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FOOD HABITS

It is no light undertaking to make a scientific study of the food habits of a nation, especially when that nation is at war and is sending vast quantities of its basic foods to its allies in a world which is also at war. The United States Committee on Food Habits is one of two committees set up in 1940 by the National Research Council at the request of the National Defense Advisory Commission, as part of the plan for mobilizing science for defence and war effort. Its report is published under the title, "The Problem of Changing Food Habits"*.

The task of the Committee was to study the psychological and cultural pattern of human nutrition, while the other committee appointed at the same time (the Food and Nutrition Board) had the task of dealing with the biochemical and physiological aspects of this problem. The aim was not merely to tell us why we eat what we do eat, but also to guide the food habits of various kinds of people in the direction required by health and national and world needs. This study requires the consideration of economics, culture, tradition, agriculture, national and individual psychology and other factors which govern the consumption of food by communities or individuals. As the preface to this brochure explains, little had been done when the Committee was appointed to study the relation of culture and behaviour and personal traits to food habits, and it had a pioneer job. It had to collect existing knowledge of what foods were liked and disliked by different kinds of people, to stimulate research and to be ready to advise. Dr. Carl E. Guthe, the chairman, contributes a detailed history of the Committee, and Miss Margaret Mead, the executive secretary, reviews the work done.

One of the Committee's first tasks was to organize the mass of existing knowledge, which ranged from studies of soil agronomy to studies of historically changing diets, the relationship between purchasing power and foods eaten, the relation of learning to eat with other types of learning and such medical data as those supplied by the study of gastro-intestinal diseases and other illnesses which profoundly affect food consumption. At the same time new methods of acquiring further knowledge had to be devised. The study had to be world-wide, and the effects of lend-lease and nutritional relief of other countries had to be included. Gifts of white flour for the relief of famine might, for example, inculcate in a population accustomed to eat whole grains a habit which would have disastrous effects on their health in the future. The way in which foods substituted in war-time for normal ones are presented may affect the post-war acceptance of those foods. The enforcement of nutritional standards may have all kinds of repercussions. The giving of emergency food tickets to children may, for example, break down parental authority, with undesirable results in communities in which this authority is traditionally or culturally strong. The whole cultural picture must be considered

* Bull. National Research Council, No. 108: The Problem of Changing Food Habits. Report of the Committee on Food Habits, 1941–1943. Pp. 177. (Washington, D.C.: National Academy of Sciences, 1943.)

before changes are introduced which may be desirable nutritionally, but may be socially undesirable.

The Committee's method has been to approach the problems largely through the conceptions of cultural anthropology; food habits were seen as "the culturally standardized set of behaviours in regard to food manifested by individuals who have been reared within a given cultural tradition". But these behaviours are related to other standardized behaviours in the same culture. Preference for meat or aversion to milk were not, for example, treated as isolated items, but were referred to the total complex of behaviour which constituted the food habits. Methods of changing food habits are similarly related to psychological factors of learning. The cultured individual reacts both to the food itself and to its production and distribution.

There was no immediate prospect of financing intensive cultural studies of American food habits. Methods for the quick appraisal of some of the more important factors were therefore devised by Prof. Kurt Lewin, of Iowa State University, who contributes an account of the study which he directed by means of a questionnaire addressed to 2,300 Iowa school-children and by interviewing housewives; and Dr. Franklin Dove devised a method of defining the content and pattern of regional food practices. These studies, and others of resistance to change, rationalizations of resistance and so on, have made it possible to identify various social-psychological characteristics of the American food pattern. Examples of these are the tendency, in counties with a Puritan tradition, to use food for purposes of reward and punishment; or the conflict between the emphasis in the southern United States upon personal taste rather than upon health and duty, with consequent catering for the individual tastes of each member of the family; and the emphasis in the north upon "moral overhauling" of the behaviour of each member of the family.

Studies of emergency feeding showed that the most practical way of avoiding giving offence to anyone in a mixed group was to cook single foods with a minimum of seasoning and to serve all condiments separately. The contemporary American cafeteria and methods of self-selection of meals are examples of social institutions well adapted to a variety of incompatible food habits. "The attitude of many European peasants who treat bread as sacred and guard against a single crumb falling on the floor has vanished in a country in which food was the certainty and money the uncertainty"; for, until 1942, very few Americans under forty had had the experience of having money for food while the food was not obtainable. The study of food habits is also necessary for the understanding of subcultural groups in the United States. To this subject Natalie F. Joffe contributes an interesting paper. This aspect must also be studied because the United States will send food to other countries, to the food habits of which these rations must be related.

The study of the number, form and composition of meals reveals some interesting features. A nutritional substitute for meat may, for example, be milk, but culturally the container may have been substituted for the thing contained, so that food which is not nutritionally a substitute for, say, protein, may be accepted if it is put on the table in a casserole or other suitably shaped container. If the shape and size of the container of food is so important to some human beings, they would seem to resemble some animals in this respect, for the farmer knows that he is asking for trouble if he gives his pigs or hens, for example, their food in containers to which they are not accustomed, or if he puts these containers in a new place.

Industrialists will be interested in the section which deals with the effects of altering the time of a meal or of changing the name given to it. Prof. Lewin, discussing this question, claims that people eat according to the clock and that, if they start work at noon, breakfast foods, such as fruit juice, eggs, cereals and milk, may be omitted from the diet. Two other papers also discuss this and other effects conditioned by hours of work.

Prof. Lewin's study further considers the effects of shopping habits, to which must be added the effects of the ration card, the queue and similar factors. If Prof. Lewin's contention is correct that the person who buys the food controls the diet, increased shopping during the War by men or children may affect the content of the meals considerably. In Great Britain this conclusion will, no doubt, be disputed.

Prof. Lewin also provides a discussion of motives for buying different kinds of food, among which, of course, are the amount of money available, the price of foods and the conflicts between these and other economic factors and the ideals of health and cultural tradition. A Czech or an American of Czech origin and a Negro will omit different foods as a result of the conflict between these factors, and there will be similar differences between the decisions of the Jew and the American of German or Anglo-Saxon descent. Meat, concludes Prof. Lewin, is the "most typical husband's food", and this introduces another complication. For whom in the family is the food to be bought? If the husband is a keen gardener, as, for example, the Czech in the United States apparently is, will the family eat more fresh garden produce? If it is true that a man acquires his personal food tastes within the family, he will carry these to public eating places and so affect their catering. But it would be interesting to find out whether this often, or indeed ever, happens in Great Britain; and how much the home catering can be affected by family experience in a public eating house.

Another series of questions arises out of the consideration of the housewife's knowledge of cooking and food values and the degree of her influence on the home. Prof. Lewin suggests as a partial explanation of why we eat what we do eat the "channel theory", which amounts to the self-evident proposition that we do not eat at home what does not come into the home. This forms, nevertheless, the basis of his study of how food comes to the table and why. Prof. Lewin gives paramount importance to the view that once food is on the table, most of it will be eaten by some of the family. This view also will be challenged by some British authorities. Nor should we forget the importance of the way in which food is served. The effects, for example, of the method of serving it on individual plates are discussed by the Committee on Food Habits, and all of us have probably suffered—or benefited—from the system of training children to eat up what is on the plate, without adequate consideration of what the physiological or mental results may be.

In a leading article in the same issue (p. 47), *The Lancet* gives the salutary reminder that it was not science that made our forbears healthy on the food which they liked; science only enables us to understand why they were healthy. The primary error that we have made, says Mr. F. Le Gros Clark (also in the same issue of *The Lancet*, p. 55), is that of looking upon food habits as a health problem. To the public, milk, for example, is a beverage, and we have almost succeeded in converting it into a medicine. Neither Lord Horder nor Mr. Le Gros Clark is, of course, seeking to belittle the value of scientific knowledge about food; they are both, like the United States Committee on Food Habits and the British Food Education Society, concerned to create a gradual and irreversible change in food preferences; but the views of Lord Horder and Mr. Le Gros Clark will be welcomed for their practical common sense.

The study of the influence of methods of preparation of foods leads the inquirer into many complex problems. *The Lancet* (542, April 22, 1944) has pointed out, in a discussion of a memorandum on hospital diet issued by King Edward's Hospital Fund for London (1943), that the hospital ward offers an unparalleled opportunity of giving people experience of the value of rightly chosen and properly prepared food. The King's Fund memorandum lays down the principle that the food service of a hospital should be one of its essential remedial services; and most of us will agree. The remarkably good recipes for war cookery issued in Great Britain by the Ministry of Food and other agencies during the War have taught the people a great deal about the choice and preparation of meals which are both adequate and appetizing. Lord Horder, in his address to the Food Education Society last June (see *The Lancet*, 53, July 8, 1944), has reminded us that the science of nutrition is a young one and that we should not strain too far the few facts of which we seem certain. Balance the day's diet, by all means, he says, but it is not necessary to balance the individual meal. He also said wise things about white and other kinds of bread.

The many other questions raised by the American report cannot be discussed here. It is already possible, says Miss Mead, to predict the general lines which resistance to, or acceptance of, proposed changes in food habits will follow; but recommendations of methods have to be related to the whole complex of the War and to the cultural, social and individual ideas about food of a variety of peoples. She suggests that, during the War and the immediate post-war period, two tasks must be tackled. One is to maintain the health of the people by the skilful use of existing food supplies; the other is to present the increased knowledge about the use of foods in such a way that it does not become associated with war-time deprivation and therefore is not rejected later on. The additional long-term task, in the United States, is to alter American food habits so that they are based upon a tradition which embodies science and yet are sufficiently flexible to incorporate new scientific results. Altered production and distribution of foods will not by themselves effect this. Nor will authoritative pronouncements effect it, for they tend to breed regional conformity rather than intelligent flexibility. The responsibility rests on those individuals who plan what others will eat. New knowledge must therefore be conveyed to the woman on the farm, in the village and in the city. Mr. Le Gros Clark (*loc. cit.*) would seek the point at which social preferences are most readily influenced, and suggests that the school canteen, aided by committees of parents, could be developed gradually into an institution for the education of public tastes. The pressing need, writes Miss Margaret Mead, is for the integration of the techniques which have been devised for dealing with various aspects of these problems.

ENGLISH AGRICULTURE, NOW AND AFTERWARDS

(1) The Farm in the Fen
By Alan Bloom. Pp. 192+20 plates. (London: Faber and Faber, Ltd., 1944.) 10*s*. 6*d*. net.

(2) This Farming Business
By Frank Sykes. Pp. 160+8 plates. (London: Faber and Faber, Ltd., 1944.) 8*s*. 6*d*. net.

FORTUNATELY for the countryside of England, there have always been men who have felt the urge to reclaim heaths, moors and wastelands and bring them into agricultural use. Reclamation went on vigorously during the Napoleonic Wars, during the War of 1914–18, and during the present War; it has hitherto been essentially an emergency activity. Unfortunately, a great deal of the land thus brought into cultivation has been allowed to go derelict again, so that the whole of the capital embarked has been lost. Reclamation on the grand scale has been undertaken during the present War and a fascinating account of one of these enterprises has now been published.

