of dreadful terms such as 'organoleptic acceptance'. Shall we live to see a hoarding bearing the slogan 'Guinness is organoleptically acceptable'?

J. C. D.

Human Histology

A Guide for Medical Students. By Dr. E. R. A. Cooper. Pp. xiv+424. (London: H. K. Lewis and Co., Ltd., 1939.) 16*s*. net.

DR. E. R. A. COOPER, lecturer in histology at the University of Manchester, whose work is introduced by Prof. F. Wood Jones, the professor of anatomy, is to be warmly congratulated on the production of a text-book which will be of the utmost value to the medical student and graduate both in the laboratory and in the study. The volume, which is clearly and concisely written, consists of twenty-one chapters dealing with the microscopic anatomy of the various systems and organs. A remarkable and praiseworthy feature is the insertion at the end of each chapter of a practical examination to be carried out by the reader.

The text is liberally interspersed with microphotographs, and an excellent index is supplied.

Modern Physical Laboratory Practice

By Prof. John Strong, in collaboration with Prof. H. Victor Neher, Prof. Albert E. Whitford, Dr. C. Hawley Cartwright, and Roger Hayward. Pp. x+642. (London, Glasgow and Bombay: Blackie and Son, Ltd., 1940.) 25*s*. net.

UNTIL recently, when the physicist wanted a good advanced book on a branch of the subject, he expected to find it in a bibliography of German books. Now he is far more likely to find what he wants in an American publication. The present volume is a striking example. Three physicists, an astronomer and an architect have collaborated to produce a guide of outstanding excellence to the many special techniques now apt to be needed in the advanced or research laboratory. Two chapters at the end of the book deal with moulding, casting, and various workshop operations in metals, together with instrument design, including kinematical design. The rest of the book covers glass-blowing, optical work of all kinds, from grinding to surface coating, high-vacuum technique and such electrical instruments as electrometers, electroscopes, Geiger counters, photo-electric cells, amplifiers, and vacuum thermopiles.

The chapter on photography is a good example of the skill of the authors in giving briefly enough of the theory of an operation to enable the worker to adapt the instructions to his special needs.

Quite outstanding are the diagrams drawn by the architect collaborator, Roger Hayward. Several hundreds consist of perspective drawings with just the right amount of shading to give a pictorial effect. This, together with arrows and concise wording on the actual diagrams, gives the next best substitute for seeing the operations carried out. These diagrams deserve the serious attention of every future illustrator of physics text-books. The strict biological accuracy of including the sweat on the brow of the operator in grinding a 6-inch mirror by hand in the traditional way, adds a touch of humour, as well as giving a subtle warning.

Altogether, the book can be strongly recommended to the attention of all physicists. Several copies kept always at hand would help the work of any large group of physicists who, in times like the present, may be working at high pressure with semi-skilled assistants. W. H. G.

Penobscot Man

The Life-History of a Forest Tribe in Maine. By Prof. Frank G. Speck. Pp. xx+325. (Philadelphia: University of Pennsylvania Press; London: Oxford University Press, 1940.) 24*s*. net.

IT is a matter of frequent remark that in the last ten or fifteen years few if any of the sciences have made more rapid strides than anthropology in the development of methods of inquiry. This applies in particular to researches in social anthropology in the field and no less to the United States than to Great Britain, notwithstanding the differences in aim and outlook which mark the leading schools of thought in the Old World and the New. It is instructive to consider from this point of view the material recorded in a study of the Penobscot, an Algonquian Indian people of the State of Maine, by Prof. F. Speck, whose record of the little-known Naskapi of Labrador aroused no little favourable interest when published a few years ago.

Prof. Speck's observations of the Penobscot began in 1907, were continued until 1912, and resumed in 1918, and his record prepared from then onward. As he recognizes, observations on the lines of modern method would have produced a study of a very different character. Yet his work rounds off an epoch in the development of the Indian tribesmen. When he saw them much of their traditional culture remained unchanged from perhaps so far back as colonial days, when the British administration declared them outlaws and in 1756 was offering so high a price as £300 for an Indian scalp. So great has been the change in the interval since the date of Prof. Speck's investigations, that a student of the Penobscot nowadays would be constrained to make his investigation one of acculturation. Incidentally it may be mentioned that the Penobscot who enjoy an independent system of local administration of their own in the State of Maine and for whom ultimate extinction was prophesied a generation ago, like a number of other Indian tribes, have actually increased in numbers and there are now more than five hundred members in the tribe. They are, however, much mixed in blood.

Strength of Materials

By Dr. Arthur Morley. Ninth edition. Pp. x+571. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1940.) 15*s*. net.

THE late Sir George Greenhill, referring to Rankine's paper on the screw propeller, described it as a classic, adding, "which means something that is seldom read". This cynicism could scarcely apply to the work before us, now in its ninth edition totalling 52,000 copies. But if we accept the Oxford Dictionary as an authority we find Dr. Morley's book admirably qualified as "simple, harmonious, proportioned, and finished".

The first edition, reviewed with pleasure by the present writer thirty-two years ago, marked a distinct advance in engineering literature, and despite the progress in materials since then the book is remarkably modern. This is due to the candid style, rational outlook and clear planning of the original edition; an excellent tree on which shoots could be grafted. Although the book is a students' manual with 'exercises' to each chapter, it is also a lucid, accurate and handy work of reference and refreshment for the practitioner. The specialist may find here and there that the latest work has not been fully embodied into the text, but usually he will see a useful reference in a footnote. In later editions more complete treatment of ideas now fermenting may be possible; plasticity, auto-frettage, notch sensitivity, fretting, damping, and the effects of surface polish and machining stresses. The new plastics and the use of models in plaster and rubber may be added. In any event the book has still a useful future. H. S. R.

COCARBOXYLASE

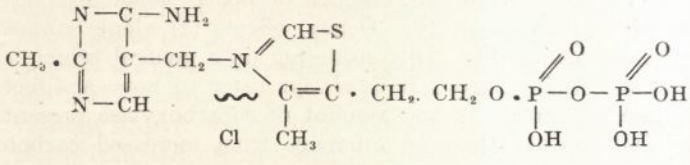
By Prof. R. A. Peters, F.R.S.,
University of Oxford

KNOWLEDGE of the detailed action of vitamin B_1 in Nature has advanced farther than in the case of any other vitamins with the possible exception of riboflavin, and nicotinic acid; even in the case of these, detailed knowledge has come to hand more recently. This is not only due to the striking advances in the pure chemistry but also to the fortunate circumstance that it was the first vitamin in which specific action *in vitro* upon an animal tissue was demonstrated[1]. Since its action is so intimately bound up with a fundamental stage in the degradation of carbohydrate, it justifies in a way the conception originally lying behind the use of the word 'vitamine' by Funk. Useful as the new terms for this vitamin 'aneurin' and 'thiamin' undoubtedly are, it seems a pity to lose sight of the idea of the "amine essential for life", because in a way this is very nearly true. Formation of carbon dioxide depends more upon this factor than upon any other.

In 1912, Neuberg and Kerb reported the presence in yeast of an enzyme called carboxylase, which catalysed the decarboxylation of α-keto acids according to the equation

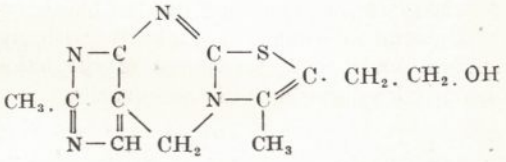
$$R.CO.COOH = R.CHO + CO_2$$

where R is a simple aliphatic radicle. Auhagen (1932), working in von Euler's laboratory, split carboxylase into two factors, both needed for activity, a protein one and a thermostable factor known as cocarboxylase. There had been a previous claim (1928) that there was a form of vitamin B_1 precipitable by lead acetate[2]. In 1936, Lohmann and Schuster, in a now classical paper, isolated cocarboxylase as a crystalline compound, and proved that it was the pyrophosphate of this vitamin (I).



I

Short hydrolysis (7′) in *N* hydrochloric acid converts cocarboxylase to vitamin B_1 monophosphate, an inactive compound. Owing to esterification upon the —OH group of the thiazole ring, cocarboxylase does not give the formaldehyde azo reaction of aneurin, though it still reacts with alkaline ferricyanide to form the brilliant blue fluorescent 'thiochrome' ring (II), giving thiochrome



II

pyrophosphate; this can be distinguished from free thiochrome (though not from thiochrome-monophosphate) by its failure to pass from an alkaline solution into a butyl alcohol layer, a property which can be used in estimation. Digestion with takaphosphatase and pepsin can be used to convert phospho forms to free vitamin for estimation as thiochrome[3]. In milk especially the cocarboxylase is more firmly bound to the protein present, being not freed as in yeast by boiling, so that a predigestion is essential for accurate estimates of total vitamin B[3a]. An earlier and usual method of estimation makes use of the carbon dioxide production from pyruvic acid over periods varying from 30 sec. to 2 hr. In this a yeast preparation, usually known as ætiozymase freed from cocarboxylase by washing under alkaline conditions, is treated with pyruvic acid, when the extent of carbon dioxide production is determined by the amount of cocarboxylase added; Mg or Mn″ must be present. Accumulating acetaldehyde brings the reaction gradually to a stop; Zn and Cu ions are inhibitory. Doubt was cast upon some earlier results reached by this method, when it was found by Ochoa in 1937 that free vitamin much stimulates carbon dioxide production with a given amount of cocarboxylase when no synthesis to cocarboxylase could be detected. This effect, due to the pyrimidine half of the molecule, was so regular that it could be used by Ochoa and Peters as a means of estimating separately both vitamin B_1 and cocarboxylase in a boiled tissue extract. In spite of this regularity others, notably Lipton and Elvehjem, and Weil-Malherbe, have obtained ætiozymase preparations which show no 'Ochoa' effect. The explanation of this puzzle, at any rate in part, is due to Westenbrink and van Dorp (1940). The addition of B_1 (or the pyrimidine) inhibits

the action of a phosphatase, which if present breaks down the added cocarboxylase. So the effect is an artefact, a conclusion which Oxford workers had reached owing to failure to see it with animal tissues. Still the inhibiting action upon phosphatase may be more important than we know. (There is yet unexplained why Lipton and Elvehjem should get less activation with fresh yeast, where one would expect the presence of more active phosphatase.)

Cocarboxylase has been synthesized by chemical methods using heating of vitamin B_1 with pyrophosphoric acid[4] or by treatment of the halogen compound along the lines of the equation[4].

$$C_5H_6N_3-CH_2-C_4H_4NS-CH_2CH_2Br + AgH_3P_2O_7 = C_5H_6N_3 - CH_2 - C_4H_4NS - CH_2CH_2OP_2O_6H_3 + AgBr.$$

The yields are spoilt to some extent by the difficulty of separating the monophospho B_1 formed[4].

Since cocarboxylase is an essential factor in the final stage by which acetaldehyde is formed, it is clear that it is also essential in the formation of alcohol. There have been several problems in the minds of workers in this field. Is the vitamin in the animal tissue, as in the yeast cell, only active in the pyrophosphorylated form? This was what Lohmann and Schuster thought, though did not really prove. What is the distribution of the factor? How is it synthesized by animals and yeast? With these questions is bound up the interesting problem of exactly what the vitamin does in the body in its relation to the metabolism of pyruvic acid.

Normal animal tissues contain cocarboxylase in larger, much larger, amounts than free vitamin. After injection or feeding of vitamin B_1 especially with avitaminous animals there is a large increase of cocarboxylase in the liver, showing the marked capacity for synthesis possessed by this tissue, which is shared by kidney[5]. The predominance of the phosphorylated form was certainly in favour of the view that this was the active form, though this has only recently been put beyond all reasonable doubt. Banga, Ochoa and Peters[6] have succeeded in an apparently final proof using the avitaminous animal with symptoms as the crucial test. Very briefly, the facts are as follows: normal pigeons contain 4 μ gm./gm. of cocarboxylase, avitaminous in symptoms, 0·4 μ gm./gm., 'rice fed' animals but not in symptoms, about 1·2 μ gm./gm. The loss of some 0·8 μgm. is enough to precipitate the symptoms. With brain brei from an avitaminous bird, the catatorulin effect of vitamin B_1 (extra oxygen uptake due to addition of vitamin, pyruvate as substrate) is greater than that of cocarboxylase. This formed a stumbling block to a final proof, because the action of cocarboxylase should have been at least equally great. Using two types of finely ground brain preparations (dispersions), it was found that with the most macerated of these only cocarboxylase stimulates oxygen uptake; with an intermediate type both vitamin B_1 and cocarboxylase are active, but in the reverse order to the brei. Further there was a small but sufficient synthesis both in brei and also in dispersions, where stimulation with vitamin was observed. So it is clear that failure of cocarboxylase to give good catatorulin effects with brei was due to lack of penetration of the phosphoester to the active centre, as had been previously suspected. These new facts seem to settle finally that the form responsible for normal brain activity is cocarboxylase, and give a good idea as to what happens to the vitamin after administration. Sinclair and Goodhart have found cocarboxylase present in blood corpuscles, especially when nucleated, but there are small amounts of free vitamin in plasma. So we can conclude that though liver and kidney trap aneurin as cocarboxylase, it is carried free as wanted in the blood and synthesized to the pyrophosphate after passage through the cell membrane. The brain enzyme system is saturated with about 1 μgm., cocarboxylase per gm. of fresh brain. Under optimal conditions, 1 mol. of cocarboxylase will catalyse the uptake of 1,500 mol. oxygen per minute.