Mr. Alan Bloom is a born reclaimer. He began as a nurseryman producing flowering plants for gardens, and having had difficulties owing to dryness of his soil, he looked out for a fen-land farm to which he might transfer the moisture-loving varieties. In 1939 he found a farm in the Burwell Fen which was certainly not short of water; it had, however, been badly run down. Next to it lay Adventurers Fen, which, though at one time cultivated, had long since been abandoned, and had reverted to a water-logged waste. It was a familiar story. Until recently, drainage had been the responsibility of a number of small local bodies, none of them possessing resources or power to do the work properly; as the farms fell in value, so their resources dwindled and less and less drainage could be attempted. Seeing the hopelessness of the situation, some of the owners leased out their land to turf diggers, who left the surface so badly pitted and lowered that any faint chance of restoration to agriculture vanished.

Mr. Bloom was fortunate in beginning work in 1939, when the threat of war compelled the Government to increase the output of food. His financial difficulties disappeared when the War Agricultural Executive Committee not only ensured the proper drainage of his farm of two hundred acres but also appointed him its agent to reclaim another two hundred and eighty-six acres of Adventurers Fen.

Mr. Bloom has a keen sense of detail and describes vividly the draining and the ditching; the work was not without danger, and, indeed, one man lost his life through the caving in of peat and mud, which engulfed him; a horse also was lost and two tractors only narrowly escaped. The removal of the water was followed by the clearing of the scrub growth and by such levelling as was possible. The land was then ready for ploughing, but another difficulty was met: buried in the fen just below the surface were numbers of oaks, ranging up to 50 ft. or more in length, and, of course, very heavy. Much labour and ingenuity were expended in getting these out. Finally the land was sufficiently friable to allow of cultivation.

The crops grown were wheat, sugar beet, potatoes and smaller areas of peas, feeding linseed, buckwheat, etc. Only little grass could be kept for the cattle. The soil lacks phosphate, which so far cannot fully be supplied; it shows signs of manganese deficiency; it would be interesting to know whether there is a copper deficiency as in somewhat similar soils in Holland and North Germany.

In the end a considerable amount of food was produced; it was so badly needed that the cost did not matter. The land, too, is back into proper shape for farming, though, of course, it will always need precautions against weeds, against wind erosion, and against flood and fire. But, as stated above, this kind of thing has been done before. Will Adventurers Fen revert once more to the wild after this War is ended, and the great cost of reclamation simply be lost? The difficulties of keeping reclaimed land in cultivation were ably discussed by Dr. C. S. Orwin some years ago in his account of the reclamation of Exmoor forest. They are great, but they are not insurmountable, and it is devoutly to be hoped that the prodigious amount of labour and money expended in land reclamation during these past few years will not be wasted.

The second book on our list is also a record of splendid achievement in food production, but in very different circumstances. Mr. Sykes, like Mr. Bloom, came new to farming and proved to have a great flair for it. In 1927 he took over the tenancy of 1,200 acres of corn- and downland near Salisbury. Prior to 1914 it had maintained four flocks of sheep and employed a staff of twenty men; then during the War years of 1914–18 there had been much ploughing up and corn growing: the productivity ultimately fell so much that the farm had to be abandoned. Mr. Sykes began by laying it down to grass on which he kept Cheviot ewes and dairy heifers and so was able to make a living for himself and the few men still retained. Later he took another similar farm. By 1935 prices were recovering and he was able to improve his system: he had been impressed by what he had read about the advantages of breaking up and reseeding pastures; he tried the method and found that it succeeded. So he decided to adopt ley farming, and as the natural conditions are suitable he has been able greatly to increase his output of food in consequence.

Mr. Sykes briefly but ably summarizes his methods, and the book is a valuable guide to any young farmer on chalk soils. For seeding the ley he uses a mixture of Aberystwyth rye grass (16 lb. per acre *S*23) and white clover (2 lb. *S*100) on good land, while for poor hill land he adds 5 lb. per acre cocksfoot. He grazes the herbage in the first year and cuts it for hay in the second; he ploughs up directly there is any sign of the appearance of turf. This is done in autumn, and wheat is sown immediately without any break for a bastard fallow, of which he does not approve. A good crop can be obtained relatively cheaply—about £2 per quarter at present prices. But a second crop of wheat on the same land costs much more to produce, and Mr. Sykes brings out clearly the steep rise in cost as the output of wheat is increased. Like many other farmers, he wishes there was a good autumn barley. He has considerable faith in flax, but not much in sugar beet which, in his view, could never stand against sugar cane in free competition. Potatoes he regards as a crop for the specialist, owing to the extent to which it is becoming mechanized; market-garden crops are beginning to interest him, but he prefers to say little about them at present.

Mr. Sykes sets out his views on the future of British farming. The present enormous output of food from our farms is, of course, being achieved regardless of cost: Mr. Sykes states that the only business part of farming now is filling up forms and keeping the Inland Revenue at arm's length. But it will not always be so, and before long the cry will be for cheaper food. Mr. Sykes admits that we could not completely feed ourselves so cheaply as we could import the food, but he thinks that wheat production at some level between pre-war and present output could be maintained at a contract price of 50*s*. per quarter, the wage-rate being as at present. But the British corn-grower cannot stand up against the competition of soil exploiters, or of subsidized imports.

Milk is likely to remain one of the leading farm products, and Mr. Sykes has much to say about its production in greater quantity, in cleaner state, and at lower cost. The present average annual output per cow he puts at 400 gallons, but this could be greatly increased; 1,000 gallons is not an uncommon yield. The trouble is that milk yield is inherited from the sire, and few recorded sires are available. If artificial insemination were adopted much better use could be made of them. He has much to say about the working of the 'clean milk' campaign, tuberculin testing, attested and accredited herds, etc. On individual farms improvement has been effected, but the consumer (who paid the cost) gained little because unclean milk got mixed in during transport. Three diseases, tuberculosis, mastitis and contagious abortion, play havoc with our dairy herds, and he puts the average life of the dairy cow in the milking herd at only two or three years. (The usual figure is higher.) Widespread improvement is difficult because 'reactors' are often sent to market and bought by some other dairy farmer looking for a 'bargain'. One of the great advantages of dairy farming is that it is well suited to the small farmer—and England is and always has been a land of small farms.

Ley farming would also improve our capacity for lamb production, and it should be possible to carry one ewe to the acre. On the other hand, Mr. Sykes is not sure that our pre-war output of poultry and eggs can be maintained at anything like pre-war prices. The conditions were rather special and may not recur. Our farmers were guaranteed 45*s*. per quarter to produce wheat. But foreign wheat was coming on to the market at much lower rates. Mr. Sykes states that French wheat, for which the French Government had paid the French peasant 60*s*., was sold in England at 18*s*. per quarter. Much of it was bought by poultry-keepers and converted into cheap eggs. However, with more folding of poultry on the farms, and better arrangements for collecting, grading and storing the eggs, Mr. Sykes thinks that a good and regular supply of poultry products can be assured.

Mr. Sykes is no advocate of self-sufficiency, but he considers that imports should be controlled by an import board. Under this would function production boards for the different farm products on which would be represented producers, retailers and consumers: these boards would fix prices and production levels, improve the quality and the marketing of the products. A national marketing board would correlate their work. He does not, however, wish to see the War Agricultural Committees continue in existence, still less does he want control by officials. The poor farmer must obviously be eliminated, but this will proceed automatically if the production boards insist on adequate standards of quality: to these the poor farmer never could conform.

The book is refreshing and full of good points. A few slips in the chapter on manuring should be corrected if another edition is printed.

A word of praise is due to the publishers, who in spite of war-time difficulties have presented both books in very attractive form and furnished some admirable illustrations. E. JOHN RUSSELL.

ECONOMIC STUDY OF PLANNING

The Road to Serfdom

By F. A. Hayek. Pp. viii+184. (London: George Routledge and Sons, Ltd., 1944.) 10*s*. 6*d*. net.

THERE are some who regard this War as liable to become economically a war against the middle class, as indeed the War of 1914–18 was as touching the middle classes in Germany. Even were this the case I do not know that it would greatly awaken my sympathy. By their chauvinistic short-sightedness they have 'asked for' their own extinction. They correspond to the national phase in human development. They made the National State and will perish with it. However, Prof. Hayek undertakes to show us the way by which they and others will travel to that total servile State, which he, along with Dr. Friedmann, sees as the next phase.

Prof. Hayek does an excellent piece of work on the analytical side. Primarily an economic study of what is involved in 'planning for all', it has some of the sombre quality which distinguished Otto von Seeck's great study of 'the rotting away of the best' at the time of the middle Roman Empire. The aristocratic quality of liberty, such as Signor Croce applauds, is at a discount. Prof. Hayek reminds Englishmen of their own distinctive tradition in which they have now lost confidence. He quotes Milton: "They who seek nothing but their own just liberty have always the right to win it". Milton adds, "wherever they have the power". He indicts Profs. Laski, Mannheim and Carr as "the totalitarians in our midst", and he doubtless would add other names such as those of Messrs. Crowther, Haldane, Bernal, Strachey *et al.* Economically Prof. Hayek points out that planning of production means planning of consumption and of "the means of all our ends"; that when a man's life is so planned he loses his economic liberty, not sometimes, as under capitalist unemployment, but always. When material life is controlled, as the Socialists also have said, political liberty is an empty name. John Smith is one forty-millionth of a sovereign and one whole slave. The abstract rule of law departs and the tyrannous 'rule of men', the Hitlerite-Stalinist administrative State, arrives, in which law is subject to considerations of particular effects, *raison d'état* and bureaucratic convenience. Instead of a man planning his own life, it is planned for him (so much more 'efficiently') by the State. He is allocated a 'status', as in the later socialist days of the Roman Empire. As, indeed, Aristotle said was inevitable, "a democracy may set up the most complete despotism imaginable".

Where Prof. Hayek, Dr. Erich Fromm, Peter Drucker and (if I may mention him in the same breath) Prof. Mannheim are weak is on the constructive side. Prof. Hayek agrees with the Marxists that planning must be all or nothing. He therefore wants *laisser-faire* and recognition of "money as one of the greatest instruments of freedom". In Prof. Mannheim's middling position that we can "plan for freedom", he sees only words. I have objected to this Marxist 'die-hardism', and I agree no more with Prof. Hayek or with Mr. Belloc, whom he cites. His is the old argument of Locke (and Hegel) that private property is morally necessary, for those who have got it, as a 'defence of personality'. This is very true but not true enough. Those who control the economic plan can persecute, even to death by starvation—"who does not obey shall not eat"; yet the final liberty remains spiritual and includes the power to refuse co-operation. The point is more than academic. It is being demonstrated by Gandhi to-day, and by the Danes on strike in Copenhagen. It is true that Gandhi only confronts the British Raj, full of Victorian moral inhibitions, and not the tyranny of the modern totalitarian State; but the same methods would probably apply.