Synthesis of cocarboxylase by yeast and animal extracts has been studied. Kinnersley and Peters were actually the first to record that fresh baker's yeast readily formed this from free vitamin under simple conditions; it was separated by lead acetate; a little later Euler and Vestin claimed a conversion with dried yeast upon not very substantial evidence. In 1938, Lipschitz (now Lipton), Potter and Elvehjem made the claim that cocarboxylase was synthesized by an ætiozymase preparation in their possession. It was based upon the finding that (*a*) vitamin B_1 stimulated the carbon dioxide output in presence of magnesium, pyruvate and boiled tissue extract, and (*b*) that hexosediphosphate increased this decarboxylation, again in presence of boiled tissue extract. In view of the 'Ochoa' effect, (*a*) alone cannot prove this. In considering (*b*) a general principle is involved. It is always safer to have a direct estimate of the amount of cocarboxylase present rather than an inference from increased carbon dioxide outputs. When it was found at Oxford that hexosediphosphate alone increased the carbon dioxide output in complete absence of vitamin provided that both pure cocarboxylase and cozymase were present, an alternative explanation became available. By dismutation of triosephosphates (formed from hexosediphosphate) with acetaldehyde in presence of cozymase, ethyl alcohol

and phosphoglyceric acid would be formed ; thus the concentration of acetaldehyde would be reduced, which is known to inhibit carbon dioxide output in this system. Another factor involved is the stability of the cocarboxylase, which is destroyed by phosphatase, but continually resynthesized and so maintained at its constant level in presence of cozymase and carbohydrate[7]. Though these experiments did not provide the necessary proof of synthesis, later work by the same authors and by Weil-Malherbe has done so.

Before considering this, we may turn to the animal, where positive results for synthesis reported by Euler and Vestin for rat liver extracts and for avitaminous brain by Peters were invalidated by ignorance of the 'Ochoa effect'. Tauber's claim for synthesis by acetone preparations of intestinal mucosa also could not be confirmed by Ochoa except under conditions where growth of bacteria was possible. Likewise Stern and Hofer failed with glycerol extracts of various tissues. On the other hand Lohmann and Schuster had originally reported a well-controlled synthesis with brain under alkaline conditions, which was finally confirmed for biological *p*H in the work already mentioned. Synthesis *in vitro* with liver has been studied by Ochoa using the avitaminous pigeon, because the amount found in the normal is near the limit for synthesis. Liver slices, brei or dispersions showed a similar degree of activity, extracts less, and acetone-dried preparations none. Quadrupling the vitamin at amounts near the maximum did not increase synthesis, so that the percentage conversion is larger for smaller amounts. The synthetic reaction occurs from *p*H 6·2 to 10 (optimum *p*H 8·5), and is dependent upon the presence of an intact oxygen uptake or respiration ; it was not improved by addition of adenosine triphosphate, phosphoglyceric acid, glucose or sodium hexosediphosphate, and was much more inhibited by iodoacetate (0·009 *M*) than by sodium fluoride (0·04 *M*). A point of importance was the proof that the tissues contained a soluble enzyme, which would destroy cocarboxylase anærobically, in amounts parallel to the ærobic synthetic activity, which led to the inference that in respiring systems there is continual resynthesis. Ochoa thinks that one and the same enzyme catalyses the reaction vitamin B_1 pyrophosphate $\rightleftarrows$ vitamin B_1 + 2 phosphate, the energy from respiration being required to shift the equilibrium in this reaction to the left. Recently, Goodhart and Sinclair (1939) have achieved synthesis of cocarboxylase with nucleated blood cells.

Returning now to synthetic work with yeast, both Lipton and Elvehjem and Weil-Malherbe[8] have recently formed cocarboxylase with ætiozymase from brewer's bottom beer yeast under conditions now quite convincing, because either (1) the preparations show no B_1 stimulation or (2) interpretation has not depended solely upon increased carbon dioxide production. As with liver, the degree of synthesis is determined by saturation of the protein component of the enzyme. Upon addition of free vitamin, Weil-Malherbe finds an induction period of 15 min. ; the synthesis is much stimulated by adenosine triphosphate. Phosphopyruvic acid is decomposed if there are simultaneously present vitamin B_1, a phosphate carrier (adenosine triphosphate), and an acceptor such as glucose. Differing somewhat in detail, the others reach the same general conclusion that phosphorylation is induced by adenosine triphosphate, this being connected with various stages of the Embden-Meyerhof cycle, much as would be expected from the previous work of Meyerhof and D. M. Needham. There are several points of interest in this work lying outside the scope of this review.

The course of the reactions with yeast appear comparatively simple ; cocarboxylase and a protein factor together catalyse production of acetaldehyde and carbon dioxide from pyruvate. In the animal it is more complicated ; acetaldehyde never appears. In brain tissue, the course of oxidation of pyruvate is represented by the following three simultaneous equations in the proportions indicated :

19·5 per cent $2CH_3.CO.COOH + O_2 = 2CH_3.COOH + 2CO_2$ . . . (1)

67 per cent $2CH_3.CO.COOH + 5O_2 = 6CO_2 + 4H_2O$ (2)

10 per cent $2CH_3.CO.COOH + H_2O = CH_3.CHOH.COOH + CH_3.COOH + CO_2$. (3)

This is known from quantitative data by Long upon acetic and lactic acids and by McGowan upon oxygen/pyruvate ratios and respiratory quotient, (CO_2/O_2). The Krebs dismutation equation 3 need not concern us further, except to point out that Barron and Lyman have now proved that this reaction is separate from that of equation 1. Reactions 1 and 2 required simultaneous decarboxylation and oxidation, and the exact nature of the systems involved has given rise to much work. What enzymes are needed for the complete oxidation ? Are the reactions of 1 and 2 separate or is 2 conditional in part upon 1 ? What is the course of pyruvate oxidation ? What is the biological object of pyruvate oxidation ?

Reaction 1 is carried out anærobically by washed brain tissue in presence of methylene blue. Lipmann has studied a simple example of this in more stable acetone dried lactic acid bacteria preparations ; he has found the following essential, cocarboxylase, Mn'' or Mg, a protein and inorganic

phosphate, also the adenine flavin dinucleotide[8]. He considers now that acetyl phosphate is an intermediate in acetic acid formation, being formed oxidatively as in the equation

$$CH_3CO.COOH + H_3PO_4 + O_2 = CH_3COO.PO_3H_2 + CO_2 + H_2O_2$$

When added to the bacterial preparations (with pyruvate), adenylic acid was phosphorylated to adenosine triphosphate, without increase in pyruvate dehydrogenation. Ochoa, Stocken and Peters could not find that acetyl phosphate behaved as an intermediate in brain reaction 1, which is known to need inorganic phosphate. But Banga *et al.*, in the last eighteen months, using dialysed dispersions, have proved that for reaction 2 there are wanted in addition to the above, fumaric acid (the Szent-Gyorgyi C_4 catalytic system ; this system involves the acids succinic fumaric, malic, and oxaloacetate, the enzymes succinic and malic dehydrogenase and fumarate), cozymase (probably) and adenylic acid. The function of the latter differs from that in Lipmann's experiments in the sense that the oxidative removal of pyruvate is greatly increased in its presence. So there is proof for the first time that the 'adenine nucleotide' is needed for respiration and oxidation of pyruvate in animal tissues ; both oxygen is taken up and carbon dioxide evolved in the completed system. For this important and to some extent final step in metabolism, brain cells mobilize a complex of their enzymes.

Earlier work suggested that in brain an unknown intermediate from reaction 1 could either be oxidized along the lines of equation 2 or, in absence of some factor in the complete oxidation system, be merely degraded to acetic acid ; in other words, reaction 2 is bound up with reaction 1. This was supported by quantitative evidence from the behaviour of α-keto butyric acid, which, though disappearing at the same rate as pyruvate, is merely degraded to proprionic acid. More recent unpublished work[9] suggests that the matter is not quite so simple, so that the question must still be considered an open one as to whether reactions 1 or 2 are related or not. The course of oxidation in reaction 2 is not yet clear. Obviously this would be well realized if C_2 fragments in phosphorylated or other form (due to decarboxylation) were resynthesized to carbohydrate, afterwards to be degraded upon the usual lines. But though it is known that phosphoglycerate will re-enter the system in dispersion, the poor oxygen uptake given by hexosediphosphate with the dispersion is much against this attractive view. Turning to the possibility that oxidation may take place either through the C_4 acids or through some combination of these and citrate, a very complete scheme has now been produced by Krebs and colleagues[10] for muscle. This must be distinguished from the idea that these acids act catalytically. It can be said that citrate alone will not replace fumarate in catalytic action upon pyruvate oxidation in brain dispersions, showing that it is not readily convertible to this in the dispersion ; also, the rate of oxidation with brain of α-keto glutarate ($COOH.CO.CH_2CH_2$-$COOH$) suggested as intermediary seems too slow to satisfy conditions as an intermediary ; hence for the moment the balance of evidence seems against the idea that the citrate cycle is directly involved in brain. Experiments in this field are complicated, however, by the ease with which oxaloacetate ($COOH.CO.CH_2COOH$) formed from fumarate via malate can pass back to pyruvate ; there is no doubt that some cycle involving this decarboxylative return to pyruvic acid with loss of carbon dioxide is attractive ; but whatever scheme is involved, it does not seem possible to dispense with some C_2 fragment as at any rate part of the oxidation, and therefore with cocarboxylase.

Considering the function, it seems clear now from recent work by Ochoa[11] that under suitable conditions oxidation of pyruvate in presence of adenylic acid can cause phosphorylation of both hexosemonophosphate and also most interestingly of glucose itself, 'adenine nucleotide' being the intermediary carrier of phosphate. (Cori, Colowick and Cori[12] have shown that in kidney, synthesis of phospho esters from glucose is coupled with succinate oxidation, following up work by Kalckar[12].) This phosphorylation of glucose by a dialysed brain dispersion with appropriate additions in presence of fluoride is an achievement of no small significance, not least because of the claims for the existence of non-phosphorylating glucolysis in brain. It may be emphasized that this step only takes place ærobically so far as it is produced by pyruvate oxidation, and so far as our present knowledge goes ; of course there can take place anærobically transfer of phosphorus from phosphopyruvic acid via the adenylic acid system. It will be fascinating when we can say exactly how the phosphate is transferred to adenylic acid during pyruvate oxidation, but meanwhile the main object of the oxidation appears to lie in the maintenance of mobile phosphate.

Finally we come to the question of the mechanism of decarboxylation (yeast) and decarboxylation-dehydrogenation (animal and *B. delbruckii*). There has been no lack of speculation upon this, both in print and out of it, and much play with various models. It has often been suggested that decarboxylation occurs through combination of the keto group of pyruvate with the $-NH_2$ group on the pyrimidine molecule upon the lines of Langenbeck's much quoted scheme. Likewise

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Weil-Malherbe has directed our attention to the familiar scheme of Martius and Knoop for transamination, and indicated a way in which (on paper) we may get the desired decarboxylation and dehydrogenation. Unfortunately the acetyl cocarboxylase required to implement the hypothesis is missing. Lipmann has the idea that hydrogen can be added to the quaternary group as in cozymase, and has been able to get a stable reduced thiazole product with benzthiazole; unfortunately the reduction product of cocarboxylase is unstable, so that we have not yet proof from this work that reversible oxidation and reduction can occur; but Stern has recently joined with the statement that though free vitamin can be broken down by hydrogenation with platinum black, cocarboxylase is reduced to a compound which is still active. In a repetition of these experiments Ochoa (personal communication) finds that the rate of hydrogenation of either, with platinum black or hydrosulphite, is much slower than that of cozymase; in view of this slowness, the claim does not carry conviction. Considering the large amount of thought given to the details of this reaction, it is quite extraordinary how it still stands up to investigation; this is shown by the battered fragments of research which finally see the light! Probably we must first know more about the protein component, which is likely to alter the reactions of the molecule. Nevertheless the challenge as well as the interest remains, and we can at least say that we know much better now why vitamin B_1 is important.

(I am much indebted to Dr. Ochoa for helpful criticisms.)

[1] Gavrilescu, Meikeljohn, Passmore and Peters, *Proc. Roy. Soc.*, B, **110**, 431 (1932).
[2] Kinnersley and Peters, *Biochem. J.*, **22**, 419 (1928).
[3] See especially Pyke, *J. Soc. Chem. and Ind.*, **58**, 338 (1939).
[3a] Houston, Kon and Thompson, *Soc. Chem. and Ind., Proc. Biochem. Soc.*, July 1939.
[4] Weijland and Tauber, *J. Amer. Chem. Soc.*, **60**, 2263 (1938); Weil-Malherbe, *Biochem. J.*, **34**, 980 (1940). Stocken (unpublished).
[5] For many references see recent lecture, *J. Soc. Chem. and Ind.*, **59**, 373 (1940).
[6] Banga, Ochoa and Peters, *Biochem. J.*, **33**, 1109 and 1980 (1939).
[7] Ochoa (unpublished).
[8] Lipton and Elvehjem, also Lipmann-Sympos. Quant. Biology Cold Spring Harbor (1940); Weil-Malherbe, *Biochem. J.*, **33**, 1997 (1940).
[9] Ochoa and Long (independently); unpublished.
[10] Krebs and Eggleston, *Biochem. J.*, **34**, 442 (1940).
[11] Ochoa, NATURE, **146**, 267 (1940).
[12] Cori, Colowick and Cori, *J. Biol. Chem.*, **133**, 359 (1940).

THE RATE OF A MOVING CLOCK

By Prof. Herbert Dingle,
Imperial College of Science and Technology

In an earlier article[1] it was pointed out that there is no foundation for the oft-repeated and generally believed statement that the rate of a moving clock is reduced by a certain factor compared with that of a similar stationary clock. The statement is baseless because in physics there is no explicit definition of a clock. A time-scale only is prescribed, and any instrument which records intervals agreeing therewith can legitimately be used as a clock. Three examples of such instruments were chosen, and it was shown that in no two of them was the ratio of the rates of stationary and moving clocks the same. It follows that, for any particular type of clock, this ratio (which, however, has no fundamental importance) can be determined only by taking into account the principle or the mechanism by which the clock operates. The familiar relativity transformation, $dt' = dt/\sqrt{1 - v^2/c^2}$, refers to the *time-scale* of physics, and can be logically deduced from the experimentally determined effect of motion on space measurement because the time-scale itself is defined in terms of space measurement: it is quite independent of the behaviour of moving clocks.