The mass of men tolerate more readily death in war than unemployment. There is nothing fine in unemployment. It may well be true, as Dr. Fromm suggests, that the mass of men (perhaps unlike the American pioneers) far prefer security to liberty, of which they are no little afraid. The record of history seems to bear this out. It may be bad for progress that this should be so, but progress was always, as Mill said, of a few. If, however, we decide deliberately to move for a civilization less dominated by large-scale heavy industry and more by peasant farming, then the quite inevitable tendency in machine industry to plan for security will be thrust into a more proper perspective against the freedom of the small owner. The real enemy here lies in war, with its tendency to subordinate all to totalitarian planning, even architecture, even child-bearing. Conversely we discover the imperative necessity for liberty of peace—not this or that political gadget but, as Gandhi has insisted, actual peace—shall we say the flat refusal in the future to fight either the U.S.A. *or* the U.S.S.R.? The Master of Balliol has described the prescription of Prof. Hayek and those who think with him as the certain recipe for revolution. Man, being made as he is, he is not a liberty lover except in quite small doses. I agree with Dr. Lindsay. But I submit that the Mahatma sees further than either of them. At least the Indian experiment remains one of the few radical ones, that escapes from the compulsions of domination-politics, in our days. I cannot conclude without noting Prof. Hayek's support of that federal union of the whole West, with an Anglo-Saxon nucleus, which I have urged for many years and which now also receives the support of Mr. Walter Lippmann in his "War Aims".

GEORGE CATLIN.

CERAMICS AS INSULATING MATERIALS

Porcelain and other Ceramic Insulating Materials
By Dr. Ernst Rosenthal. Vol. 1: Raw Materials, Manufacturing Processes, Testing and Characteristics. Pp. xii+287. (London: Chapman and Hall, Ltd., 1944.) 28*s*. net.

THE pottery industry is almost virgin territory for the worker in applied science. Despite the trails blazed by J. W. Mellor in Great Britain and H. Seger in Germany, there are still wide tracts quite unexplored. There is still no institution of university status in Great Britain offering a full-time course in ceramics, and the number of qualified chemists and physicists engaged in the pottery industry together scarcely exceeds a baker's dozen. Things seem to be somewhat better in the United States, and there is a number of universities and State colleges at which full-time courses may be followed and degrees obtained in ceramics, usually in the engineering department. Faced with this position, the prospective writer of a book dealing with the scientific and technical aspects of the manufacture and applications of pottery must choose between two alternatives: either he writes for the ceramist and accepts the joy of writing as his main recompense, or he seeks to write a popular work, broadening the range and almost inevitably lowering the level. Dr. Rosenthal has neatly avoided this dilemma by writing a book on ceramics, not primarily for the potter, but for the much more ubiquitous engineer.

The book constitutes a remarkable *tour de force* for a man of science writing in an adopted tongue. Comparatively little trace of foreign terms remains, though the absence of hyphens causes the phrase "felspar containing steatite" to mean just the opposite of what the author intends it to convey, and the extension of this form to "each clay substance containing material" is likely to bewilder the average English reader until he has had time to sort it out. These constructions and some mistranslations, such as precipitation for sediment, subsequent for consecutive, compressor for press, feldspatic for felspathic, and talcum (though not invariably) for talc, might well have been eliminated by more conscientious proof-reading. A few misspellings have crept in by the same door, though "vacuum plugging" is obviously an invention of the printer's devil.

Where numerical data are given, the author has apparently taken over without conversion the units adopted in the original publication, thus compelling the reader to do a fair amount of mental arithmetic if he wishes to compare the figures given in different tables. Still more disturbing to the pedant will be the scant attention which has been paid to uniformity and accuracy in the dimensions of physical quantities. Impact strength appears at least once as cm. per kg., while in the footnote to a table of tensile strengths we learn that 100 lb. per in.^{2}=70·3 gm. per cm. or 7·03 kgm. per cm.^{2}. Power factor is stated to be expressed as cos δ=sin δ (though given correctly later), and phase angle between current and voltage as 90 per cent. We are informed that thermal conductivity of ceramic materials is usually expressed in K. cal. per m.^{2} h. °C. on the Continent, and in Cal. per sec. per cm.^{2} per °C. in American literature; but the variants K. cal. per m.^{2} per h. °C. and Watts Cm.$^{-1}$ (deg. Cent.)$^{-1}$ also occur in the book.

The statement that slop stone at 26 oz. per pint contains 18·33 lb. stone per peck is an obvious arithmetical slip, but the Brongniart formula looks strange with the plus and multiplication signs interposed. As the whole basis of body compounding by the wet method depends on an accurate knowledge of specific gravity (pint weight) one surmises that the slip maker whose pint measure held *approximately* 20 oz. would soon be parting with his can or his job. The mineralogist will be surprised to read that calcium carbonate occurs in Nature as whiting. Flint as a general term for silica is American rather than British practice. Photomicrographs are mostly called microphotographs in the book—a common error.

All too frequent blemishes of the type indicated above should not blind the reader to the merits of the book; it contains too much of value to be lightly dismissed. The author's wide experience both as investigator and manufacturer invests what he has to say with authority, and the persistent reader will be well rewarded for his pains. Chemical and physical formulæ have been reduced to a minimum. The engineer with even a smattering of chemistry will find no insurmountable barriers, while at least 75 per cent of the book will be comprehensible to 95 per cent of potters. Every pottery manufacturer interested in vitreous bodies or tunnel oven firing, to mention only two 'actualities', would be well advised to read it. There are few ready-made recipes for bodies or glazes, and no specification of the ideal tunnel oven, but much thought-provoking discussion of principles and practice.

Each material has its own characteristic limitations and possibilities which, in turn, influence design. The engineer who thinks that ceramic products might provide the answer to some of his problems should consult the ceramist at an early stage in development. In this connexion the sections dealing with shaping methods and tolerances will be of interest. Though not stated explicitly, the book is primarily addressed to electrical engineers. It can, however, be heartily recommended to engineers in general (the chemical engineer is apparently to be catered for in a subsequent volume), many of whom would probably be surprised to see the numerous photographs of ceramic products in the book—some small and complicated, others large and evidently extremely robust.

In the preface to his book Dr. Rosenthal expresses the view that ceramics could further advance industrial progress if their excellent technical characteristics were more generally known. Is it too much to hope that this view will be shared by those responsible for rebuilding and rehousing schemes?

MARCUS FRANCIS.

LITERATURE AND SCIENCE

Science and Criticism

The Humanistic Tradition in Contemporary Thought. By Herbert J. Muller. (Dwight Harrington Terry Foundation: Lectures on Religion in the Light of Science and Philosophy.) Pp. xiv+303. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1943.) *25s.* net.

PROF. MULLER, who is a professor of English, is perturbed at the incoherence and lack of standards in modern literature and modern life; as well he may be. He here expounds and criticizes (with good knowledge, sound sense and a pretty wit) many recent scientific theories in all branches, apparently because he thinks a better knowledge of them would improve literary standards. It is almost as though he thought "Macbeth" would be improved by substituting three psycho-analysts for the witches, or "Paradise Lost" by introducing Einstein's theory and the expanding universe.

Perhaps this is a parody of Prof. Muller's intentions. He says himself that he has tried "to make really available, for the purposes of literary criticism, the revolutionary findings in the natural and social sciences, with which critics are generally familiar but of which they make only superficial, incidental or erratic use". If this means anything it can be applied to a concrete case. From the preface to Shaw's "Doctor's Dilemma" it can be seen that his knowledge of medical science is less than superficial because he misconceives the whole character of scientific investigation. Nevertheless the play portrays excellently the contrasts between the medical humbug, the surgical 'go-getter' and two types of honest medical man. Shaw is a good enough observer to reproduce the general flavour of current medical jargon and that was all the technical knowledge he needed. Could any amount of medical knowledge have made any appreciable improvement? As to literary criticism, do critics differ in their judgment of this play according to the extent of their medical knowledge? Surely the knowledge Shaw chiefly needed was of the difference between an honest man and a humbug; knowledge outside the scope of science. It is remarkable that the feeblest character in the "Doctor's Dilemma" is the young artist, who is just stock stage property.

Prof. Muller has been strongly influenced by the philosophy of Dewey and shares his robust good sense, proper suspicion of high-flown theory and respect for the factual and concrete. But even more than Dewey he is shaky on fundamentals. Though he has acute criticisms to make of some recent advocates of 'scientific humanism', he seems to share their inability to distinguish between matters of fact and standards or criteria of value. In literary criticism he obviously has standards which are not those of the average man or the majority, nor are they just expressions of private likes and dislikes. He gives no account of his own standards, but it is clear (pp. 1, 47 note, 283 and elsewhere) that for him they are absolute. Yet, when it comes to other people's absolutes and standards, he takes a severely 'relativist' and 'naturalist' view, urging that every judgment is relative to a particular concrete situation, that nothing has value except to some individual who values it, that it is difficult to define standards of value, perhaps impossible. All these assertions are correct; but if they suffice to demolish other people's standards they demolish his own. Confusion about standards seems to be the key to the writing of this book. The author sees that literary judgments are too often based on caprice or convention or defiance of convention that is equally conventional; that literary standards are hard to discover and impossible to define. Science, on the other hand, seems to possess its own standards, definite and easily understood. Therefore if only the literary man could borrow scientific standards all would be well.

Literary men may learn from this book that if they ride scientific hobby-horses they do so at their own risk, but scarcely anything else. Men of science may benefit by learning what an intelligent, critical outsider thinks of some of their activities. Those who theorize in the realm of the social sciences may benefit by some wholesome criticism.

A. D. RITCHIE.

A TEXT-BOOK OF ZOOLOGY

Thomson's Outlines of Zoology

Revised by Prof. James Ritchie. Ninth edition. Pp. xii+1021. (London: Oxford University Press, 1944.) *28s.* net.

THE ninth edition of the "Outlines of Zoology" appears after a lapse of fifteen years, and is the first since Sir Arthur Thomson's death. In the preface, Prof. James Ritchie expresses his appreciation of the opportunity afforded to him of paying a tribute to his former teacher "by endeavouring to prolong the usefulness of his widely known Outlines". He was assisted by Dr. Gresson and Mr. G. F. Friend.

In considering a new edition, as opposed to a new book, three questions confront the reviewer. Does the new edition preserve the original character of the book? Have the emendations been fitted into the whole so that the balance has been preserved and overburdening of the text avoided? Has the subject-matter been brought up to date? The outstanding feature of Sir Arthur Thomson's book was that the blending of animal structure and function with a broader 'natural history' made the book readable, and presented the subject to the student so pleasantly that it encouraged him to explore both the main site and the nooks and corners of this vast field of study. Prof. Ritchie has preserved and improved this feature and his re-arrangements do not disturb the flow of thought. His emendations and additions concern chiefly the portions on cytology, histology, embryology and palæontology, while nearly a hundred new drawings, lettered with complete words instead of abbreviations, have been inserted, or used to replace earlier figures. All this has been done without disturbance of the balance of the book.

The cytology section has been modernized; but is it not generally recognized to-day that the chromosomes persist through the resting stage of the nucleus? In the short portions of chapters devoted to embryology more recent work and better figures might have been utilized; for example, Conklin's researches on the origin and development of the mesoderm in Branchiostoma, and the interpretation of cinematograph studies of the primitive streak area in the chick.

On the whole, however, the new edition can be regarded as a most successful effort. Its bulk has been increased only slightly by the addition of about fifty pages, but the price has risen considerably. Despite the latter drawback, the book remains a rich source of information, and should prove useful to many generations of students.

N. B. EALES.

MEDICAL RESEARCH COUNCIL UNIT FOR APPLIED PSYCHOLOGY

By DR. K. J. W. CRAIK
Director of the Unit

THE Medical Research Council Unit for Applied Psychology consists at present of eleven research workers who had previously been carrying out investigations in the Psychological Laboratory, Cambridge, principally on problems arising from the War, under the direction of Prof. F. C. Bartlett, who continues to have general supervision of the Unit. Of these, six are graduates in psychology, four in medicine and one in physiology. Until the end of the War it is likely that work of the type now in hand will continue. This has necessarily involved problems largely of an *ad hoc* character, undertaken in response to requests from Service departments, but certain common principles have emerged, which may assist in guiding a fruitful approach to future and peace-time problems. These principles are that of suiting the job to the man, of suiting the man to the job, and of improving the man's performance.

The first involves mainly the design of instruments, machinery, lay-out and illumination of maps, panels, etc. These problems may be broadly divided into those of *display* and *control*. The first term is that used by Service scientific departments to cover the methods by which information is laid visually before any operator, whether on a map, a graph, a cathode-ray tube or an instrument panel. Often the best type of display is a compromise, for example, between an instrument-panel so complex that its interpretation is slow or so simple that it gives insufficient information, or, in the case of a night-fighter aircraft panel, so brightly lit that it dazzles the pilot or so dim that it cannot be read. Psychological experiments, employing laboratory simulations of the real conditions, often enable the optimum type of display to be decided upon. Even where an optimum does not exist, a graph of the relation between, say, the distance of a plotter from a map and his accuracy in reading grid references will show a very steep rise in error beyond a certain point, and thus indicate a definite practical limit to the viewing distance, as in certain work by Dr. H. N. Mackworth. There should be a great deal of scope for such work in peace-time industrial design, especially in ensuring easier operation and preventing accidents, for example, in instrument panels, indicators, information charts and graphs. General principles have emerged which narrow the field for *ad hoc* experiments. Exact methods of scoring efficiency in war-tasks, such as watch-keeping, which are of a boring but responsible nature, have shown ways of determining optimal spells of work. The effect of discomfort, fatigue and noise on such tasks is also being studied. These techniques for the measurement of human abilities may eventually provide useful ways of assessing the progress of patients recovering from physical or mental illness, and perhaps may also test innovations introduced by researches in preventive medicine.

On the motor side, the positions, forces and gear-ratios of handles and levers on guns and machine-tools are usually compromises between the factors of speed and precision of operation, of simplicity and mechanical perfection or of psychological and physiological suitability. Here, again, particular cases are being dealt with by laboratory simulations with exact scoring of performance, and interesting principles of muscular action and sensory – motor co-ordination are emerging. These studies verge on physiology and preventive medicine.

Similar problems arise in industrial design (such as the handwheels on a machine-tool, the stage at which servo-motor or remote control becomes necessary, and the most suitable form for such control), while general principles of use to designers in less important cases could be formulated.

Any human act can be regarded as the result of a sensory – mental – motor chain of events, and hitherto those in the Unit who have worked on the above problems have concentrated rather on the sensory and motor ends of this chain, partly because of their individual aptitudes but partly, perhaps, because these are the most fruitful sites for instrumental modification. There is probably, however, an interesting future field in the analysis of the factors that make a task intellectually difficult and have led industrialists to division of labour, with its advantages of increased output and its disadvantages of boredom and discontent.

This approach—suiting the job to the man—should, we feel, be explored to the full, since it puts the industrial jobs necessary for improved standards of living within the power of the majority, whereas psychological selection alone, especially when the job has been made unnecessarily difficult, may result in a high rate of rejection and unemployment. There is, however, need for *allocation* of the available workers so that they are given tasks for which they are suited, and some selection where a task is unavoidably difficult.

This second approach—suiting the man to the job—is principally being tackled by a team under Dr. A. W. Heim. They are members of the Unit, but are working on behalf of the Industrial Health Research Board of the Medical Research Council. They have devised a battery of tests and standardized it on a large number of entrants to factories and Government training centres and some university undergraduates, and are obtaining follow-ups on the industrial subjects. This battery contains a paper test (*AH4*) consisting of a verbal and arithmetical, and a visual part based on relations of identity and opposition, analogy, completing series, and following instructions; a mechanical ability test, an inspection test consisting of metal blocks containing small defects, performance being scored on an accuracy index, speed also being recorded; some other performance tests resembling factory gauging and assembly tasks, and the National Institute of Industrial Psychology Form Relations test. The emphasis of such work must necessarily be on individual differences in ability, rather than on the features of a task which make it difficult to everyone. Research is being carried out on consistency and validity of test results and of assessments, and on the relation between these two criteria. The extent to which the value of a test depends on its degree of analogousness and the distinction between differences of *grade* and *type* of ability are also being studied.

Certain members of the Unit are investigating night vision and other tests from the point of view of selection and of diagnosing vitamin-deficiency and disease. It is hoped that there will also be some time for fundamental work on the special senses. Mr. E. Farmer has begun a study of the capacities of blinded Service personnel with the view of their obtaining suitable employment. Others are using methods which link almost equally with both the two main approaches discussed above. For example, Miss M. D. Vernon is working on visual form perception and memory with the view both of lay-out of visual tasks and the allocation of personnel, and Dr. D. R. Davis is investigating the sensory motor co-ordination and responses of temperamentally different types of people in controlling machinery.

The third main approach is to improve the performance of the man, either by nutritional means or by mental and physical training. This, again, involves exactly controlled experimental tests of sensory and motor efficiency and scoring of performance. Various synthetic training devices have also been produced for Service use. Similar devices may well have a peace-time application, for example, to motor-car driving or machine-tool operation, where the novice is apt to injure either himself or the machine and to gain little insight into what he is doing wrong. Synthetic training equipment with exact scoring devices can assist here ; but psychological experiments should always be undertaken to see whether any given trainer is in fact saving training time and improving performance, and whether it would do so equally well if it were simplified, or very much better if it were slightly complicated.

All these lines of approach involve much statistical work—for example, to establish the significance of the optimum values found for some feature of instrument design and to reveal the consistency or inconsistency of an allocation test, and its validity as judged by follow-up evidence. Though most of the members do the simpler statistical treatment of their own results, Mr. E. G. Chambers and Mr. J. W. Whitfield help in applying more complicated methods and in the development of new ones. Mr. Whitfield is also instituting a new type of recording system in a group of coal mines and two factories with the view of tracing causes of absenteeism, sickness and accidents. Such investigations indicate where there is a definite field for experimental research into improved equipment or for re-allocation or re-training of accident-prone workers.

It is hoped that there will be close contact with other bodies undertaking similar work—for example, the National Institute of Industrial Psychology—and with personnel managers, safety-officers and medical officers in factories. It must be emphasized, however, that the Unit is primarily a research body and has not the personnel or time for investigations of purely specific and local interest. Thus Dr. Heim has introduced, in several factories for which she has worked, a scheme by which members of her team inspect the problem and decide what existing test would seem appropriate and develop new ones if necessary ; the firm then provides a suitable person who is trained for a fortnight or so at Cambridge, and returns to the firm to give the tests and forward the results at intervals to Cambridge. Similarly, it will be impossible to take on a large number of particular problems in display or control design ; but wherever a problem of wide interest arises, or one involving test-methods which could be applied as routine elsewhere when once they have been developed, the Unit is very anxious to be of assistance to any firms who raise them ; and it is hoped that similar work may continue for the Services in regard to their more fundamental problems. The essential thing is that the scientific abilities of the members for basic research which ought, sooner or later, to have its effect on particular problems, should not be swamped by work of transitory and local value.

MODELS OF THE UNIVERSE AND COSMOLOGICAL TIME-SCALES

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THE two time-scales, one 'dynamical' and the other 'cosmological', introduced by Prof. E. A. Milne into his theory of the structure of the universe, have certain curious biological consequences pointed out in *Nature* by Prof. J. B. S. Haldane[1]. Another time-scale has just been put forward by Sir Arthur Eddington[2] on the basis of his unification of general relativity and quantum theory. It is therefore an opportune moment to attempt a general survey of cosmological investigations and, in particular, to direct attention to the very special assumptions on which the results of such inquiries depend. I do not believe that it is possible to give an accurate account of cosmological theory without expressing oneself to some extent in mathematical terms, and I trust that the reader will forgive this necessary evil—if evil it is.

Models of the Universe

Cosmological theories, whether connected with general, or with Milne's kinematical, relativity, start from the conception of an ideal universe which we shall call a 'model of the universe'. Essentially this may be regarded as a geometrical model in which the observed aggregate of spiral nebulæ is idealized into a set of mathematical points tracing out certain curves called 'geodesics' in a 4-dimensional space-time. This space-time possesses a 'metric' of the general form

$$ds^2 = dt^2 - e^{g(t)}\left\{\frac{dr^2}{1-kr^2/R_0^2} + r^2d\theta^2 + r^2\sin^2\theta d\varphi^2\right\} \quad (1)$$

Here r, θ, φ are space-co-ordinates, t is a time-co-ordinate*, and k, R_0 are constants which, together with the undetermined function $g(t)$, we leave for later discussion, only remarking here that (1) defines not one, but a whole class, of space-time models.

To arrive at this formula we need no theory of gravitation or of dynamics : we require only the following assumptions[3]. First, the aggregate of spiral nebulæ must form a *homogeneous* aggregate, which means that the nebulæ must be uniformly distributed in space at each 'instant' t ; secondly, each nebula must trace out a geodesic of space-time ; and thirdly, these geodesics must form a 'coherent' set. The last assumption means that the aggregate of moving nebulæ is imagined as having had a continuous past history and not as having been formed by the fusion of two or more independent streams of nebulæ. In short, the metric (1) is derived from kinematic considerations together with the hypothesis of uniformity of distribution in space of the nebulæ.

Apart, however, from differences in their theories of dynamics and gravitation, general and kinematical relativity differ at this preliminary stage also. One important difference is that general relativity presupposes only that a model of the universe must possess *some metric or other*, the particular class of metrics (1) holding if it is in fact the case that the aggregate of nebulæ satisfies the homogeneity conditions set out above. If it should turn out that

* Purely as a matter of mathematical convenience, t and r are both measured in the astronomical unit of distance, the *parsec*, which is $3{\cdot}08 \times 10^{18}$ cm. The time in years is t/c, where c is the velocity of light expressed in parsecs per year.

these conditions are not satisfied at present or were not true at some time in the past, general relativity would deal with the situation by discarding the models (1) and replacing them by others corresponding to the non-homogeneous conditions found to exist. Kinematical relativity, on the other hand, *postulates* homogeneity as the intrinsic character of the aggregate, and so is necessarily led to one or other of the models (1) as the only possibility. Another important difference is that, whereas in general relativity the paths of *all* material particles are by hypothesis geodesics of space-time, in kinematical relativity only the paths of the 'particles' representing the spiral nebulæ have this character. The paths of 'free' particles are curves of a more complicated type.

The uniformity postulate implies that the 'points' representing the spiral nebulæ are mathematically interchangeable with one another. It is therefore admissible to select one of them as representative, and it is usual to choose the one at the origin, $r = 0$, $\theta = 0$, $\varphi = \theta$, and to regard the nebula it represents as the typical nebula from which all the rest are being surveyed.