This article has given rise to a mass of correspondence, a small fraction of which has been published in NATURE. Almost every correspondent has dissented from the conclusion summarized above, and as the objections have mainly been based on the same few considerations, it seems desirable to make a further attempt to elucidate the question by discussing them specifically. It will be sufficient to limit attention to two of the three sample clocks chosen, which we may call a 'mass-clock' and a 'volume-clock', respectively. It may be remembered that these were instruments of hour-glass type, in which drops of water fell into a receptacle, and the time interval from a given zero was defined to be proportional in one case to the mass, and in the other to the volume, of water which had fallen. The instruments were presumed to have been adjusted at an observatory so that their rates when at rest both agreed with the mean solar time scale. It then follows that, since the transformation formulæ for mass and volume are different, the rates of the clocks when in motion must be different also.

One complication, which most correspondents have introduced, should be excluded at the outset: the problem has nothing to do with the comparison of observations by different observers. One observer only is involved, and it is his business

to compare the rates of two similar clocks, one at rest and the other moving uniformly with respect to him. Anyone, therefore, who has "disproved" the thesis of the article by invoking the findings of a second observer will be well advised to simplify his argument by eliminating this superfluous being. A second observer can, of course, be admitted as an auxiliary, provided that the argument can, in essentials, survive his withdrawal. When, as in all the instances I have so far seen, it cannot, it is clear that the argument is beside the point.

The commonest example of this confusion is found in the contention that the mass-clock and volume-clock are legitimate instruments, provided that their readings are taken by observers moving with them instead of by the observer standing by the 'stationary' clock. It is difficult to see any justification for this arbitrarily imposed condition, but let us see what it becomes when the auxiliary moving observer is removed. The condition then is that the time-interval must be defined as proportional, not to the mass or volume of fallen water, but to the rest-mass and rest-volume respectively. I have no quarrel with this as a definition of other types of clock, though it is open to the objection, so far as our present problem is concerned, that a 'moving' clock is by definition an impossibility, and the problem is therefore unapproachable. What I find difficult to understand, however, is why the inventors of these clocks think that they will exhibit the relativity transformation of the time-interval, dt. Rest-mass and rest-volume are, of course, invariant to uniform motion, and the transformation formula is therefore $dt' = dt$. This simply reinforces my point by giving additional variety to the behaviour of moving clocks.

A large number of correspondents seek to throw light on the matter by examining the process of observing the dial of the moving clock. The passage of light to the observer, and the effect on the time of its arrival of the motion of the clock, are discussed in detail—always, of course, with the standard relativity transformation formula emerging triumphantly at the end. These considerations are very interesting and instructive; their defect is simply that they have nothing to do with the point under discussion. This might have been guessed from the fact that the principles underlying them were well understood before the theory of relativity was thought of, and if they could have yielded a transformation formula differing from the classical one, that fact would have been discovered long ago. It may be worth while, however, to show their irrelevance by presenting a condensed form of the argument concerning the mass- and volume-clocks. Let two mass-clocks and two volume-clocks be adjusted so that in the former 1 gm. and in the latter 1 c.c. of water falls in each mean solar second when all are at rest. The four clocks then run at the same rate when there is no relative motion between them. Now let the observer stand by a mass-clock and a volume-clock, and let the other mass-clock and volume-clock move away from him, side by side, at uniform velocity. The process of observing the moving clocks will then be the same for both but, since density is not invariant, 1 gm. of water will not fall in the same interval of time as 1 c.c. The two moving clocks therefore run at different rates, and there is no difference in the process by which they are observed to account for their disagreement.

The objection that a clock must not be defined by a principle (such as that time interval is proportional to mass of fallen water) but is simply a piece of matter the dial readings of which must be accepted without correction has already been dealt with[2]. Anyone who holds this view must explain why the measurement of time differs radically from that of temperature, pressure, etc., and must state, and justify his statement, which of the many varieties of 'clock' is the one which must be used in an experiment to test the rates of moving clocks. Having done this, he must explain why we know the transformation formula for dt although experiments on this unique clock have not been made, and he must further consider what, in the event of such experiments being made and yielding an unexpected result, he would do about it. These duties not having yet been performed, we are justified in accepting as a clock any instrument defined and constructed in such a way that its readings, so long as it obeys the definition and preserves the construction, are passed by a recognized observatory as a true record of the standard time-scale.

It seems, therefore, impossible to avoid the conclusion that if one sets in motion any instrument normally accepted as a clock, and compares its rate with that of a similar instrument at rest, the result will be quite unpredictable without an exact specification of the principle of operation or detailed mechanism of the clock. If, as is probable, the result should not agree with the relativity transformation of the t-co-ordinate, the fact would be trivial; it would simply indicate that the particular clock used recorded, when in motion, a different time-scale from that adopted in physical theory, in precisely the same way as the failure of an air thermometer to verify the laws of thermodynamics at low temperatures would indicate that the air thermometer under those conditions did not record the temperature-scale adopted in physical theory.

The significance of this conclusion lies in its relation to what is probably the most fundamentally important effect of modern physics—namely, the revision which it makes necessary in our ideas of that in our knowledge for which we depend on experience and that which can be acquired by pure reason. The transformation of the t-co-ordinate is not a fact of experience : it is a logical deduction from the experimental fact sometimes called the 'Fitzgerald contraction' and the convention of physics by which time is measured in terms of the space covered by a specified moving body. It can be shown, in fact[3], that the whole of the special theory of relativity follows logically from the effect of the 'Fitzgerald contraction' on the traditional definitions of classical physics.

There is no doubt that a great deal of knowledge which has been acquired by experiment, and for which we are still generally thought to be dependent thereon, is a necessary consequence of other knowledge. Sir Arthur Eddington takes an extreme view in this matter, and maintains that the whole of the laws of physics could, in principle, have been derived by reason without recourse to experience[4]. Those who accept the scientific tradition must hold this to be an obvious error, for a law of physics is by definition a rational statement of the regularities found in experience ; hence, no experience, no law. Any purely rational deduction of what is apparently a law of physics must be a deduction from certain premises, and if those premises are not guaranteed by experience they must be assumed arbitrarily. Other premises would have yielded other 'laws', and only experience can tell us which are the laws of physics.

Eddington's contention is based on the general theory of relativity and the quantum theory, and is, we hold, an over-generalization of the fact that those theories have shown that a little experience goes a long way in theory. The special theory of relativity alone is an inadequate criterion by which to judge it, but that compact department of physics affords an excellent example of both the power and the limitations of reason in the building-up of knowledge. By the wisdom of our ancestors, metrical physics has been constructed entirely in terms of one fundamental unit—that of length : all other units are, by definition, dependent on that. The experimental discovery of the dependence of length on velocity therefore creates a disturbance which travels through the whole of physics, and its effect is to show that certain conceptions, formerly thought to be independent and fundamentally necessary, are actually different forms of others already adopted. The identity of mass and energy, and the unity of the electromagnetic field and of the space-time continuum, are examples. But these achievements in no way remove the dependence of laws of physics on experience. They simply allow us to express in simpler terms the regularities found in experience. We may perhaps look forward to the time when a single conception—possibly a sufficiently elaborated 'space-time'—will suffice to express all the order which experience exhibits, and we may then predict all that lies ahead. But we can never be sure that, even in that event, our predictions will not be falsified and our laws will not need amendment.

[1] NATURE, **144**, 888 (1939).
[2] NATURE, **145**, 427 (1940).
[3] See "The Special Theory of Relativity" (Methuen's Monographs on Physical Subjects. In the press).
[4] "The Philosophy of Physical Science" (Camb. Univ. Press).

OBITUARIES

Prof. A. E. H. Love, F.R.S.

PROF. A. E. H. LOVE, Sedleian professor of natural philosophy in the University of Oxford, died on June 5, 1940, at the age of seventy-seven. Though of late years in frail health, he had been active in lecturing and attending to University business up to the time of his brief illness, and he had seemed well and brisk when meeting his colleagues at a sub-faculty meeting early in the summer term. He was unmarried ; his sister Blanche, whose devotion to his welfare was extreme, survives him.

Augustus Edward Hough Love—the name Hough arose from a connexion with the Cape astronomer of that name—was born at Weston-super-Mare on April 17, 1863 ; his father was police-surgeon to the Borough of Wolverhampton, and Love attended the Grammar School, Wolverhampton, from 1874 until 1881. The then headmaster was Thomas Beach, a man of some force of character ; and Love was taught mathematics by the Rev. Henry Williams, who afterwards succeeded Beach. Love maintained an attachment to his old school, giving an annual mathematical prize. Love is said to have been a little odd as a schoolboy—not an uncommon thing for mathematicians—and a certain whimsical touch endeared him to his friends throughout later life. He was awarded a sizarship at St. John's College, Cambridge, in 1881, and went into residence there in 1882. He became scholar of the College in June, 1884. He was Second Wrangler in Parts I and II of the Mathematical Tripos in 1885, between Anthony Berry and H. W. Richmond (both of King's) ; he was placed in Division I, Part III in 1886 and was awarded the

First Smith's Prize in 1887. He held a fellowship at St. John's College from 1886 until 1899 and became a College lecturer (two of his colleagues being R. R. Webb and Sir Joseph Larmor). This was a time of great mathematical activity for Love, and he was elected fellow of the Royal Society in 1894. It was then, too, that there commenced his long association with the London Mathematical Society; besides filling the presidential office, he served for fifteen years as an honorary secretary, and was altogether thirty-three years on its Council.

Love was elected to the Sedleian chair in Oxford in 1899, and the increased leisure allowed him even to increase his research activity in his chosen subjects of elasticity, geodynamics and electrodynamics. He won the Adams Prize at Cambridge in 1911 for an essay entitled "Some Problems in Geodynamics", which was soon afterwards published. He was awarded a Royal Medal in 1909, the De Morgan Medal of the London Mathematical Society in 1926 and, as a fitting tribute to his life-long devotion to mathematics, the Royal Society's Sylvester Medal in 1937. He was elected an honorary fellow of St. John's College in 1927, in which year also he became a fellow of the Queen's College, Oxford. His international standing was recognized by his associateship of the Academy of the Lincei and his election as a corresponding member of the Institute of France.

Love will chiefly be remembered for two outstanding achievements, his discovery of what afterwards became known as 'Love waves' and his authorship of his treatise on the "Mathematical Theory of Elasticity". It is a classical result that any disturbance in an elastic medium resolves itself into the propagation of trains of compressional and distortional (equivoluminal) waves in three dimensions, but it is not immediately obvious that there exists a mode of combination of such trains which results in the propagation of a disturbance in two dimensions over the *surface* of a semi-infinite elastic body. Such a form of waves was discovered by Rayleigh. Love showed that in a medium consisting of a superficial layer of one density and rigidity resting on a subjacent layer of different density and rigidity, there exists a new form of two-dimensional waves, decreasing in amplitude exponentially with depth, propagating themselves with a tangential disturbance transverse to the direction of propagation, and depending for their existence essentially on the heterogeneity of the medium. These are of importance in seismology. Love investigated the dispersion of such wave-trains, and the application of his methods in the hands of seismologists has led to important information about the crust of the earth. The essay on geodynamics in which these investigations first appeared has a completeness of mathematical detail which makes it attractive reading to-day, and which contrasts strangely with the modern suppression of details of mathematical technique in physical papers which came in after the War of 1914–18, owing to the need for compression. Love's sentences—whether in English or in symbolism—come with the leisurely perfection of the great memoirs of a former century.

The treatise on the "Mathematical Theory of Elasticity" stands in a class with Lamb's "Hydrodynamics", and is a classic. If a comparison between 'good' things is at all legitimate, it may be said that Love's work is if anything the more scholarly but the tougher reading, as befitting a more intractable subject. Love was essentially a mathematician, delighting in partial differential equations and spherical harmonics; the eye to applications was there, but he was no engineer. The "Elasticity", like Lamb's "Hydrodynamics", is academic in character, but what a joy does the academic reader derive from it, once properly afloat on that inland sea! Whether it be the foundations of the subject, the equilibrium of strained bodies, the torsion of prisms, the vibration of solids, the propagation of waves, the bending of beams, or the theory of thin shells, the whole is verifiable, calm, controlled by the mind of a master. Love was perhaps attracted to the subject because after a controversial start it had settled down into a subject in which the principles were well accepted and well understood; the mathematician could, up to a point, have complete confidence in the foundation on which he was building.

Love's lectures at Oxford were ever models of form, and he devoted much care to the preparation of courses on subjects outside his researches—notably on relativity and the tensor researches. In this connexion it is the more remarkable that in the "Elasticity" he scarcely recognizes that the components of strain on one hand and of stress on the other form tensors—three-dimensional symmetric tensors of a most instructive kind. His notation was in fact unfortunate, as it concealed the tensor nature of these entities; his Xy and Zx for components of stress are quite frankly abominations of un-symmetricality, and his omission of the factor $\frac{1}{2}$ in his definitions of the non-principal components of strain is disastrous in transformation formulæ. But everything may be forgiven to a man of Love's attractive geniality and modesty of character.

It is not generally known that Love, in the War of 1914–18, made a contribution to ballistics which resulted in 'Love's method' for the calculation of trajectories being applied for some time at Woolwich. No notice of him would be complete without a mention of his hobby of croquet. Oxford is the poorer by the loss of his characteristic figure on the croquet lawn in the parks.

E. A. MILNE.

The Duke of Bedford, K.G., K.B.E., F.R.S.