Multiplicity of Models

We have already mentioned that the general considerations from which the metric (1) is derived do not define it completely, so that a wide multiplicity of models is possible. This arises, first because the function $g(t)$ is not explicitly obtained, the only restriction imposed on it being that $g(t_0) = 0$, where $t = t_0$ is the 'present moment'. Secondly, the constant k can have one or other of the three values $+1$, 0, -1, according as space is spherical, flat or hyperbolic, while R_0, the so-called 'radius of space at the time $t = t_0$', determines the scale of the model (for $k = +1$ or -1) and may have any positive value.

The mathematical distinction between one model and another is unfortunately not a simple one, but it is very important. The geometrical properties of the different models correspond to intrinsic differences in the velocities and accelerations of the points representing the nebulæ, in their number and their distribution in space under the general over-riding requirement that the distribution is to be homogeneous. We begin by defining the 'coefficients of the metric', namely, the factors

$$1, \quad -e^{g(t)}/(1 - kr^2/R_0^2), \quad -e^{g(t)}r^2, \quad -e^{g(t)}\, r^2 sin^2\theta,$$

which multiply the squares of the 'differentials of the co-ordinates' dt, dr, $d\theta$, $d\varphi$. A model is defined completely when the function $g(t)$ has been explicitly stated and the values of k and R_0 assigned. For example, the choice

$$g(t) \equiv a(t - t_0), \quad k/R_0^2 = 0,$$

where a is a constant, defines a 'de Sitter' universe. Now the intrinsic geometrical properties of a model depend on the coefficients of its metric, and we might therefore jump to the conclusion that models with different coefficients were necessarily intrinsically different. This, however, is not the case, because of the possibility of performing co-ordinate transformations within a given model the sole effect of which may be to alter the mathematical expression of the metric without affecting the intrinsic geometrical properties of the model. An example may make this point clearer. The ordinary 2-dimensional Euclidean plane, when expressed in terms of rectangular co-ordinates, has the metric

$$ds^2 = dx^2 + dy^2;$$

but it becomes

$$ds^2 = dr^2 + r^2d\theta^2,$$

when polar co-ordinates are used. In the first case, the coefficients of the metric are 1,1, in the second, 1, r^2. But, whichever form we use, the Euclidean geometry of the plane is the same: the three angles of a triangle sum to 180°, straight lines are of infinite length, and so on. The general mathematical problem of determining whether, of two given metrics, one can be turned into the other by a co-ordinate transformation, has not been solved in a manner which can be conveniently applied in practice. But it has been discovered that the coefficients of the metric determine a property called the 'curvature' of the model, and that the equivalence of two models depends on establishing the identity of their curvatures in a certain technical sense. A particular case of importance is that in which the curvature is identically zero, since this can be detected irrespective of the co-ordinate system used. The model of zero curvature is that of *special relativity*, the metric of which is expressible in a variety of useful forms by changing the co-ordinate system. In the customary form, we use a co-ordinate system t_1, r_1, θ, φ, with the coefficients $g(t_1) \equiv 0$, k/R_0^2 infinite, so that

$$ds^2 = dt_1^2 - (dr_1^2 + r_1^2d\theta^2 + r_1^2 sin^2\theta d\varphi^2). \qquad (2)$$

Another form which we shall need later is obtained by the co-ordinate transformation

$$t_1 = t(1 + r^2/t_0^2)^{1/2}, \quad r_1 = rt/t_0, \quad \theta = \theta, \quad \varphi = \varphi; \quad (3)$$

so that the metric (2) now becomes

$$ds^2 = dt^2 - \frac{t^2}{t_0^2}\left(\frac{dr^2}{1 + r^2/t_0^2} + r^2d\theta^2 + r^2 sin^2\theta d\varphi^2\right). \quad (4)$$

The last formula is seen to be a special case of (1) in which

$$g(t) = 2log(t/t_0), \quad k = -1, \quad R_0 = t_0, \qquad (5)$$

and serves to illustrate the point that a different choice of g, k and R_0 may yet lead to the same model in two different guises. In (3) and (4) we may regard t_0 as the present moment in the history of the typical nebula at the origin of space co-ordinates and the co-ordinate transformation then shows that for points near this origin and for times near to t_0, the co-ordinates t_1, t and r_1, r are approximately equal.

It is essential to remember that two genuinely different models—models the curvatures of which are intrinsically different—cannot be reduced to one another by co-ordinate transformations, a point sometimes slurred over in cosmological discussions. To illustrate again from 2-dimensional geometry: the Euclidean plane with metric $ds^2 = dx^2 + dy^2$ cannot be turned into the surface of a sphere with metric $ds^2 = d\theta^2 + sin^2\, d\varphi^2$ the curvature of which is unity. This is the reflexion in differential geometry of the fact that the geometrical properties of the surface of the sphere are not the same as those of the plane, one instance of the difference being that the angles of a spherical triangle no longer sum to 180°.

Different Time-scales

While we are still discussing co-ordinate transformations, we may mention a transformation of the time co-ordinate which plays a great part in kinematical relativity. It has the effect of turning the metric (1) into the form

$$ds^2 = q(\tau)\left\{d\tau^2 - \left(\frac{dr^2}{1-kr^2/R_0^2} + r^2d\theta^2 + r^2\sin^2\theta d\varphi^2\right)\right\} \quad (6)$$

The transformation is obtained by evaluating the integral in

$$\tau = A + \int e^{-\frac{1}{2}g(t)}dt, \quad (7)$$

where A is an arbitrary constant, and then expressing $e^{g(t)}$ as a function of τ which we have denoted symbolically by q. It follows from (7) that for every choice of the function g which causes the integral to 'diverge at $t = 0$', as the mathematicians would put it, the zero value of t will correspond to an infinite value of τ. In other words, in any such model, if the history of the universe be supposed to begin at the zero value of t, it will begin at an infinitely remote past time when the τ time-scale is used.

The Red-shift

There is another result common to general and kinematical relativity which depends only on the form of the metric (1) and on the assumption that the path of a light-ray in space-time is a null-geodesic. This is that all nebulæ when viewed from the typical nebula will exhibit a displacement of the lines in their spectra either towards the red or towards the violet, according to the form of the function $g(t)$, and that there is an equilibrium model possible (the 'Einstein' universe) in which no displacement occurs. It is a matter of observation that the existing aggregate of nebulæ viewed *at the present moment* exhibits displacements to the red only. The amount of the displacement is, to a first approximation, $\frac{1}{2}g'(t_0)$ per unit of distance, the moment of observation being t_0 and the dash denoting the derivative of g with respect to t. Hubble's observations[4] of the red-shift yield the numerical value[5]

$$\tfrac{1}{2}g'(t_0) = 1\cdot 83 \times 10^{-9}\,\text{parsec}^{-1}. \quad (8)$$

We thus obtain the important result that the present-day observations of red-shift do not permit us to distinguish between one model and another: they merely provide us with an instantaneous value of the derivative of g with respect to t.

General Relativity and Eddington's Model

How then are we to discover the model to which the universe we see around us does, in fact, correspond? Sir Arthur Eddington's answer[2] to this question is that the combination of Einstein's gravitational equations with those of a generalized quantum theory will identify the model, and that the numerical values of any constants needed to specify it are deducible from the constants of atomic physics measured in the terrestrial laboratory.

We cannot attempt here an account of the quantum theoretical part of Eddington's theory, but we must briefly state Einstein's gravitational equations. These connect the properties of matter such as density, pressure, momentum, etc., with the curvature of the model. In the models with metric (1), it is found that the matter can have two properties only, namely, density, ρ, and pressure, p. The former is interpreted as the density of all matter contained in the nebulæ imagined as smoothed out into a uniform cloud; and the latter, as the effect of small random motions of the nebulæ and of radiation pressure. It is to be expected, therefore, that this pressure will not be sensibly different from zero, and this value is commonly assumed in cosmological investigations. The pressure and density are connected with the curvature of the model and with the celebrated cosmical constant λ by the equations

$$\varkappa p = \lambda - 3\left(\frac{g'}{2}\right)^2 - g'' - \frac{k}{R_0^2}e^{-g} \quad (9)$$

$$\varkappa\rho = -\lambda + 3\left(\frac{g'}{2}\right)^2 + \frac{3k}{R_0^2}e^{-g}, \quad (10)$$

$\varkappa$ being proportional to the constant of gravitation G.

An important feature of Eddington's theory is the assumption that the expansion of the universe (manifested by the red-shift) began from a state in which the nebulæ were in equilibrium in a space of finite extent. Such a condition is found in the 'Einstein' universe the equilibrium of which, moreover, is unstable. There are models which are initially in the Einstein state but do not remain in it and start expanding instead. Eddington's model is one of these, and he can specify it completely with the help of his generalized quantum theory. His results are as follows: the model is spatially finite ($k = +1$); the total mass, M, of the matter it contains is also finite and fixed in amount, and the cosmical constant, λ, has the value $(\frac{1}{2}\pi c^2/\varkappa M)^2$. The radius of space, R_0, lies between 10 and 25×10^8 parsecs, and it is in calculating this quantity that Eddington makes one of his rare appeals to astronomical observation for an estimate of the density of matter ρ in the model. The initial value of the radius is about one fifth of R_0. The function $g(t)$ is the simplest solution of equation (9) with $p = 0$ and is expressible in terms of logarithmic functions. But perhaps the most remarkable result of Eddington's theory is his calculation of the maximum possible value of $\frac{1}{2}g'(t)$ without appealing to astronomical observation but from the constants of atomic physics. Converting his 'speed of recession' to the units we are using, we find that $\frac{1}{2}g'(t) = 1\cdot 91 \times 10^{-9}$ parsec^{-1}, which is in very remarkable agreement with the observed value (equation (8) above). Lastly, the time, on the t-scale, since the expansion of the model began is about 90×10^9 years. Thus, using theory together with the values of the constants of atomic physics, Eddington constructs his model, having made little or no appeal to astronomical observation in the process.

Kinematical Relativity: Milne's Model

In contrast to general relativity, Milne does not start from the metric of the model, nor does he accept Einstein's equations (9) and (10) as defining the properties of matter in the model. But the definitions which he does use and, in particular, the requirement that all his equations shall be invariant under Lorentz transformations of the co-ordinates lead him[6] to the model (2) of special relativity and, through a co-ordinate transformation, to the form (4) of its metric. All the arguments and definitions are *a priori* and theoretical, Milne's object being to construct a model of the universe with no empirical elements.

The model of special relativity in terms of the co-ordinates t, r (Equ. 3) has interesting properties. In the first place, 'space' is now defined as the 3-dimensional 'surfaces' $t =$ constant, and, since k is equal to -1, it is hyperbolic and of infinite extent.

In the second place, the form of $g(t)$ is such that the zero value of t corresponds to zero value for the radius of space. Physically, we should have to imagine all the nebulæ concentrated at a point with infinite density, and this is indeed the moment of Milne's 'creation'. The present radius of space, R_0, is identical with the age of the universe on the t-scale and is deducible directly from the red-shift formula (8). The radius is therefore $5{\cdot}5 \times 10^8$ parsecs, and the time since the critical moment $t = 0$ is $1{\cdot}8 \times 10^9$ years. Thus the time-scale is far shorter than in Eddington's model. The two models are, of course, not reducible to one another by a co-ordinate transformation, their curvatures being intrinsically different.

Milne's dynamical and gravitational theory is again without empirical elements, and depends on a definition of the acceleration of a free particle which makes the acceleration formula invariant under Lorentz transformations. He proves that the resulting equation of motion of the free particle can be reduced approximately to that of a particle moving under Newton's inverse square law of gravitation provided that two very remarkable conditions are fulfilled. The first condition is that the constant of gravitation, G, is not a constant at all but varies with the time, and the second is that the 'time' of dynamics and gravitational theory is τ, whereas the 'time' of cosmological investigations is t or t_1. This ambiguity in time-scales has hitherto escaped notice because τ, t and t_1 are all indistinguishable locally. The relation between τ and t in this model is, by equations (5) and (7),

$$\tau = t_0 \log (t/t_0) + t_0,$$

the constant A being adjusted so that $t = t_0$ shall correspond to $\tau = t_0$. The model, moreover, is of the kind in which the integral (7) 'diverges at $t = 0$', so that the 'time' from 'creation' is finite or infinite, according as we measure it by means of t or of τ, respectively. We have seen that this property is not peculiar to Milne's model but occurs in a much wider class, and is possible in general, just as much as in kinematical, relativity. It is the 'dynamical' significance attached to τ that gives this time-variable whatever importance it may possess, *not* the infinite life-time for the universe to which it leads.

Milne's model is thus an entirely theoretical structure containing one disposable constant only, t_0, the value of which is fixed by the red-shift observations.

Model Deduced from Observation

We have so far discussed models arrived at in the main on *a priori* grounds. But it is also possible to treat cosmology as a branch of mathematical astronomy, and to take the appeal to observation as the important test. There is indeed a very close analogy in this respect between Newtonian planetary theory and cosmology. The former predicts on theoretical grounds that the path of a planet or comet may be an ellipse, a parabola or a hyperbola; the latter, that the observed universe may conform to one or other of a wide class of models. It is not regarded as satisfactory to announce *a priori* that the orbit of a newly discovered comet must be an ellipse, for example, and to disregard the observations of its path however few and inaccurate they may be. Yet such an attitude is not uncommon among cosmologists.

Pursuing this possibly old-fashioned and certainly unpopular line of thought, I have tried to identify the model to which the universe conforms by using astronomical observations combined with Einstein's gravitational equations ((9) and (10) above). We have the following observations at our disposal: measurements of the red-shift, estimates of the number of nebulæ per unit volume and of the mass of an average nebula; and, most important of all, observations[4] of the distribution of nebulæ 'in depth'. These give the average number of nebulæ per unit area of sky at successively fainter apparent magnitudes. None of these observations are either so accurate or so complete as they might be, but the important point is that they *do* give a solution of the cosmological problem. In reaching it, I discarded Hubble's method of applying *a priori* 'corrections' to the observations, since I was able to show that one at least of these corrections was equivalent to imposing an unacceptable restriction on the function g. Hubble[4], indeed, had arrived at a model in which space was finite ($k = +1$) but of such small extent that he rejected the interpretation of the observations by means of *any* of the models (1) in favour of an account in terms of the loss of energy of light-radiation as it traversed space. Nevertheless, taking Hubble's observational figures without applying 'corrections', I was able to show[5] that they led to a model with the specifications: $k = -1$, $R_0 = 4{\cdot}515 \times 10^8$ parsecs, $\lambda = -0{\cdot}050 \times 10^{-16}$ parsec^{-2}. The function $g(t)$ is a solution of the equation (9) with $p = 0$ expressible as an elliptic function. The model, therefore, has hyperbolic space, which is of infinite extent, and the expansion begins at $t = 0$ from an infinitely concentrated state as in Milne's model. The function g is of the kind for which the integral in (7) does not diverge at $t = 0$, so that the life-history of the model is finite, whichever time-scale we use. On the t-scale it amounts to $1{\cdot}5 \times 10^9$ years. The curvature of the model is intrinsically different from that of Eddington's or Milne's, so that it cannot be transformed into either of them by co-ordinate transformations. No doubt more accurate observations will, in the future, alter the model, just as the orbit of a comet is perhaps found to be a parabola on the basis of the first available observations of its path but later turns out to be an ellipse as more numerous and accurate measurements accumulate.

In deriving this model, I made use of Einstein's equations, which do not apply in Milne's theory. But using the equations which take their place in kinematical relativity, I have not succeeded[7] in reconciling the predicted and the empirical formulæ for the distribution of nebulæ in depth to the same degree of accuracy as is possible in general relativity.

Conclusion

We are thus presented with three different models of the universe, two of which are based essentially on theory whereas the third is derived by the maximum of appeal to observation. Eddington's model implies a time-scale some fifty to sixty times longer than the time-scales of the other two. Milne, however, gives a physical interpretation to a second time co-ordinate in terms of which the universe has an infinite life-time. All three models imply that the universe began expanding from somewhat peculiar initial conditions: Eddington's from a state of unstable equilibrium; the other two, from 'explosions' at a point. The calculated time-scales are measured from these initial states and are therefore dependent on the assumption that the roughly homogeneous conditions observed at the present day have persisted through the past history of the universe. It is scarcely necessary to emphasize the speculative and provisional nature of such extensive extrapolation.

[1] Haldane, J. B. S., *Nature*, **153**, 155 (May 6, 1944).
[2] Eddington, A. S., "The Combination of Relativity Theory and Quantum Theory", *Dublin Inst. Adv. Studies*, A, No. 2 (1943). A summary of the astronomical implications of the theory appeared in the *Observatory*, **65**, 209 (August 1944).
[3] Robertson, H. P., *Rev. Mod. Phys.*, **5**, 22 (1933).
[4] Hubble, E., *Astrophys. J.*, **84**, 517 (1936).
[5] McVittie, G. C., *Proc. Phys. Soc.*, **51**, 529 (1939).
[6] Milne, E. A., *Proc. Roy. Soc.*, A, **158**, 324 (1939); **159**, 171 (1939).
[7] McVittie, G. C., *Z. Astrophys.*, **14**, 312 (1937); **16**, 21 (1938).

OBITUARIES

Prof. G. F. Stout

BY the death in Sydney of Prof. G. F. Stout, emeritus professor of logic and metaphysics in the University of St. Andrews, at the age of eighty-four, British philosophy and psychology have lost one of its most representative and distinguished figures. A first class in the Classical Tripos in Cambridge in 1882, followed in the next year by a first in the Moral Sciences Tripos, seem, on the face of it, strange preparation for a man who was to become a dominant figure in British psychology for the next two generations, and who, as late as 1936, after fifty years of academic life, could enter into equal fray with the new *Gestalt* experimental psychologists from Germany. But three further factors must be taken into account: the presence of Ward at Cambridge, the nature of British philosophy and Stout's own penetrating insight. That Ward was one of the dominating influences in his life, Stout himself was ever ready to admit. Ward's article on psychology, in the "Encyclopædia Britannica" of 1885, ultimately embodied in his "Psychological Principles", was the precursor of Stout's "Analytic Psychology" (1896) and his "Manual of Psychology" (1898), and both these latter books bear the marks of this influence. But both Ward and Stout were following in the clearly marked tradition of British psychologists and philosophers from the seventeenth century onwards, and Stout himself was, until his death, the ablest survivor of a type of philosophy which included Locke, Hume, the two Mills and the Scottish school.

Neither Ward nor British tradition, however, can account for the fact that a text-book on psychology written nearly fifty years ago is still, despite the many changes in technique and outlook, an indispensable work for teachers and students alike. Here two points call for comment. The first was Stout's superb intellect, with its keen insight into philosophical and psychological problems, and the second, his freshness of mind, which never lost its interest in his subject and enabled him to revise one edition after another.

Stout left Cambridge in 1897 and was for two years lecturer in Aberdeen in comparative psychology and for four years Wilde reader in mental philosophy at Oxford. In 1903 he was appointed to the chair at St. Andrews. From this period his writings were, in the main, on epistemology and metaphysics. In the former, the influence of Plato, and particularly the Theatetus and Sophist, is obvious; in the latter, his animism and his views on the body and mind are Spinozistic. But Stout was never merely a copy of any other thinker; his originality was too strong for that: and for this same reason, although his knowledge of philosophical literature was astounding, he was not a mere scholar. He was a thinker first and always, and in his reading he both re-thought and re-moulded. It is not possible in a short notice to go into details of Stout's philosophy, but I hazard the opinion that if readers of *Nature* would ponder the Gifford Lectures (Stout, "Mind and Matter", 1931) of a former editor of *Mind* (Stout edited *Mind* from 1891 until 1920) British scientific philosophy would be a far better thing than it is at present.

To the bulk of St. Andrews students—Stout, in the main, lectured only to a small number of advanced students—and to most members of the staff he was a mythical figure, spoken of with awe and around whom legends and anecdotes were spun of a recluse living in a rarified atmosphere of pure thought. Those of us who worked with him and who talked and walked with him for many years knew what a caricature this was. In addition to his extensive knowledge of philosophical and psychological literature, Stout was one of the best read men of a reading generation, in literature, history and in many branches of science, and his judgment of men and affairs was unerring. He seemed to have read (and to remember) everything, and he showed the same penetrating insight in his judgment on affairs that characterized his professional work. Those who only know the latter never really knew Stout, who will always be remembered by his friends as a man who not only gained the highest distinction in his own branch of study but who had also assimilated the matter and spirit of European culture from the Greeks downwards. Even among academics he was an aristocrat. We of a later generation knew that, as did men like Ward and Bradley of his own.

J. N. WRIGHT.

Dr. E. N. Miles Thomas

WITH the death of Dr. E. N. Miles Thomas on August 8, there passed one of the most brilliant women botanists of the century. Educated at the Mays High School (Home and Colonial School Society), she studied also at University College, London (where she was later made a fellow) and at the Imperial College of Science and Technology. Her contact with Miss Ethel Sargent, to whom she acted as research assistant (1897–1901), and with Mr. (later Prof.) A. G. Tansley was probably responsible for her life-long devotion to problems of seedling anatomy.

Her appointment as lecturer at Bedford College in 1908 marked the inauguration there of a separate Botanical Department, and in 1912, she was also awarded the status of reader in the University of London. The Department made rapid progress under her vigorous leadership and was already well established in the new premises of the College in Regent's Park when war broke out in 1914. Like others, Dr. Thomas felt the urgency of war claims, and when her appointment terminated in 1916 she became an inspector of the Women's Land Army for London and the Home Counties. Afterwards she became acting head of the Botanical Department in University College, Cardiff, during 1918–19 and keeper of the Department of Botany in the National Museum of Wales during 1919–21. In 1923, she was appointed lecturer in biology at University College, Leicester, a position which she held until her retirement in 1937. Her activities in these various spheres were tireless, but as a life member of the British Association for the Advancement of Science, she also took part in many of the meetings, including those of Australia (1914), Canada (1924), and South Africa (1929); also acting as recorder (1920, 1921) and vice-president (1933) to Section K. She was elected fellow of the Linnean Society in 1908 and served on the Council during 1910–15. She was deeply interested in questions affecting the professional status of women workers. She also tried to promote the formation of a central botanical research institute; but the funds collected were insufficient and were used in furtherance of research by other means. She had friends in many lands, and in 1924 served, appropriately, on the executive committee of the Imperial Botanical Conference.