THE Duke of Bedford, who died on August 27 at the age of eighty-two, was elected to the Council of the Zoological Society of London in 1896. He was already known as an ardent and competent naturalist with a special interest in ducks, geese, cranes, gallinaceous birds, and herbivorous mammals. The foundation of his magnificent collection of animals at Woburn Park was already laid, and throughout his life he continued to improve it, spending large sums through the late Carl Hagenbeck and other collectors to add to its richness. He was not content

with acquiring exotic animals ; his great desire was to establish them and make breeding herds in Great Britain, and he acquired a unique knowledge of the conditions which made for success and failure. He was the first to introduce Prevalsky's wild horse to Europe. There is a small herd of the European bison, now extinct in its wild haunts, being nursed at Woburn, and he secured the last survivors of Père David's deer from the Royal Park at Pekin, so that there is at present in England the sole survivors of this unique species. Another accomplishment, very interesting to zoologists, is the successful acclimatization in the Woburn woods of the brush turkey.

On the Council of the Zoological Society, the Duke made the acquaintance of the late Mr. Oldfield Thomas, and began to subsidize collecting expeditions to Central Asia, Japan and China, with the result that the British Museum (Natural History) has an extraordinarily fine series of Chinese and Japanese mammals, including the types of many new species.

During his early years on the Council, the Duke, in his characteristically modest fashion, took little active part in its proceedings, but was a regular attendant and a shrewd observer. In 1899, on the death of Sir William Flower, he was elected president, a position which he held until he retired in 1936, and from then on, took a leading part in all the affairs of the Society. The great progress made during that time was due to his ready generosity, but still more to his wise but prudent counsel. On the resignation of P. L. Sclater, who had been secretary for many years, he appointed a special committee to examine the affairs of the Society and make plans for its reorganization. The control of the Council was made more direct ; changes in staff and the allotment of duties were arranged. Financial control was strengthened ; the general hygiene of the Gardens was vastly improved, and scientific investigation into the diseases and parasites affecting the animals—subjects in which the Duke took special interest—was arranged and provision for visitors was improved.

The financial position of the Society from increased numbers of fellows and of visitors quickly reacted to these changes, and it was possible to construct a large number of new buildings. The Duke was interested in all of them, but probably he was most deeply concerned with the Aquarium, and with the great experiment of Whipsnade. Jointly with the Fishmongers' Company he guaranteed an annual sinking fund to pay for the former, but fortunately the success was so great that the total cost was paid off from revenue in two years. Up to the last months of his life he took a deep interest in the progress of Whipsnade Park, remaining an honorary member of the Committee and visiting it frequently.

P. CHALMERS MITCHELL.

Prof. A. D. Arkhangelsky

THE death occurred in a sanatorium near Moscow, on June 16, at the age of sixty, of Andrei Dmitrievich Arkhangelsky, one of the foremost geologists of the U.S.S.R. Prof. Arkhangelsky's investigations of the geology of the U.S.S.R., based on a study of the laws of the geological development of the earth's crust, are of great theoretical and practical importance. His work has proved an accurate guide in the search for useful minerals.

Prof. Arkhangelsky is noted for his work on the tectonics of the Russian platform, which contributed so much to the discovery of the deposits of iron ore in the Kursk magnetic anomaly and the oil resources of the region lying between the Volga and the Urals, now come to be known as the "Second Baku". The expedition, led by him, of the Academy of Sciences of the U.S.S.R., which made a geological study of the European part of the U.S.S.R., applying geophysical methods to prospecting, laid down the lines of future prospecting for oil, coal and iron.

Prof. Arkhangelsky rendered valuable service to his country in the training of new geological personnel. From the early years of the Soviet regime he took an active part in the reform of higher education. For a considerable period he was professor in the Moscow Mining Academy, the University of Moscow and the Moscow Geological Prospecting Institute. His course on "Geology of the U.S.S.R." has become a standard work for every Soviet geologist.

Prof. Arkhangelsky was elected a member of the Academy of Sciences of the U.S.S.R. in 1925.

Prof. S. Schönland

THE death on April 24, at the age of seventy-nine, of Prof. S. Schönland marks the passing of a botanist of international repute.

Educated at the Universities of Berlin and Kiel, Schönland as a young man was assistant to the professor of botany at Berlin and later at Oxford. He went to South Africa in 1889 and shortly after was appointed director of the Albany Museum. In 1904 he was appointed as the first professor of botany at Rhodes University College, a position he held until his resignation in 1925.

His main interests lay in systematic botany, to which he made many and valuable contributions. His botanical work, however, also extended over many other aspects ; he published papers on plant distribution, ecology, biology, and practical problems such as weed eradication.

Schönland was much interested in education, and he played a big part in the building up of the University of South Africa and especially of Rhodes University College.

WE regret to announce the following deaths :

Sir Harold Carpenter, F.R.S., professor of metallurgy in the Royal School of Mines, Imperial College of Science and Technology, University of London, on September 13, aged sixty-five.

Prof. R. T. Hewlett, emeritus professor of bacteriology in the University of London, on September 10, aged seventy-five.

Miss E. L. Turner, the well-known field ornithologist, on August 13.

NEWS AND VIEWS

Educational Facilities for the Armed Forces

IN a leading article in NATURE of April 6, p. 526, attention was directed to the importance of providing adequate educational facilities for men and women in the armed forces. Evidence was available to show that, in the then period of comparative calm, there had been a regular and insistent demand for educational services from members of the Army and Air Force, and, in a different degree, the Navy. Suggestions are made to indicate how these demands might be reasonably met. An important announcement was that the Board of Education had agreed to nominate a senior officer to a liaison post between its own department and corresponding establishments in the Services. Since that time the development of the War has caused a temporary, although only partial, postponement of this and other schemes for expanding educational programmes for the fighting forces. The recent statement announcing the appointment of Mr. F. W. D. Bendall of the Board of Education to act as adviser in educational matters to Service men and women must therefore be greeted with considerable enthusiasm. It is to be hoped that with any lull in the air battles over Great Britain during the coming winter, opportunity for making use of the existing schemes that have been carefully prepared, and any others that might arise, should be freely utilized.

It is encouraging to record that, despite the bewildering changes of the last few months, steady progress has been made in catering for those periods when members of the forces are not taking part in more rigorous military duties. Single lectures on topics of current interest have been given to appreciative audiences in many areas, while instructional courses in various subjects have been highly acclaimed. Among these, particular reference must be made to certain classes in arts and crafts of varying types that have been successful with soldiers, sailors and airmen who were convalescing after injury. For these results, much credit is due to the Central Advisory Council for Adult Education in H.M. Forces. In the Army it is heartening to learn that the Army Educational Corps, which has been largely instrumental in arranging the details of the programmes which are already in operation, has been actively seizing every opportunity for increasing the range of its work. The value of the Army Educational Corps and the corresponding organization in the Royal Air Force, when viewed in the light of Mr. Bendall's appointment, seems to have been given well-earned, if belated, recognition. An increase in the establishment and range of these organizations seems to be the next logical step. An announcement to this effect could not be greeted with anything but acclamation by educationists.

Racial Freedom and the Colour Bar

THE open letter dealing with racial freedom and the abolition of the colour bar, which bears the signatures of the leaders of the organized religious bodies of Great Britain, headed by the Archbishop of Canterbury, and issued with the support of Cardinal Hinsley, Archbishop of Westminster, carries to its logical conclusion the full implication of the repudiation by members of the Christian faith of the doctrine of racial dominance held by Nazi Germany, with its train of misery and injustice (*The Times*, Sept. 12). It takes the British Government's "Statement of Policy on Colonial Development and Welfare" as the most authoritative of numerous recent reassertions of the British tradition, and points out not only that it proves the serious purpose of His Majesty's Government, but also that the full value of that generous gesture of a promised expenditure of £55,000,000 on improving health, education and economic conditions among colonial peoples can be realized only "if the worth of the individual members of the Empire comes to be measured by personal character and ability rather than by the colour of their skins or the accidental circumstances of birth". It is well that it should be impressed upon the British people how largely the British Empire is a coloured Empire—a fact, as we are here reminded, upon which the general public is insufficiently informed—and that the unity necessary to its survival can be secured only if the principle of equality as between people of different race and colour "is applied in methods of government and in human relationships alike in Europe and in Asia or Africa". The letter concludes by calling upon all who value the principles upon which the British Empire has been built up to join in an effort to secure the removal of certain disabilities, in the forefront of which stands as fundamental "the barriers of race and colour which exist to-day in British colonies", while at the same time it enjoins the creation of an informed public opinion in Great Britain which will no longer acquiesce passively in applications of the colour bar, now to be observed in certain circumstances.

The Archbishop of Canterbury and his co-signatories affirm the identity of the tradition to which expression is given in their declaration with the Christian tradition, of which, they say, the prejudice which erects a colour bar or prompts racial exclusiveness is a denial. This tradition, however, as has been stated again and again with the strongest emphasis, is one with which science is in full accord in both theory and practice in advancing knowledge and promoting the well-being of mankind. In the attainment of its aim of enlarging the spirit of man through the increase of knowledge of the universe, it recognizes no distinction of race or creed in its servants, no bar among those to whom its benefits are laid open. At the same time, however, while science maintains the validity of its faith in its own field, it recognizes that in practical everyday affairs a like disregard of such racial and other differences as those which lie at the root of the colour bar is not to be attained merely by pious aspiration or

exhortation. The colour bar is not entirely a product of that racial prejudice and exclusiveness to which such exhortation is addressed. Its roots extend to cultural, social and economic conditions, from which spring problems demanding the closest examination and study before their solution will bring about that co-operation between different classes in the community, each according to its kind and its capacities, instead of present antagonisms. This constitutes the real elimination of the colour bar—a partnership in realities and not a brotherhood by adoption in which the conditions of unity have yet to be attained.

Road Travel in Air Raids

A NEW aspect of road safety emerges with the decision to allow road traffic to continue during air-raid warnings. General agreement seems to have been arrived at that this decision is a wise one. As pointed out in *Roads and Road Construction* of September 2, the long lines of vehicles held up during the early raids, with their occupants standing about waiting for something to happen, presented an excellent target for machine-guns. It is difficult to see what other course could have been taken. Judging by experience learned from recent raids, many motorists are taking advantage of this concession. Travelling along roads deserted of all but police and A.R.P. personnel is a curious experience; and so is the feeling of frustration in a closed car produced by inability to see what is going on overhead. Something of what is happening can be guessed from the attitude of wardens and others, but in the absence of exact knowledge one tends to develop what has been called a sort of 'musical chairs' attitude towards the public shelters passed when driving, the question now being where the music (?) will start—not when it will stop. It has been suggested that something might be done to give motorists a feeling of greater security, or rather to reduce their feeling of insecurity, by way of signposting shelters along the main traffic routes. In many places signs have already been erected, but these are scarcely conspicuous enough to be seen by passing traffic; they cater more for the local inhabitants. Shops and private houses with surplus shelter accommodation might also be induced to co-operate.

Medicinal Herb Production in Great Britain

A SHORT memorandum, presumably a preliminary one, has been issued by the Ministry of Health declaring its policy regarding the domestic cultivation of medicinal plants and outlining the arrangements which have already been made in respect of belladonna, digitalis, henbane and stramonium. These four potent drugs are to be made the special care of the Ministry, and it is understood that the owners of established herb farms have undertaken to extend the acreages under cultivation. Outside effort is not discouraged; but, as the memorandum states, "Farmers and owners of large private gardens who wish to engage in the cultivation of herbs are recommended to operate in close association with commercial firms to ensure that the crop is properly harvested and dealt with". This is sound advice, and if followed will help amateur gardeners to avoid pitfalls, which are not a few in number. It is hoped that the deficiency of supplies of these four important drugs, which is due to the cessation of imports from Continental sources, will be made up by greatly increased home production. The Ministry has given no guidance with regard to the many other herbs which, although of lesser medical importance than the four specifically named plants, are of considerable commercial interest as household remedies. The matter might perhaps be taken up by the Ministry of Agriculture, and the Board of Education might give official advice about the collection of herbs by school children.

Rectifier Plant in Time of War

IT has been doubted by some engineers whether the glass bulb devices used in some electric stations for converting alternating into direct current are able to withstand the blast and other effects of aerial bombing. It has to be remembered that the bulbs, being spherical, present a minimum surface to blast contact. They are flexibly mounted and are made of a special toughened high-grade glass. They are always operating under an external atmospheric pressure of approximately 15 lb. per sq. in. (as the bulbs are various). This is equivalent to a total pressure of about 20 tons in the case of a large rectifier bulb and so its inherent strength is very considerable. It has been computed that one ton of high explosive will cause a blast pressure of about 2½ lb. per sq. in. at 100 yd. distance. Such a pressure might be sufficient to knock down a 9-in. brick wall (because of the large resistance surface it presents), for 2½ lb. per sq. in. is the equivalent of 1½ tons per sq. yd. A rectifier bulb is always working at 15 lb. per sq. in. and can withstand many times this amount.

A further point is that the bulbs are always installed inside sheet steel cubicles, and the cubicles are generally housed inside a building. The concussion effect that can reach a bulb through the walls of the building and the walls of the cubicles is only a small fraction of the blast impinged on the external sub-station walls. The bulbs can withstand much higher pressures than the normal sub-station walls and yet it is the walls that must take the brunt of the blast. Finally, the multi-unit construction of the glass bulb rectifier makes it far less vulnerable than most other types of plant to the secondary effects of aerial warfare, as for example, shrapnel. *Electrical Industries* of September 2 points out that a splinter which would be sufficient to put a one-unit type of plant, whether static or rotary, out of operation, would probably damage at most one cubicle of a bulb rectifier plant.