Dr. Thomas's published work included double fertilization (*Ann. Bot.*, **14**; 1900); anatomy of *Acrostichum* (*New Phyt.*, **4**; 1905) and a series of articles on seedling anatomy, reinforced by those of some of her students. Her name is especially associated with the theory of the double leaf-trace (*New Phyt.*, **6**; 1907); but the trend of her views on more general questions of seedling anatomy is clearly indicated by a series of summaries (British Association Reports for 1906, 1914, 1923 and 1924) as well as by longer articles (*Ann. Bot.*, 1914; *Proc. Linn. Soc.*, 1923). She had hoped to develop these researches further, but failing health and other circumstances prevented her from bringing her work to full fruition. On her breakdown in 1940, her slides, records, etc., were catalogued and placed in the Jodrell Laboratory, Kew. She was married to Mr. H. H. F. Hyndman, but his sudden death in 1934 brought to an untimely end a particularly happy union. The shock, though faced with characteristic courage, was undoubtedly one of the causes precipitating her final breakdown.

NEWS and VIEWS

British Non-Ferrous Metals Research Association: Retirement of Dr. Harold Moore, C.B.E.

Dr. Harold Moore, who will retire from the position of director of the British Non-Ferrous Metals Research Association on October 31, has occupied that position for the last twelve years. Dr. Moore is a native of Middlesbrough, and received his metallurgical training from the late Dr. J. E. Stead, taking a London degree. After two years in a Northamptonshire blast-furnace works he joined Messrs. Beardmore at their Parkhead works, where he was engaged on problems of armour-plate manufacture. In 1904 he became chief metallurgist in the Research Department, Woolwich, being given the title of Director of Metallurgical Research in 1919. Besides controlling a staff engaged in research on armaments, he did valuable work on the development and interpretation of the hardness test, and in collaboration with S. Beckinsale published an important investigation on the season cracking of brass, work which arose out of difficulties with cartridge cases, but was the starting point of a study which has been actively taken up by others.

Dr. Moore was awarded the C.B.E. in 1932, in which year he was appointed to succeed Dr. R. S. Hutton as director of the British Non-Ferrous Metals Research Association. During his tenure of the directorship the equipment and staff of the laboratories in Euston Street have grown considerably, and many investigations of great value to the non-ferrous metals industry have been carried out. Dr. Moore has from the beginning taken an active part in the work of the Institute of Metals, of which he was president during 1934–36. In 1943 he received the Platinum Medal of the Institute. He has also served on many councils and committees concerned with metallurgy. In all these capacities his personal qualities have contributed largely to the smooth working of research organizations.

Royal Holloway College: Chair of Mathematics

The chair of mathematics at the Royal Holloway College, vacant through the resignation of Prof. Bevan Baker, has been filled by the appointment of Prof. W. H. McCrea. Since 1936 Prof. McCrea has been professor of mathematics at the Queen's University, Belfast, but for some time has been on leave in London on war service. Prof. McCrea had previously been an appointed teacher in the University of London, while holding an assistant professorship at the Imperial College during 1932–36, and during that time he took an active part in the scientific life of London, particularly in connexion with the Royal Astronomical Society. In addition to being an excellent teacher to university students over a wide range of mathematical ability and interest, his scope as a researcher is unusually extensive. He is specially distinguished for his researches in astrophysics, to which he has contributed many fertile ideas. His theory of the solar chromosphere, modifying an earlier theory by Prof. E. A. Milne which attributed the main support to selective radiation pressure, is generally accepted, and includes pioneer work that first showed the importance of turbulence for the structure of the sun's atmosphere. He also constructed a model of a stellar atmosphere based solely on physical as distinct from astronomical data, thereby initiating a method of investigation afterwards widely followed. Among his other astrophysical researches are a theory of the ejection of matter from 'new' stars (novæ), and a study of the drag of one gas on another through which it is streaming. Prof. McCrea has also shown marked originality in other fields, which include the quantum theory of specific heats and of quadrupole radiation, cosmological relativity theory, wave-tensor calculus, and differential and difference equations.

New Chair of Geography at McGill University

Mr. George H. T. Kimble has been appointed first professor of geography and head of the newly created Department of Geography in McGill University. Until the outbreak of the War, when he volunteered for the Naval Meteorological Service, Mr. Kimble was lecturer in geography in the University of Reading. He took his bachelor's and master's degrees at King's College, London, during 1927–31, where he studied under Prof. Ll. Rodwell Jones and the late Prof. A. P. Newton, and did his early work in historical geography. The results, so far published, of these researches are contained in "Geography in the Middle Ages" (Methuen, 1938), in a memoir accompanying the Royal Geographical Society's reproduction of "The Catalan World Map of the R. Biblioteca Estense at Modena" (1934), and in a critical edition of Pacheco's "Esmeraldo de Situ Orbis", published by the Hakluyt Society (1937). On the human side he has made a number of studies of marginal environments and economies, notably of the Berbers of the Algerian Atlas (*Geog. J.*, 1941), and shortly before the War he wrote a popular introduction to the subject called "The World's Open Spaces" for Nelson's Discussion Series. The preoccupations of the past five years may be held to explain the temporary diversion of his interests as revealed in his most recent publications, namely, "The Shepherd of Banbury's Rules for Telling the Weather" (University of Reading, 1941) and "The Weather" (with Raymond Bush) published by Penguin Books in 1943. Mr. Kimble hopes to take up his new appointment in January 1945.

Pulkovo Observatory Library

ALTHOUGH information had been received that the most valuable of the instruments had been removed from the Pulkovo Observatory before it was shelled and bombed by the Germans, there had been no news about its valuable library, which contained many rare treasures, including the manuscripts of Kepler. It is now learned from the *Moscow News* that the library had remained in the building, stored away in the basements. After the Observatory had been shelled for three weeks, it was decided to save the library at any cost. In the middle of October 1941, under incessant German artillery fire, the removal of the library was undertaken by the employees of the Leningrad Museums and Park Administration. Truck after truck pulled up to Pulkovo until all the books had been removed. The Observatory is now a mass of ruins, but the Academy of Sciences of the U.S.S.R. has been instructed by the Government to draw up and present by November 1 a project for the rehabilitation of the Observatory.

Illuminating Engineering Society

THE presidential address delivered by Mr. E. Stroud at the opening meeting of the Illuminating Engineering Society on October 10 took the form of a survey of the Society's activities and its future. The Society was formed by Mr. Leon Gaster in 1909 and its first president was Prof. Silvanus P. Thompson. At that time there was little information in regard to lighting practice, and the instruments available for the measurement of illumination were few and cumbersome. Much original work was done by Mr. A. P. Trotter and other early pioneers to deal with the lighting of schools and libraries and other subjects. The setting up of the Home Office Committee on Factory Lighting in 1913 was an important landmark. During the War of 1914–18 members of the Society did useful work on the measurement of the candle-power of flares and the brightness of radium compounds for coating gunsights, etc., and the year 1915 saw the issue of the first of the series of reports on factory lighting issued by the Departmental Committee. During the first twenty years the foundations of the Society were laid. The floodlighting of London buildings, which accompanied the holding of the International Illumination Congress in London in 1931, did much to direct attention to its work. Efforts were made to create interest in the provinces, where the first centre, in Manchester, was formed in 1932.

From 1934 onwards there ensued a period of development. The membership, at this time about 450, advanced to 850 at the commencement of the present War, and has now reached more than 1,600 —nearly a fourfold increase during these ten years. Several ambitions of the Society have since been realized, such as the formation of the nucleus of a library, the issue of *Transactions* and the establishment of a class of fellowship. This present growth of membership has been mainly due to the development of centres, now ten in number, with which, and with five supplementary groups, there are associated more than a thousand members. The growing recognition of the importance of good lighting is illustrated by the official recognition given to the I.E.S. Code of values of illumination. The inclusion of lighting in the Factory Act of 1937 makes good an omission stressed by Prof. Silvanus Thompson in his inaugural address thirty-five years ago. During the present War the Society has devoted much attention to A.R.P. lighting problems. A series of "Lighting Reconstruction" pamphlets has also been issued. There are various plans in preparation, such as those relating to the education of lighting engineers. In years to come there should be great opportunities for lighting. Closer links should be established with the sister societies in the United States and the Dominions, and international contact should be revived.

Dried Plasma Sheets for Burns and War Wounds

"IT has often been said," remarks Lieut.-Colonel B. Pollock, U.S.N.R. (*U.S. Naval Bull.*, **42**, 1171; 1944), "that this is a burn war." The incidence of burns has greatly increased, and there is urgent need of an ideal coagulum for them. Such a coagulum should be durable, non-contractile, indefinitely pliable, non-toxic, non-irritant, resistant to trauma, bactericidal, painless, not unsightly, and it should contain fibrin and not be costly to make. Dried plasma sheets apparently come closer, he thinks, to these requirements than any other coagulum yet introduced. Dried plasma dissolved in water and dried in a hot oven gives a transparent, slightly elastic, adherent coagulum, and the addition of sulphanilamide or sulphathiazole increases its bactericidal effect. These substances are slowly liberated as the fibrin is used up, and they thus keep the wound clean.

The sheets are made in a Petri dish to a size of 4 in. in diameter. 20 c.c. of sterile water is put in the Petri dish and 1·5–2 gm. of dried plasma added. After this has dissolved 0·2 gm. of sulphanilamide powder is added. This is then dried in an oven at 140° C. until a sheet is formed. This requires 15–20 minutes. After cooling, the sheet should be applied directly to the burn. Sheets can be quickly made by heating the preparation over a Bunsen burner until the sheet separates itself in less than five minutes. The addition of more or less water or plasma thickens or thins the sheet. Its transparency increases or decreases according to the amount of sulphanilamide added. If the preparation is dried for only ten minutes, it forms a paste which is also useful. The sheets tend to curl at the edges as skin does, but this can be overcome by moistening them with water before application. They adhere to a burn in a few moments and the patient may feel a burning or stinging sensation for one or two or possibly thirty minutes. No dressing is needed. The sheets will adhere to the unbroken skin. They can be kept for weeks if they are moist in a refrigerator; or they may be heated until they are crisp and dry, when they may be stored in a refrigerator. The sheets gave good results when they were applied to indolent, ulcerating war wounds, all of which were infected. Wounds still unhealed after sixty days of other treatment healed in six to nine days. Tissue reactions subsided forty-eight hours after their application. None of the patients was confined to bed and some had shower baths without protection of the plasma sheet. Dry dressings were used at night only.

Taxation and the Social Structure

THE papers presented before the American Philosophical Society in the symposium on "Taxation and the Social Structure" at its midwinter meeting on February 18–19, 1944, have now been published (*Proc. Amer. Phil. Soc.*, **88**, No. 1, 1; 1944). American conditions, with the complex relations between State and Federal taxation, to which there is no exact parallel in Great Britain, make the papers somewhat difficult for British readers to follow. Nevertheless, they are of interest at present in view of the reconsideration of the relations between national and local taxation which is being enforced upon Great Britain by some of the trends towards social security, and also of the bearing of fiscal policy on industrial development, such as the concessions announced by the Chancellor of the Exchequer in relation to obsolescence and research in his last budget speech. In Britain, as in the United States, it is realized that taxation is no passive instrument, but that it inevitably affects the social structure and determines the course of social evolution. Accordingly, taxation policy is an integral part of general social and economic policy, and as such must be recognized in our social philosophy.