Guide to Fuel and Allied Industries

THE War has profoundly influenced life, industry and technology, and especially in all that concerns fuel and allied industries. Organizations have been modified, their activities suspended and new ones established. As a result people concerned are often at a

loss for addresses and sources of information. To meet this need, the Association of Special Libraries and Information Bureaux has issued "ASLIB Guide to British Sources of Specialised Information. No. 1, Fuel and Allied Industries (excluding Electricity)" (2*s*. 6*d*. to non-members. ASLIB, 31 Museum Street, London, W.C.1). It indicates what new organizations have arisen and what modifications have been made in war-time. Particulars are given of relevant Government and other departments, professional, trade, and research organizations, university teaching departments and libraries, commercial and industrial organizations, periodicals printing abstracts and references, trade periodicals, periodicals issued by professional bodies and industrial concerns, and annuals. The list is comprehensive, and a perusal failed to note the omission of any address or paper concerned with fuels in war-time. It should find a useful place on the table of everyone concerned with administration or investigation of fuel affairs in these times.

William Withering and Erasmus Darwin

THE June issue of the *Bulletin of the History of Medicine* contains an interesting notice by Drs. Ruth Musser and John C. Krantz, jun., on the friendship of William Withering and Erasmus Darwin. In 1775, nine years after graduating as M.D. at Edinburgh, Withering, who was in practice at Birmingham, became intimately associated with Erasmus Darwin, an Edinburgh doctor of medicine ten years his senior, and was admitted by him to the Lunar Society which Darwin and others had founded. The outstanding members of this Society were James Watt, Joseph Priestley and Josiah Wedgwood, and the visitors included among others Herschel and Benjamin Franklin. The friendship of Darwin and Withering continued for many years. Each enjoyed a wide reputation and an extensive practice. The greatest contribution which Withering made to posterity was his use of the purple foxglove in the treatment of dropsy, the description of which is to be found in his classical work published in 1785 entitled "The Foxglove, an Account of its Medical Properties", while of Darwin it has been said that there was scarcely an invention in the world to-day that his mind did not foresee. Withering died in 1799 at the relatively early age of fifty-three, but Darwin survived until 1802, or seven years before the birth of his grandson, the author of "The Origin of Species".

The Newcomen Society

THE Newcomen Society has recently published vol. 19 of its *Transactions*, its sixth *Quarterly Bulletin* and its programme of papers for the session 1940–41. Seven meetings have been arranged, and the papers to be presented deal with the history of many subjects, among these being the sugar-cane industry, the iron industry, Henry Corte's bicentenary, the Surrey iron railway, needle-making, wire and plate gauges and the hydraulic extrusion of metals. In the *Quarterly Bulletin*, reference is made to the movement in the United States to preserve the birthplace of Robert Fulton, and to the erection of a tablet on a granite shaft over the burial place of Oliver Evans, in Trinity Churchyard, Broadway, New York. The 'pilgrimage' of members of the Society in America which was to have taken place in New Hampshire in June was abandoned on the receipt of the news of the defeat of France.

The new volume of the *Transactions* contains thirteen papers and nine other communications, together with a continuation of the valuable analytical bibliography of the history of engineering The volume runs to 290 pages and contains twenty-four plates. Most of the papers were referred to in our columns at the time they were read. Among the notes and communications is a list of 320 engineering drawings dating from 1775 to 1840 preserved at the Science Museum in the Goodrich Collection, and a description of the first dry dock in the Netherlands (1707) by Lieut. J. J. Bootsgezel, of the Netherland Royal Navy, who, it has been learnt, lost his life through a mine when escaping from Holland. He was well known for his great interest in the records of Dutch engineering. The president of the Society for the current year is Col. C. E. Davies, secretary of the American Society of Mechanical Engineers; his address will be read in both New York and London on November 13.

Electromagnetic Levitation

AN exhibit which has proved attractive at the Centennial Exhibition of the Dominion of New Zealand is showing an aluminium plate floating in air in a strong alternating-current field and frying eggs in a pan without visible means of heating and support. An iron core is concealed beneath a table top and excited by A.C. windings so arranged and connected that they produce alternating magnetic fields, toroidal in form, of high intensity and opposite polarity. An aluminium pan floats on this field with such definition of position that considerable effort is required to move it downwards or sideways. Heat generated in the pan, by currents induced by the field, does the cooking. It is very suitable as an exhibit for publicity purposes, but at present it does not look as if it has any practical application, as a very large electrical input is required to maintain a magnetic field of suitable form and intensity.

Seismological Data from India

MUCH useful seismological data is contained in the *Seismological Bulletin* of April, May and June, 1939, recently published by the Government of India Meteorological Department. It contains interpretations of the seismograms obtained at seven observatories in India and Ceylon together with macroseismic data supplied by voluntary observers in nine regions. About sixty earthquakes were recorded at each of the observatories for the three months, though only nineteen were registered at the Haig Observatory at Dehra Dun. This is not considered significant on account of the types of instruments in use at the stations, a full list of which is given. The region near Shillong appears to have experienced more earthquakes than any other during the period, having had

five on four separate days. The most intense activity, however, seems to have been near Silchar on May 27, 1939, when eight shocks were felt attaining a maximum intensity seven on the Rossi-Forel scale (overturning of loose objects ; fall of plaster ; general fright, though no damage to property). The total duration of shaking was approximately 3½ minutes.

Undulant Fever in Normandy

In his inaugural thesis (*Thèse de Paris*, 1940, No. 322), Dr. M. L. Rose-Legrand remarks that until the last few years the five departments of Normandy were regarded as free from human undulant fever. Recent publications, however, indicate that Normandy has by no means escaped visitations of this disease, as is shown by the fact that the writer has been able to collect at least twenty-seven cases in the course of the last six years, eleven being in Seine-Inférieure, six in Calvados, five in Eure, three in Manche and one in Orne. With the exception of a single case caused by *B. melitensis*, all the cases of human undulant fever have resulted from infection by *B. abortus bovis*. Not a single case in the departments of Normandy has been due to goats or sheep. In two instances infection was caused by accidental inoculation, namely, by a polyvalent vaccine in a veterinary surgeon, and in another in a cattle breeder. In the majority of cases inoculation has taken place through the skin and only in a minority by consumption of raw milk from infected cows. Hitherto, there have been no instances of human infection by cheese. In conclusion, the writer recommends that the well-established existence of undulant fever in Normandy should receive the attention of veterinary and medical practitioners, especially in rural districts. In another thesis (*Thèse de Paris*, 1940, No. 277), Dr. R. G. C. F. Grigny states that he has recently collected ten cases of undulant fever which have occurred during the last four years in the department of the Somme, where contagious abortion has recently been frequent among the cattle.

Carnegie Institution of Washington

Year Book No. 38 of the Carnegie Institution of Washington has been issued and covers the year July 1, 1938–June 30, 1939. It includes the report of the President, the reports of the various Departments, including the Mount Wilson Observatory, the Geophysical Laboratory, the Department of Terrestrial Magnetism, the Division of Plant Biology, the Division of Animal Biology and the Division of Historical Research, as well as reports on investigations by research associates and on special co-operative studies such as those of the committee on co-ordination of cosmic ray investigations. The astronomical staff at Mount Wilson has continued to co-operate with the physicists and engineers of the Californian Institute of Technology in the construction of the 200-inch telescope with the aid of funds furnished by the Rockefeller Foundation.

The Department of Terrestrial Magnetism, in co-operation with George Washington University, held a conference on theoretical physics in the spring, and keen interest was also taken in a similar conference on the ionosphere. Special reference is made in the report to the work of the Division of Plant Biology on photosynthesis, including studies of the quantum efficiency of photosynthesis. The work of the Division of Animal Biology has included biochemical studies of secretion, the physiology of reproduction, endocrine studies, studies of the central nervous system, as well as investigations on the chromosome and the gene. Research activities in the Nutrition Laboratory have centred largely around the factors governing heat regulation and heat production in animals and human beings.

A Guide to Farming

The fifteenth issue of the "Farmer's Guide" has been published in the *Journal of the Royal Agricultural Society of England*, **101**, Part 1. It follows the lines of former issues, but naturally a good deal of the work under review bears on the special problems of war-time farming. The contributors to the various sections are the same as last year, except that Prof. T. Dalling has replaced Dr. F. C. Minett as the writer on animal diseases. In future the *Journal* will be issued in two parts only, at half-yearly intervals, instead of in three parts as originally planned. So far as can be foreseen at present, Part 2 of the current volume will be published in March 1941.

Announcements

In connexion with Dr. R. Melville's letter on p. 403 of this issue, it may be noted that the Board of Education has issued a memorandum suggesting the collection by school children of wool, dandelion roots, autumn crocus roots and seeds, acorns and beech mast, and horse chestnuts.

Dr. Ivor Jenning has been appointed principal of the University College of Ceylon, and Mr. Stanley A. A. Hammond educational adviser on the West Indian Comptroller's staff.

According to *Science*, Dr. Bruno Gerhard, formerly curator of the Museum of Hygiene in Dresden, has been appointed director of the Cleveland Museum of Health and Hygiene, which will open in October. Since 1937, Dr. Gerhard has been serving as technical consultant for the medicine and public health exhibits at the World's Fair in New York. Plans for the Cleveland Museum were initiated in 1939 when Mrs. Francis F. Prentiss gave the building. In addition to exhibits for education in public health, the museum expects to have workshops for the creation of visual health aids for schools, colleges and other educational institutions.

Dr. Joseph Needham has pointed out that a misprint appears in the title of an article by him in association with Dr. A. S. C. Lawrence and Dr. Shih-Chang Shen in Nature of July 20, p. 104. The full title of the original paper was "Studies on Protein Solutions with the Co-axial (or Couette) Viscosimeter, with reference to the Relations between Molecular and Morphological Shape" ; this would of course have been too cumbersome for an article in Nature.

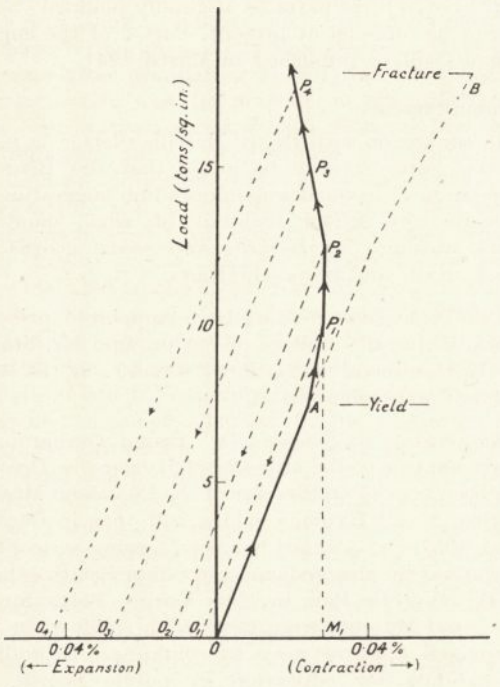
LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They 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.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

A Lattice Stress-Strain Diagram

THE technical application of metals involves a detailed knowledge of their behaviour under external stresses. In the usual method of testing, measurements are made of the changes in external dimensions of a test piece when stresses of known magnitude are applied, as in the determination of the elementary load extension diagram. It is nowadays practicable, however, by use of modern X-ray diffraction technique, to obtain simultaneously with the external load-extension diagram the analogous diagram for the atomic lattice itself, in which direct measurements are made of the displacements of the atoms from their normal positions under stress and of their recovery when the applied stress is removed.



Percentage change in (310) spacing

The 'lattice stress-strain diagram', as it may be termed, presents novel features of theoretical and practical interest. The main characteristics may be illustrated by the accompanying figure, which records measurements made on pure iron in the following way. When a metal is stretched in one direction, it contracts by a related amount in the perpendicular direction, and the measurements refer to the contraction in this latter direction of selected atomic planes, here the (310). The contraction in the spacing of these planes has been plotted against the applied tensile stress.

The load-contraction curve then obtained is given by $0AP_4$. Up to the external yield point, which corresponds to the point A, the contraction in atomic spacing is proportional within limits of measurement to the applied stress. Beyond the yield point, however, the contraction proceeds at a slower rate and reaches a limiting value indicated at P_1P_2. With still further increase in stress the atomic spacing actually tends to expand.

If the stress applied is less than the yield value, the atomic spacing returns to its original value upon removal of the load. In the range $0A$, therefore, the atomic displacements are reversible and in accordance with Hooke's law. If, however, the applied stress is greater than the yield value then, when the stress is removed, the contracted spacing does not merely return to its normal value during recovery, but passes beyond that value and ends up with an expanded value, which persists indefinitely at room temperature. Thus, on unloading from the point P_1, the curve follows the line P_1O_1 and the atomic spacing exhibits the permanent expansion 00_1 over the normal value at 0. The greater the load involved, the greater is the final permanent set imposed on the atomic spacing, an effect illustrated by the further lines P_2O_2, P_3O_3 . . .

If after being unloaded from P_1 the specimen is reloaded to the same stress, then the curve, commencing at O_1, follows the line O_1P_1, the total range of contraction being then O_1M_1. This total range increases with the value of the applied stress up to the fracture stage as shown by the additional curve $0B$.

The lattice load-contraction diagram thus reveals information on the properties of the metallic state which could not have been deduced from consideration of the corresponding external load-contraction diagram. We may conclude that two processes occur upon loading a specimen: first, a contraction of the atomic spacing which, since the external dimensions also contract, is to be expected, and, second, as the yield point is exceeded, some form of distortion which results in a permanent expansion of the lattice. It is as if the metal, though actually at room temperature throughout, were undergoing a rise in temperature and that the expansion thus resulting was imposed on the contraction due to the simultaneous external elastic deformation. This expansion is retained by the lattice spacing after removal of the load and represents an absorption of energy or 'latent energy' due to cold work. Its observation is of particular interest since it provides a systematic approach to the study of the phenomena, often exhibited by metals, which have been vaguely classified under the heading of 'internal strains'.

W. A. WOOD.

Physics Department,

S. L. SMITH.

Engineering Department,
National Physical Laboratory,
Teddington, Middlesex.

August 20.

Excited States of Stable Nuclei

IN NATURE of June 8, Powell, May, Chadwick and Pickavance report the use of a camera connected with the cyclotron to study the scattering of high energy particles. Such a camera has been in use by me for more than a year[1]. A picture of the camera was shown in the Royal Photographic Society exhibit last July and a description published[2]. The detection of elastic and inelastic groups for scattered protons has also been reported[3]. For 6·7 Mev. protons the inelastic group in the case of magnesium is relatively slightly larger than shown for neon in the experiments reported by Powell and for aluminium is smaller. In both cases 6·7 Mev. protons have been used. The peak separation for aluminium is about 0·8 Mev. and for magnesium, 1·3. Experiments have also been made with deuterons which will be reported shortly.

T. R. WILKINS.

University of Rochester,
New York.
July 19.

[1] Wilkins, T. R., and Kuerti, G., *Phys. Rev.*, **55**, 1134 (1939); Kuerti, G., and Wilkins, T. R., *Phys. Rev.*, **57**, 1081 (1940).
[2] Wilkins, T. R., *J. App. Phys.*, **11**, 44 (1940).
[3] Wilkins, T. R., and Kuerti, G., *Phys. Rev.*, **57**, 1082 (1940).

THE facts quoted by Prof. Wilkins are plain; but these alone, and put in this way, may suggest more than he intends. It has often happened that similar experiments have been carried out at the same time in different laboratories, and I have no doubt it will happen again. The note by Prof. Wilkins and G. Kuerti on the detection of inelastically scattered protons appeared in the *Physical Review* of June 1, and thus before the letter of my colleagues and myself. Prof. Wilkins's experiments and ours have much in common, for they not only deal with the same phenomena but also use the same method for detecting and recording the scattered particles, namely, the photographic plate. The actual arrangements, that is, the 'camera' designs, appear, however, to differ considerably. We were of course unaware of his results at the time of our communication to these columns.

J. CHADWICK.

George Holt Physics Laboratory,
University of Liverpool.

Velocity of Hydration of Carbon Dioxide in the Presence of Extraneous Substances

THE available biological and chemical evidence indicates that the effective germicidal life of aerosols containing sodium hypochlorite depends on the velocity of changes occurring between the collisions of carbon dioxide molecules in the air with droplets of the aerosol, and the appearance of the corresponding hydrogen ions. One of the changes concerned, namely the hydration of the dissolved gas, has been shown by McBain[1] to be a measurably slow reaction, and it is therefore of interest to determine the effect of the salts normally present, and of other substances, upon it.

The differences in the hydration velocity in the presence of salts and certain organic compounds were studied by McBain's method: a slight excess of a saturated aqueous solution of carbon dioxide was added quickly to an alkaline (0·08 M K_2CO_3) solution of the test substance containing phenolphthalein, and the colour change timed against permanent standards. Control runs with alkali and carbon dioxide only were alternated with at least three test runs in each case.

Potassium chloride and bromide, and sodium nitrate and formate had no influence in concentrations up to 1M. The absence of a salt effect indicates that the reaction concerned is actually $H_2O + CO_2 \rightarrow H_2CO_3$ rather than $^1HO + CO_2 \rightarrow {}^1HCO_3$[2].

Alcohols of very diverse types, and also dioxane, were found to accelerate the reaction. The following is the order of increasing effect; figures in parentheses give the maximum limit of concentration tested: Dioxane (2M), methyl alcohol (2M), potassium sodium tartrate (that is, ethylene glycol dicarboxylate) (1M), β-ethoxy ethyl alcohol (2M), glycerol (2M).

Glucose (1M), and still more sucrose ($\frac{1}{2}M$) retarded the reaction very greatly.

The effect of a retarding or accelerating substance was the same in the presence of inactive salts as in their absence, and there were no differences on substituting sodium for potassium carbonate as the neutralizing alkali.

In the aerosols containing hypochlorites, where high concentrations are immediately reached by evaporation[3], the droplets can be expected to dissolve only small quantities of carbon dioxide as such, so that in this case at least the hydration of the latter may play as important a part as the purely physical factors which have usually been invoked to explain its rates of absorption in various alkaline solutions[4]. Simple hypochlorite aerosols have an extremely short active life, which is, however, increased by the addition of glycerol[5]. This may be due to the toxicity of glycerol itself (or of its oxidation products), but if it depends at all on physico-chemical effects it should be possible to prolong the action still further by using, instead of glycerol, substances which retard the hydration of carbon dioxide as well as its absorption and diffusion.

E. O. POWELL.

76 Stratford Street,
Iffley Road,
Oxford.
August 29.

[1] McBain, J. W., *J. Chem. Soc.* (Trans.), **101**, 814 (1912).
[2] Thiel, A., and Strohecker, R., *Ber. deutsch. chem. Ges.*, **47**, 1061 (1914).
[3] Finn, S. R., and Powell, E. O., NATURE, **144**, 864 (1939).
[4] Killeffer, D. H., *Indus. Eng. Chem.* (Indus. Edn.), **29**, 1293 (1937).
[5] Finn, S. R., and Baker, A. H., Private communication.

Parahydrogen Conversion on Tungsten

THIS reaction[1] has been reinvestigated using a reaction tube containing a second short filament adjacent to the catalyst filament, so that adsorbed films on the latter might be detected by a measurement of their contact potential[2]. In this way it was shown that the filament in its most catalytically active state was free from adsorbed oxygen. Under these conditions, as J. K. Roberts[3] has pointed out, the clean wire on exposure to gaseous H_2 takes up a *stable* film of hydrogen, which does not evaporate appreciably at room temperature, and so cannot give a *para* H_2 conversion by the mechanism suggested by Farkas[1], namely by $H_2 + 2W \rightleftharpoons 2WH$ (where W indicates a surface atom of tungsten). It is, however, possible[4] that the conversion might

occur by a surface interchange reaction of the type $pH_2 + WH \rightarrow oH_2 + HW$, and this mechanism gains support from the following experiment.

By evaporation from a tungsten wire under best high-vacuum conditions it was found possible to prepare clean films of tungsten on the glass walls, of real surface area of the order of 500 cm.^{2}. This area was estimated from the amount of hydrogen instantly adsorbed at room temperature, which could not be pumped off at this temperature, as measured on a McLeod gauge. These films brought about the equilibria $pH_2 \rightleftarrows oH_2$ and $H_2 + D_2 \rightleftarrows 2HD$ within a few minutes at 77° K. Such a film was contacted with D_2 gas and carefully pumped at room temperature so as to give a WD surface. It was then cooled to 77° K. and exposed to a low pressure of hydrogen, when an interchange of atoms was observed in a time similar to that required for the *ortho para* conversion. Such interchanges were also detected at 193° K. and 293° K. We can, therefore, infer that the *para* H_2 conversion occurs by a similar surface interchange between gaseous H_2 and the stable W-H film. These results will be presented and discussed in detail in another place.

D. D. ELEY.
E. K. RIDEAL.

Department of Colloid Science,
The University,
Cambridge.
Sept. 2.

[1] Farkas, A., *Z. physikal. Chemie*, B, **14**, 371 (1931).
[2] Bosworth, R. C. L., and Rideal, E. K., *Proc. Roy. Soc.*, A, **162**, 1 (1937); Bosworth, R. C. L., *Proc. Camb. Phil. Soc.*, **33**, 394 (1937).
[3] Roberts, J. K., *Trans. Faraday Soc.*, **35**, 941 (1939).
[4] Rideal, E. K., *Proc. Camb. Phil. Soc.*, **35**, 130 (1939).

Fat: an Index of Œstrogen and Progestogen Activity in the Human Endometrium

WHILE carrying out a microchemical survey of the human endometrium attention was directed to the remarkable shifts of Sharlach *R* stainable fats in frozen sections of the human endometrium during the menstrual cycle.

In the œstrogen phase there is scarcely any fat in the glandular epithelium, and where it is present it is usually found in the supranuclear region; but even there it is rare. The stromal cells, however, may contain very fine droplets 1–4 in number situated close to one or other pole of the nucleus.

In the late progestogen phase, there is a remarkable accumulation of fat in glandular epithelium and the red staining fat is seen as fine globules localized exclusively to the proximal third or half of the cell immediately below the nucleus. Occasional stromal cells may contain a few very fine globules of fat.

On the first day of menstruation in some of the desquamating epithelium, the fat may extend throughout the cytoplasm but some of the surviving cells still preserve their basal fat, which is much reduced in quantity. In very early pregnancy, basal fat, in increased amounts, is invariably present in the epithelium of the uterine glands; this fat persists until the fourth or fifth month of gestation, when it is found as large globules scattered throughout the cytoplasm of the very much-flattened cell.

The accumulation of basal fat in the epithelium of the uterine gland has been shown to occur in women under progesterone treatment in the second half of the cycle. It has even been possible to determine by this method whether too much progesterone has been used.

By using the fat test clinically, evidence is rapidly accumulating to show that excess of œstrogen in the presence of insufficient progestogen will lead to an extraordinary accumulation of stromal fat, but the uterine epithelium contains almost none. Basal fat in the uterine glands of the human female can probably be regarded as a test for the presence of *optimum* quantities of progesterone, since it is absent when only œstrogen is present and is found towards the end of the second half of the normal cycle; it can be induced by progesterone therapy, and it is invariably found in the uterine cells in early pregnancy, persisting at least until the fourth or fifth month of gestation.

JOSEPH GILLMAN.

Department of Anatomy,
University of the Witwatersrand,
Johannesburg.
August 1.

Classification of Hominidæ

PROF. G. MONTANDON[1] has recently discussed my propositions concerning nomenclature in physical anthropology and offers a classification of the Hominidæ. These appear to call for some remark. Montandon objects to my delimitation of "species", and prefers to go back to the old, pre-Darwinian concept of a species being a group of individuals which are fertile *inter se*. There seems no need here to go into the pros and cons of that argument as it has already been dealt with by Pycraft[2] in the paper already quoted by me. Pycraft very aptly used the Phasianidæ to illustrate his point, as this group is quite comparable to the Hominidæ. No modern systematic zoologist accepts that old definition of species. Actually, as Zuckerman[3] points out, the value of species does differ among different animal groups, and the question of being fertile *inter se* or not depends on the magnitude of the chromosomal difference between related or neighbouring populations. Sometimes species of the same genus have greater chromosomal differences than those of other genera. The latter may produce fertile hybrids whilst the former cannot produce anything beyond an F_1 generation. Hominids would appear to belong to the latter category, and I maintain that such obvious anatomical differences as those between, say, Negroids and Mongoloids are sufficient to demand specific status for these two forms of modern man.

The classification of the Hominidæ set forth by Montandon includes, under the subfamily title Paranthropinæ, the newly discovered anthropoid genera Paranthropus and Plesianthropus, as well as the older Australopithecus. No one has claimed Hominid status for Paranthropus or Pleisianthropus, whilst Australopithecus was originally relegated by Dart[4] to a distinct family (Australopithecidæ). Recently Dart[5] has demanded Hominid status for this form, though most authorities still regard it as anthropoid. There seems little justification as yet for raising this form, together with its allies, to the rank of a subfamily of Hominidæ as Montandon's classification requires. In any event the name could not be Paranthropinæ according to international

rules of nomenclature, but would have to be based on the name of the first known genus.

There may be some justification for giving sub-familiar rank to Pithecanthropus and its relatives; but, here again the name should be Pithecanthropinæ, and not Anthropinæ. The rules of nomenclature have also been broken in the remaining proposed sub-family Homininæ, new names, for example, *protosapiens*, being suggested without reference to any previously available names. Again, Neanderthal man is ranked as a subspecific form, presumably the typical subspecies of *H. primigenius*, but labelled *H. p. neandertalensis*, and stated to be further divisible into "diverses races".

Thus, though the general arrangement may be fairly satisfactory so far as present knowledge goes, and is clearly based on the results of the most recent work, considerable revision of the names adopted is necessary besides modifications of the exact status of some of the forms included.

W. C. OSMAN HILL.

Medical College,
Colombo.

[1] Montandon, *Revue Scientifique*, 172–173 (March 1940).
[2] Pycraft, *Man*, **25**, No. 99 (1925).
[3] Zuckerman, NATURE, **145**, 510 (1940).
[4] Dart, NATURE, **115**, 195, 199 (1925).
[5] Dart, *Amer. J. Phys. Anthrop.*, **26**, 176–186 (1940).

Wild Seeds as Animal Feeding Stuffs

IN his discussion of the supply of animal feeding stuffs[1] Dr. Norman C. Wright does not consider the collection and utilization of wild seeds such as horse chestnuts, acorns, and beech mast. Even if the whole of the present bumper crop of horse chestnuts and acorns were collected, it obviously would not counterbalance the estimated 10 million ton deficiency in imported foodstuffs, but would nevertheless provide a substantial addition to existing stocks which should not be allowed to go to waste.

When in good condition horse chestnuts and acorns are nutritious foods, their value depending largely on a high starch content. Horse chestnuts can be fed at a rate of ½–1 lb. per head, per day, for sheep, or 4–10 lb. for dairy cattle, or up to 20 lb. per day for fattening cattle[2]. Most animals soon become used to the slightly bitter flavour of the nuts, though pigs persistently refuse them. They can be fed fresh, but probably the best way of dealing with the nuts would be to collect them at central depots where facilities were available for drying and grinding to a meal. Mouldy nuts should not be fed unprepared. There must be thousands of trees in the country each now bearing ½–1 cwt. of nuts.

Acorns have long been recognized as a valuable food for pigs, and the custom of pannage was strongly established in medieval England. They can be fed in small quantities to sheep and older cattle, but young cattle are susceptible to acorn poisoning, especially in years of drought, and should not be given them. Acorns can be fed fresh or dried. They keep for a long time in good condition if buried in pits in the same way as root crops.

A leaflet[3] just published by the Ministry of Agriculture gives advice on the use of acorns, horse chestnuts and beech mast as feeding stuffs. During the War of 1914–18, collections of the nuts were made by schoolchildren and organized by the Board of Education. Similar emergency measures might well be considered this year, but prompt action must be taken if the crop is to be utilized.

R. MELVILLE.

Royal Botanic Gardens,
Kew. Sept. 7.

[1] Wright, N. C., NATURE, **146**, 251 (1940).
[2] Anon., *J. Board Agric.*, **21**, 511–528 (1914).
[3] "Growmore" Leaflet No. 39, Min. of Agric. (1940).

The Functions of Science

THERE is one persistent feature of the current discussion on the social function of science which is very disquieting. Natural science offers to society at large, as well as to the individual man of science, several distinct benefits. One is simply the existence of an organized body of knowledge, accessible to those interested in it; for science, like every other intellectual discipline, is to be valued in itself for the truth which it contains. Another is the existence of a body of men trained to appreciate this knowledge, and acquainted with the arduous work of gathering data and interpreting them; good scientific work demands that the man of science should aim to be energetic, humble, both constructive and critical, neither sterile nor credulous, accustomed to think before he acts and to act upon his conclusions. A third social benefit is conferred by the *applicability* of scientific knowledge to provide techniques for large-scale handling of matter, and hence for the improvement of the material conditions of life; properly used, this last function of science can confer real benefits, for example, by raising the life of the poor to a more tolerable standard.

This third aspect of the social function of science is (I submit) in danger of being emphasized to the neglect of the others, of no less importance. The discussion exhibits much goodwill and much concern for social justice, but not always, perhaps, an adequate knowledge either of the nature of science or of the nature of man and society. That science is pursued in the first place for its truth; that it cannot dogmatize about questions which touch on philosophy; that economics is not independent of ethics; that human nature demands culture, family life, and spiritual values, before material comfort—all these considerations are too often ignored. This tendency is lamentable. It would lead us altogether too close to the Nazi view of science (already sufficiently exposed in NATURE), with its insistence on *Anwendbarkeit* and rejection of the notion of science as an effort to reach certain truths.

A more liberal view, which does not neglect the intellectual values of natural science, is widely held, but is unfortunately less vocal[1]. A greater attention to the notion of pure science, as an ordered study with its own principles and its own intrinsic modes of development, is needed as a corrective to the current one-sided development of views on the social function of science. The admirable leading article in NATURE on "The Repudiation of Truth"[2], and a recent letter from Dr. J. I. O. Masson[3], will repay attention in this connexion.

E. F. CALDIN.

Queen's College,
Oxford. August 24.

[1] See, however, Polanyi, "Rights and Duties of Science", Manchester School of Economic Social Studies, Oct. 1939, p. 175.
[2] NATURE, **145**, 871 (1940).
[3] NATURE, **145**, 855 (1940).

RESEARCH ITEMS

Size of Family in Tikopia

RAYMOND FIRTH continues his study of the seasonal rites of Tikopia ("The Work of the Gods in Tikopia", Vol. 2. By Raymond Firth. Monographs on Social Anthropology, No. 2. Published for the London School of Economics and Political Science. Pp. v+189–378+8 plates. London: Percy Lund, Humphries and Co., Ltd., 1940. 7*s*. 6*d*.) by completing his record of the monsoon ceremonies and following on with rites of the trade-wind which do not take place in the monsoon. In opening with the text and explanation of a *fono* or public address or proclamation formerly delivered at Rarokoka, he directs attention to a remarkable injunction on population which is included as its closing section. The problem of population seems to have exercised the minds of the people considerably, migration as a means of regulating overflow was barred by size and situation, and this led to a clear apprehension of the dangers of over-population and also to definite types of social mechanism for its prevention. In the *fono* the tendency, owing to human weakness, to over-population was recognized by an exhortation in indirect but clear language to practise certain methods in sexual intercourse to avoid conception, and the size of the ideal family was hammered home, namely, "one male and one female. That is the plucking of the coconut and the filling of the water-bottles". This was an allusion to the allocation of duties in a household in native theory of four individuals, husband and wife, with a son and a daughter, making for correct economic adjustment, without imposing too heavy a strain on food resources. The boy assists the father, doing the more energetic jobs such as climbing trees for coconuts, cutting thatch, etc., the girl helps the mother, especially in keeping the family water-bottles full. If the family is much larger there is an increase in consumption without a corresponding increase in the value of labour power. The alternative to family restriction appears in the *fono* as a query "will the person go and steal ?"

Bactericidal Action of Mould Products

IT has been known for many years that filtrates from moulds such as species of Aspergillus or Penicillium may inhibit the growth of many bacteria and in some cases show bactericidal properties. E. C. White (*Science*, **92**, 127; 1940) is now investigating the nature of the bactericidal material present in *Aspergillus flavus*. Following on the experiments of Prof. A. Fleming, work carried out at Oxford (E. Chain, H. W. Florey, A. D. Gardner, N. G. Heatley, M. A. Jennings, J. Orr-Ewing and A. G. Sanders, *Lancet*, **239**, 226; 1940) has now shown that the substance penicillin which was isolated from moulds is able to exert its influence *in vivo*. Penicillin is only very slightly toxic to mice and rats. It inhibits the growth of several strains of Clostridium *in vitro*. Mice given repeated doses of penicillin were protected against lethal doses of *Streptococcus pyogenes*, *Staphylococcus aureus* or *Vibrion septique*. Penicillin is probably a new type of chemotherapeutic agent and is of interest on account of its low toxicity to animals.

Origin of Frogs

A NEW and important coal measure amphibian from Mazon Creek, Illinois, is described by D. M. S. Watson (*Trans. Roy. Soc. Edin.*, **60**; 1940) under the name of *Miobatrachus romeri*. A redescription of *Amphibamus grandiceps*, *Hylonomus geinitzi* and *Eugyrinus wilderi* and a comparative review of these and related forms leads the author to maintain the propriety of the group Phyllospondyli. This order contains four families—the Eugyrinidæ, the Branchiosauridæ, the Melanerpetonidæ and the Miobatrachidæ. These form an ascending series with the Eugyrinidæ linking up at an early stage with the embolomerous Labyrinthodonts at the one end and the Miobatrachidæ leading on to forms like *Protobatrachus massinoti*, which is an Anuran. Thus while the precise ancestry of neither the Urodela nor Apoda still remain in doubt, that of the Anura has been traced to a family of Phyllospondyli that arose from the Labyrinthodonts in early Carboniferous times.

Crustacean Larvæ

R. Gurney and M. V. Lebour ("Discovery Reports", **20**; 1940) have described the larvæ of Decapod Crustacea belonging to the genus Sergestes that were collected by the *Discovery*. In two species of the genus the complete life-history was known from previous work. In certain instances peculiarities of the acanthosoma stage enable them to be linked with the mastigopus and so with the adults, but the differences between the elaphocaris and acanthosoma stages are so great that the complete life-history cannot be pieced together from preserved material alone. To overcome this and similar difficulties both authors spent a considerable time at the Bermuda Biological Station. The present memoir provides a description of thirteen species and a key for the determination of their acanthosoma larvæ.

Genetics and Plant-Breeding

J. B. HUTCHISON (*J. Genetics*, **40**, 271–282; 1940) has discussed the influence of genetics upon plant breeding. He shows that the introduction of proper statistical methods and progeny-row testing greatly facilitates the work of the breeder and provides a more efficient selection method than mass-selection. Using examples from cotton breeding, the disadvantages of pure line methods are contrasted with the results achieved from selection of mixed populations and with the advantages of land races which although impure from the geneticist's point of view remain stable under the influence of selection of the plant-breeder and of the environment. In an accompanying paper, V. G. Panse (*J. Genetics*, **40**, 283–302; 1940) provides methods for the analysis of quantitative characters which will be useful in plant breeding. *F*2 plants of hybrids between three cotton strains were grown in a randomized progeny trial. Ten plants of each *F*2 progeny were selected at random and an *F*3 progeny was grown from these in a particular randomized arrangement. It was found that plot differences partly affect the studied character, staple length, therefore the mean value of each plot must be taken into account when selecting plants for

breeding. It is shown that it is preferable to select plants on the excess staple length over the mean length of the plot. The variance of the progeny may be split up into that due to genetic influences and that due to environmental influences. The variance due to genetic influences may be used to estimate the number of genes which are controlling the segregation of the character being investigated. The possible number of genes, however, is influenced by their dominance and other inter-relationships. Genetics systems may be set up to satisfy this requirement and thus the probable number of genes which control a particular character may be suggested.

Genera of the Pore Fungi

MYCOLOGICAL taxonomy presents many difficulties; it possesses no physiological exactitude, as in bacteria, and is much more at the mercy of varying critical standards of different monographers than almost any other systematic field. Progress must be made by ruthless revision of genera as knowledge increases, and Wm. Bridge Cooke has recently made such a contribution for the Polyporaceæ (*Lloydia*, **3**, No. 2, 81–104; June 1940. Lloyd Library and Museum, Cincinnati, Ohio). A historical survey of this section of mycological naming leads, through lists of synonyms and homonyms, towards a practical key to the forty-six genera which it is now proposed to recognize. Many of these have been created to accommodate the polypores of tropical America; but the British student of fungi will find his familiar genera sorted by characters which should be readily distinguishable.

Cornish Tin Mining

THE beginnings of tin mining in Cornwall and the much-debated location of the Cassiterides are discussed by C. E. N. Bromehead in an article on "The Evidence for Ancient Mining" (*Geog. J.*, August 1940). There is sufficient evidence in the form of picks and bronze implements in ancient workings to justify a belief that tin was mined in the Bronze Age. At the time of Pythias, about 325 B.C., the tin trade was already in existence, tin being shipped to the Loire or Garonne and then overland to the Mediterranean. Indeed this trade probably was carried on so early as 450 B.C. Earlier than that, however, it is likely that the Phœnicians sought tin in Britain, perhaps so early as 1000 B.C., by which time certainly they had sailed through the Straits of Gibraltar and founded Cadiz. Contributory evidence is the discovery of Irish gold work of about 1200 B.C. at Gaza, and beads from Brittany of equally early date in the eastern Mediterranean. The Cassiterides, however, remain an unsolved mystery. Bromehead inclines to believe they were a myth designed to mislead contemporaries of the Phœnicians as to the whereabouts of the tin mines. He discards the Isle of Wight but gives a doubtful acceptance to St. Michael's Mount for identification with Ictis, from which the tin was shipped. It certainly is the kind of port which the Phœnicians favoured in other lands.

Earthquakes registered at Hong Kong

VALUABLE data is contained in the Royal Observatory Hong Kong monthly seismological bulletin for April 1940. In this, the time of occurrence of several important phases is given to the nearest second together with the period of the waves and their amplitudes. It appears that during the month 41 earthquakes were registered on the Milne-Shaw seismographs, two of the shocks being stated to be local ones. The two largest earthquakes were recorded on April 6 at 13h. 45m. 30s. G.M.T. with an amplitude of 11 mm., and on April 16 at 6h. 17m. 8s. G.M.T. with an amplitude of 8·5 mm. In the report there is no mention of microseisms. Perhaps the observatory is fortunate in not being affected by the phenomenon.

Magnetic Properties of the Transition Elements

F. BITTER, of the Massachusetts Institute of Technology, presented a paper on this subject at the annual meeting of the U.S. National Academy of Sciences held during April 22–23. The main objective of this cryomagnetic research was to provide information about electronic configurations and interaction energies in solids. First experiments have been on compounds and alloys of the transition elements chromium, manganese, iron, cobalt, nickel and copper. It is proposed to complete a general survey of these substances from 14° to 1,200° Abs. in large and small fields. By way of illustration, the properties of iron were discussed. α-iron, Fe_3O_4, one form of Fe_2O_3, FeS are ferromagnetic; γ-iron and hæmatite (Fe_2O_3) are not. The author's results on $FeCl_2$, $FeCl_3$, and on alloys of copper containing less than 1 per cent of iron in solution show strong paramagnetism with interesting anomalies at low temperatures. Also an alloy of gold containing 12 per cent of iron in solution, although it has a face-centred cubic structure like γ-iron, is ferromagnetic up to 230° C. (*Bull. Amer. Phys. Soc.*, **15**, 20; 1940). The theory of solids is sufficiently advanced to attempt at least a qualitative description of the above facts. Such an attempt can be outlined, starting with assumptions about the Fermi energy resulting from the application of the exclusion principle and about the Heisenberg exchange energy, and then calculating the properties of iron atoms in various geometrical configurations.

Atomic Weight of Iodine

THE atomic weight of iodine is of special interest, for as iodine is a simple element a comparison of the physical and chemical scales may be made through this element with less uncertainty than in the case of a complex element. The accepted value of the atomic weight, 126·932, was found by Baxter from a comparison of silver with iodine. Hönigschmid and Striebel in 1932, by the conversion of silver iodide into silver chloride, found the appreciably lower value 126·917. Baxter and Titus (*J. Amer. Chem. Soc.*, **62**, 1826; 1940) have now redetermined the ratio AgI : AgCl by heating weighed quantities of silver iodide in a current of chlorine until no further loss in weight occurred, and they calculate an atomic weight of iodine slightly lower than Hönigschmid and Striebel's, namely, 126·915. They point out that silver iodide above its melting point seems to be somewhat unstable in air and even in nitrogen, so that some slight uncertainty exists as to the exact composition of the fused material on which the analyses were made. In a second paper, Baxter and Lundstedt (*J. Amer. Chem. Soc.*, **62**, 1829; 1940) also determined the ratio Ag : AgI as well as the ratio AgI : AgCl. It was found that when silver was fused on lime in an atmosphere of hydrogen (Richards's method) slight reduction of the lime occurred and the silver showed calcium lines in the spectrum. The value found is 126·915. It is pointed out that there is some uncertainty about the mass spectrograph value, but the figure 126·915 lies between the value 126·917 found by Hönigschmid and Striebel and the best mass spectrographic value.

ENERGY AND ENTROPY OF EXTENSION AND SPREADING OF MOBILE MONOLAYERS*

BY PROF. WILLIAM D. HARKINS, DR. T. FRASER YOUNG, AND EDWARD BOYD,
UNIVERSITY OF CHICAGO

THERMODYNAMICS reveals in two-dimensional systems a peculiar state of matter in which an extremely large amount of heat is required to increase the distance between the molecules by about thirty-five per cent without a change of temperature or of state. In three-dimensional systems at ordinary pressures these large amounts of energy are not used unless a change of state, as from liquid to gas, occurs.

In the period of the last fifty years, much work has been done on the pressure-area relations of mobile monolayers, that is films one molecule thick, particularly those of organic substances of the general type of pentadecylic acid, or on alcohol or amine, on the surface of water. On mercury or gallium the relations are undoubtedly the same, but the experimental difficulties when a liquid metal is involved are very great. If a barrier is placed between a clean water (or mercury) surface, and the same liquid covered by a film, a force acts on the barrier from the film toward the clean surface, and this force per centimetre is considered as the surface pressure (π). If the mean area per molecule of the monolayer is very large, as 100,000 A. of area (sq. A.), the film is a perfect two-dimensional gas. (Ten billion A. equal one square centimetre, or sixty-five million billion, one square inch.)

On compression this two-dimensional gas begins to change to a two-dimensional liquid (L_1) at an area of several hundred to several thousand sq. A., and is completely condensed to the liquid film at 40–50 sq. A. and a very low film pressure. Further reduction of area results in a rapid increase of film pressure, until the liquid (L_1) changes into a second liquid (L_2), which has very remarkable properties, in that it is at first very highly compressible, but becomes quite incompressible if the pressure is increased sufficiently.

At a molecular area of about 20·5 sq. A. the liquid film freezes. The remarkable fact found by the application of thermodynamics in the present work is that there is no latent heat involved in this freezing, so it differs greatly in this respect from what is found in three dimensions. Thus a kind of 'ice' is formed which requires no heat to melt it.

Thermodynamical equations have been developed, which make it possible to determine the change in either energy or entropy of these two-dimensional layers (third dimension of the order of a ten millionth of an inch) on expansion or contraction. Thus if the films are stretched (expanded) they take up heat. The work shows that when a solid film is expanded at constant temperature, and undergoes transitions from solid to liquid (L_1), from liquid (L_1) to liquid (L_2), and then to gaseous film, almost all the heat is employed in two changes of area. As in three dimensions, a considerable amount of heat is utilized in the vaporization of the liquid (L_1).

The remarkable departure from the behaviour of ordinary three-dimensional matter is that in two dimensions at constant temperature :

(1) No heat is required to melt the solid.

(2) Very little heat is required to expand the liquid (L_1) so long as its molecules stay packed about as tightly together as in three dimensions.

(3) There then ensues an expansion of this liquid film such that the intermolecular distance may increase by so much as thirty-five per cent. This occurs without a change of state, but nevertheless the heat absorbed is very great. For example, if the film consists of pentadecylic acid this extension of the film absorbs as much heat as is used in the evaporation of the same number of molecules of water at ordinary temperatures (11,000 calories per mole).

(4) In the more expanded liquid state (L_2) the heat of expansion of the film is moderately high, but only a sixth as much per unit area as in the peculiar state described in (3).

* Substance of a paper read at the annual meeting of the U.S. National Academy of Sciences held during April 22–23.

BRITISH STANDARDS INSTITUTION

IN a paper read on April 2 to the London Branch of the Association of Mining Electrical Engineers, the significance of the work being carried on by the British Standards Institution was discussed by Mr. Percy Good, deputy director of the Institution. He began by paying a tribute to the foresight of British engineers who laid the foundations of a movement, which has spread to all industries and into practically every country. In Great Britain it is established on a truly democratic basis of self-government. Each industry as a whole governs for that industry ; but due regard is taken as to the effect of any proposed change on other industries. Insistence on agreement between the interests concerned before a standard is promulgated has as a rule resulted in wide acceptance.

The original standardizing committee grew to be a chartered institution with more than a thousand industrial and technical committees, the pressure for more standards being continuous. The fundamental principles which govern its operation are : (1) to prepare a standard only when those concerned with the production and use of the product and material in question agree that a standard is desirable ; and (2) to issue a standard only if those chiefly concerned agree that a suitable draft has been produced.

The Council of the Institution offered the services of the Institution to the Government a few months before the outbreak of War. Considerable work, especially in connexion with war-time needs, has resulted in the issue of a special series of specifications prepared for the Ministry of Home Security (A.R.P. Department). The British Standards Institution owns certification marks as well as proprietary rights to the term 'British Standard'. Some important conclusions or principles have been reached which have been endorsed by all the constituent parts of the British Commonwealth, and have received some support in the United States, in places where a different view had previously been taken. These principles were being discussed with the European countries before the outbreak of war. It was desired to secure that certification marks of quality or performance to indicate conformity to a specification should be granted only to a recognized independent organization and not to one financially interested in the products it is desirous of marking. It was decided, also, that such marks should be used only under effective control. The B.S.I. considers it essential that any proving scheme should be on the basis of proving that the material conforms to a written specification, and should not be on the basis that the testing authority considers the material to be satisfactory.

The British Standards Institution believes that its present system has considerable possibilities and is proving a success. That system requires a maker, who is desirous of marking his goods with the B.S.I. certification mark, to maintain in operation a system of control during the process of production which will give assurance that the product always conforms to the specification. There are often safeguards and the scheme is found to add practically nothing to the cost of production.

War-time, with its restrictions, its price control, etc., provides the opportunity for eliminating those things, which accumulate and hang round an industry like a millstone. Everyone concerned with production should look into his own and his industry's ranges, and ask the B.S.I. to assist in the inquiry.

Mr. Good, in reply to Mr. W. C. Barry, said that technical proposals are referred to a committee which is expected to be rather commercially minded to ensure that the technical men's enthusiasm does not run away with them. In a number of cases, the representatives of a country have agreed to the acceptance of a proposal, but had said they could not change their national standard ; and so each of these countries reserved that freedom. Mr. C. Le Maistre (director of the B.S.I.), replying to a question concerning the publication of specifications in languages other than English, said that a good deal of translation is being done by the B.S.I. into other languages.

ORIGIN OF THE SUBMARINE VALLEYS ON THE CONTINENTAL SLOPES OF THE NORTH ATLANTIC*

By Prof. Walter H. Bucher,
University of Cincinnati

THE essentially 'mature' topography of the continental slopes is so fresh that it is either actively forming now or has been fashioned by 'yesterday'. Being a surface pattern produced by erosion on a slope formed by deposition, it must owe its origin to a set of circumstances that either appeared for the first time or recurred after an absence sufficiently long to allow substantial progress of the sedimentation that produced the continental shelf.

Since the submarine slope topography extends to depths far greater than can be accounted for by removal of the water or vertical uplift of the shelf, the force or forces that caused the erosion must lie in the water of the ocean itself, that is, in currents. As the ocean is a standing body of water, the only currents capable of producing erosion on the continental slope are such as arise on the bottom through wave-motion of the water. Only such waves can have an effect on the sea bottom as have wave-lengths much greater than the depths at which effects are expected. Two types of such waves are known to oceanographers. Both are observed on the shore ; the one as the 'tide', the other as seismic sea-waves or 'tsunami'.

Recent measurements (Stetson, Shepard and Revelle, *et al.*) have proved the existence of currents at great depths of an order of magnitude consistent with tidal theory. These tidal currents consist of the back-and-forth movement which results from the elongated-elliptical path that characterizes the movement of the particles in water shallow compared to the length of the waves. But, while the tidal currents are strong enough to keep the submarine valleys free from sediment, they are not strong enough to produce them. Furthermore, the tide which results from extra-telluric forces has been an essentially constant phenomenon throughout geological time. It is, therefore, not an agent that can explain the submarine slope valleys.

The tsunamic waves, on the other hand, resulting as they do from telluric forces (gravity through subaqueous landslides caused by earthquakes and submarine volcanic outbursts), are precisely of that character. They are the shoreward expression of wave-motion that originates at the bottom of the sea and therefore involves the whole column of water. Their wave-lengths, measured in hundreds of kilometres, are such that their dynamics are those of waves in shallow water. Their energy is largely dissipated when they pass from oceanic depths on to the continental shelf which, where wide enough, offers effective protection to the coastline. Even on the coast, however, the wave-motion persists for many hours and half days.

* Substance of a paper read at the annual meeting of the U.S. National Academy of Sciences held during April 22–23.

The initial energy involved in waves that leave their records on gauges 8,000–16,000 km. away must be great since the three-dimensional concentric spreading of the wave-motion into motionless water involves much loss of energy. It is safe to assume that within a distance of many hundreds of kilometres from the centre of a disturbance the energy of the tsunamic waves is a multiple of that of tidal wave motion, and that it is therefore adequate to cause the erosion in the sediments of the continental shelf.

The earthquake records of the Atlantic Ocean show that crustal unrest is now causing earthquakes at a sufficient rate to account for the submarine erosion. An important earthquake or a submarine volcanic eruption a few times a century will produce currents that on the ocean floor are as effective as the few cloudbursts per century that carve the wadis of the great desert plateaux with which the submarine valleys have been compared.

But there is good evidence that both tectonic and volcanic activity were more intense in the recent geological past, especially along the mid-Atlantic ridge. The few small parts of the latter that stand high enough to rise above sea-level, such as Iceland or the Azores or diminutive St. Paul, bear abundant evidence to that effect. It may be inferred that the erosion of the continental slope is the counterpart to the intense tectonic and volcanic activity of Quaternary time to which the mid-Atlantic ridge owes its newer and bolder features.

The systematic study of the tsunamic waves, in which the Japanese have done already much excellent work, promises results not only of scientific but also of practical value. After the Grand Banks earthquake of 1929, for example, four trans-Atlantic cables broke at once; eight others went out of service at intervals up to thirteen hours after the earthquake. The curious circumstances of these cable breaks may find their explanation in the fact that much of the damage resulted from the cumulative erosive action of the currents set up by the earthquake.

THE FIRE ALARM SYSTEM IN THE UNITED STATES

THE request which has resulted in the development of the bulletin referred to below* on the fire alarm system in the United States originated at a convention of the International Municipal Association, held in Cleveland, Ohio, during August 30–September 2, 1937. It was made officially to the United States Office of Education, and H. A. Friede was appointed to co-operate with the United States Office of Education in developing the desired analysis of the proposed work.

In practically all cities of the United States having a population not greater than 30,000, fully automatic fire alarm systems are frequently used. In larger cities the functions to be performed by the fire alarm system are such as to require the exercise of a high degree of judgment on the part of the operator, especially when large fires or other emergencies occur. Up to the present time, the requirements of the men employed in fire alarm bureaux have received little attention from those who are promoting and operating training programmes for the personnel of the departments. In many cities the bureau is organized and operated as an independent unit of the city's entire programme of public safety. When this is the case, the co-operation between the chief engineer of the fire department and the superintendent of the fire alarm bureau should be close and effective. In cities where the fire alarm bureau is under the chief, full confidence should also prevail. In some cities the fire alarm bureau is responsible not only for the operation of the fire alarm system itself, but also for the police telegraph and the municipal telephone and radio communication systems, through which all fire and police stations, and police and fire department motor-cars may be reached in any desired combination, with practically no delay.

The two principal bases for the rating of responsibilities show (1) the degree to which specific responsibilities are delegated and (2) the degree to which each responsibility involved represents trouble, difficulty or worry. A practical and simple method of rating responsibilities from this point of view is illustrated by means of a graph. An arbitrary scale from 0 to 10 is used. A rating of 10 on this scale means that the responsibility is as completely delegated as it can be, whilst a rating of 0 indicates that the superintendent believes that he cannot delegate to anyone the responsibility for doing that which is necessary in order for him to discharge the duty satisfactorily.

In fairly large cities, there are four men in each of the following three classifications: chief operator, assistant chief operator and telephone operator. This makes it possible to have three shifts, with an extra man for each job available to take care of the work in cases of absence due to sickness, vacations and leave. To the fire alarm operator, technical and operating proficiency in the handling of radiotelephone equipment is essential, seeing that in most cities he is called on to operate the radiotelephone equipment. A knowledge of the geography of the city, similar to that required of the fire alarm operator, is also important for the telephone operator. The man on this job should make every effort to perfect his knowledge of the city and of all its important details while serving in this position and awaiting promotion to the assistant chief operator's job. Analysis charts are given of the various kinds of knowledge which those filling junior posts are supposed to have.

When it appears necessary to provide some training to secure greater efficiency of operation, the mistake is often made of setting up programmes of a more or less general character. As examples of this, mention is made of a general course of instruction in the principles of electricity or a series of lectures for fire alarm personnel on the history of the development of fire alarm systems. The kind of information that is really useful to the operatives and to the station is given in appendixes illustrated by clear line diagrams. These deserve special study by everyone interested in fire alarm stations, and clearly indicate the trend of future development.

* The Fire Alarm System: an Analysis of the Work of the Fire Alarm Bureau, with a Discussion of the Problems of Training likely to be Encountered. By Frank Cushman and H. A. Friede. (U.S. Department of the Interior: Office of Education. Vocational Division Bulletin No. 207. Trade and Industrial Series No. 58. (Washington, D.C.: Government Printing Office, 1940.) 15 cents.

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C. G. BURTON,
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