Four at least of the papers in this symposium make some contribution to this end, and have a much wider bearing than the issues of Federal and State taxation to which the principles they develop are applied. R. Warren's paper on "The Capitalist and the Social Structure", R. Blough's "Conflict and Harmony in Taxation", H. S. Bloch's "Fiscal Policy and Social Reform as it may affect the Potentialities of the Personal Income Tax", and M. H. Hunter's "The Harmonisation of Fiscal and Social Aims" should make important contributions to clear thinking on these problems. Blough's paper in particular is a challenge to fundamental thought and a plea for further research on the relation of taxation to production and employment.

Potato Varieties in East Africa

THE problem of potato varieties suitable for East Africa is discussed by R. E. Moreau, of the Amani Research Institute, in the *East African Agricultural Journal*, **9** (1944). The inquiry was concerned with the direct physiological effects of climate on the plant and should give some guide to policy when the desired development of the crop is undertaken. The generally accepted view that *Solanum tuberosum* is an unsuitable crop for hot climates is called in question and the conclusion reached that, given good husbandry, excellent crops of it can be raised in parts of tropical Africa, even though air and soil temperatures seem unfavourably high. The short days appear to be of no practical importance, and it is suggested that there may be some countervailing influence in the tropics, such as increased light intensity which accounts for this. The possibility that potatoes of the *Solanum andigenum* group would do better than United Kingdom varieties of *S. tuberosum* is dismissed on purely climatic grounds, though an exception is made of *S. phureja*, which has the further advantage of possessing a particularly high protein content. It is, however, suggested that United States varieties of *S. tuberosum* merit special trial on the score of their possible better adaptation to heat.

Public Health in Haiti

IN a recent paper (*Bol. Of. San. Panamericana*, **23**, 299; 1944) Dr. Jules Thebaud, director-general of public health in Haiti, states that the public health department in his country employs 542 persons, exclusive of day labourers. Owing to lack of funds, Haiti has hitherto been unable to keep pace in public health works; but it has endeavoured to maintain close relations with the Pan-American Sanitary Office. The population of Haiti is estimated at 3,000,000; in 1942 there were 44,805 births, 12,416 deaths and 3,298 marriages. The principal causes of death in 1942 were contagious and parasitic diseases (25·9 per cent), digestive diseases (14·6 per cent), genito-urinary diseases (6·8 per cent) and respiratory diseases, except tuberculosis (6·1 per cent).

Announcements

THE Lord President of the Council has appointed Mr. W. J. Drummond, Dr. H. L. Guy, Sir William Halcrow and Mr. W. F. Lutyens to be members of the Advisory Council to the Committee of the Privy Council for Scientific and Industrial Research, in succession to Sir Joseph Barcroft, Sir Harold Hartley and Sir Frank Smith, who have retired from the Council on completion of their terms of office.

LORD SWINTON, minister resident in West Africa, has been appointed Minister for Civil Aviation, and Sir William Jowitt to be Minister of Social Insurance (designate).

DR. HARLOW SHAPLEY, director of Harvard Observatory, has been awarded the Order of the Aztec Eagle, third class, the highest decoration of the Mexican Government awarded to non-Mexicans, for his promotion of scientific co-operation between the United States and Mexico, and for his assistance in equipping the National Astrophysical Observatory at Tonanzintla, near Puebla, Mexico.

THE forty-ninth annual congress of the South-Eastern Union of Scientific Societies is being held at High Wycombe on October 14. The president-elect, Brigadier F. A. E. Crew, director of biological research at the War Office and professor of social medicine in the University of Edinburgh, will deliver his presidential address on "The Biology of War" at 11 a.m.; sectional presidential addresses will precede this address.

ERRATUM.—Messrs. Baird and Tatlock (London), Ltd., referring to the paragraph entitled "A New Type of Still" in *Nature* of September 23, p. 393, state that in line 15 "motor" should read "heater", and that the results quoted are the average of a number of experiments.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications.

Nutritive Value of Composite Dishes

In McCance and Widdowson's analytical tables, "Chemical Composition of Foods", values are given for a series of cooked dishes containing several ingredients. These values were calculated from the composition of the listed ingredients and the (experimentally determined) change in weight on cooking.

Clearly, such values can only be utilized in dietary survey work if the recipes of the observed composite dishes approximate very closely to those used by McCance and Widdowson. These authors made a preliminary study of several cookery books so as to ensure that the recipes they used should be 'standard' ones. But the war situation has since changed our ideas even of 'standard recipes', and composite dishes tend to vary from day to day, depending on what is available and what needs using up. Besides which, the composition of one of the most common ingredients (flour) has itself been changed.

It is true that there are limits to the variation which can be introduced without entirely altering the nature of the finished dish, but our experience suggests that, at least for the more watery items, these limits are pretty wide. The accompanying table gives values we have found in practice.

Values per 100 gm.	Calories	Protein (gm.)	Calcium (mgm.)	Iron (mgm.)
Rice pudding 1	158	4·9	138	0·17
,, ,, 2	183	4·8	129	0·17
,, ,, 3	88	2·7	81	0·09
,, ,, 4	97	2·6	73	0·09
(McC. and W.)	185	4·5	138	0·14
Porridge 1	66	1·7	33	0·29
,, 2	91	2·9	53	0·54
,, 3	117	3·4	62	0·63
,, 4	135	4·0	46	0·99
(McC. and W.)	45	1·5	6	0·47
Stew with meat 1	103	9·2	21	1·81
,, ,, ,, 2	101	8·0	23	1·57
,, ,, ,, 3	89	3·5	8	0·96
,, ,, ,, 4	97	7·3	31	1·48
,, ,, ,, 5	61	6·0	15	1·23
(McC. and W.)	108	11·1	14	2·49
Shepherd's pie 1	165	8·3	6	1·72
,, ,, 2	149	7·8	17	1·61
,, ,, 3	139	8·0	13	1·67
(McC. and W.)	125	7·1	15	2·31

These values have been obtained by the calculation method as employed by McCance and Widdowson, and the figures from their tables have been included for comparison.

Our method, when dealing with composite dishes in survey analyses, has always been to obtain the recipes and to note the cooking times and methods, and then to apply a concentration factor to give us the relation between uncooked weight and cooked. Recorded weights (as eaten) were then converted back to their equivalent uncooked weights and these broken down into the proportional weights of the various ingredients. As a general rule, the concentration factor applied was that found by McCance and Widdowson, but if observation showed the dish as served to be wetter or drier than is customary, then the concentration factor was varied accordingly.

We prefer this method because we think it makes for greater accuracy. Concentration factors may have differed more than we allowed for, but we feel they will certainly vary within much narrower limits than the list and amounts of the ingredients. There are, however, other advantages also. For example, it enabled us to make direct comparison between one intake and another in terms of basic foodstuffs, since they were known as a total and were not distributed among such items as puddings, stews, cakes, etc. It is easier to make recommendations for improving a dietary when the amounts of different foodstuffs already being used are known. This is particularly true at present when it is necessary to keep within allocated allowances. Moreover, this method enables us to calculate the cost of the dietary without further detailed analysis.

MARGARET W. GRANT.
(University of London Postgraduate Dietetics Course.)

Aug. 31.

Cancer Research in the U.S.S.R.

In November last we received a request from Prof. S. A. Sarkisov of the Institute of the Brain in Moscow, who was then in London, to supply some mice bearing transplantable tumours which were to be sent to Moscow for Prof. L. Shabad, formerly director of the Laboratory of Cancer Research in the Institute of Experimental Medicine, Leningrad.

The mice were to be sent by air, and probably they would be exposed to considerable changes of climate, and possibly of atmospheric pressure also. Three batches each of four mice were got ready bearing the following tumours freshly grafted: (*a*) mammary carcinoma 63; (*b*) the Crocker tumour; and (*c*) a sarcoma induced here by Dr. Hieger with the non-saponifiable fraction of human livers. The inclusion of the last tumour was appropriate because these mice embodied a development of the original discovery by Prof. Shabad in 1937, since then confirmed in several other laboratories, that extracts of human livers could produce sarcoma in mice.

Each batch of mice was placed in a wooden box (45 cm. × 30 cm. × 12 cm.) having three apertures of 5 cm. diameter covered with perforated zinc for ventilation, with hay and sawdust as bedding, and a quantity of oats, puppy biscuits and a proprietary rat food sufficient for many weeks. Water was supplied from the bulbs in use here for laboratory animals, and a syringe for filling these and directions to be translated into Russian were provided. The boxes were dispatched on November 23, and Prof. Shabad has reported that all the mice arrived safely in mid-December, and that the three tumours had been grafted successfully in the mice available in his laboratory.

Perhaps this is the longest journey yet accomplished by mice used for the purposes of research; the distance covered was probably of the order of five or six thousand miles. Before the War many such mice crossed the Atlantic on liners, chiefly from west to east, in charge of the butcher, who at sea is the custodian of animals living and dead, but this is a shorter journey without halts and changes, and the conditions of temperature are uniform.

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Amides, Imides and Peptides

PROTEIN chemistry has its origins in physiology. For the last half-century the group formed by condensing the carboxyl group of an amino-acid with the amino group of another amino-acid has been called a peptide group, and the long molecule formed by condensing a number of amino-acids, a polypeptide. Protein molecules contain numerous peptide links (—CO.NH—) in the backbone of the molecule; they also in most cases carry amido groups ($—CO.NH_2$) as terminal groups of certain of their side-chains.

'Nylon' chemistry has its origins in organic chemistry. Unfortunately, some 'Nylon' chemists have chosen to call the link formed by condensing adipic acids with hexamethylene diamine an 'amide group', and to describe 'Nylon' as a 'polyamide'. 'Nylon' chemistry is now beginning to have an influence on protein chemistry, and the use of the term 'amide' as a synonym for 'peptide' in a field of chemistry where it already has a definite and different meaning is causing considerable confusion.

Surely, in any event, to call the group —CO.NH— an 'amide' or even an 'amido' group is wrong. By general agreement substances carrying an $—NH_2$ group are amines, or an $>NH$ group, are imines. Equally, substances carrying a $—CO.NH_2$ group are amides, and surely if carrying a —CO.NH— group should be imides.

To use the term 'imide' as a synonym for 'peptide' and to call 'Nylon' a polyimide would be correct in the language of classical organic chemistry, and would bring clarity into the relations of protein chemists and 'Nylon' chemists. 'Polypeptide' could well be reserved as a term to describe a product obtained by condensing amino-acids, and 'polyimide' for the products obtained by condensing all other carboxylic acids with organic amines.

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Chemical Terms, with Special Reference to 'Oxidation', 'Acid' and 'Base'

THE words we use in everyday life often mislead us, because the same word (say 'democracy') means different things to different people. It is clearly desirable that scientific words should mean the same thing to all those who use them, and, so far as possible, that they should signify now what they signified in the past.

We say "so far as possible". When the mechanism of a process, such as the corrosion of iron, becomes better understood, the word 'corrosion' acquires a fuller meaning. This is inevitable and desirable. It would be undesirable, however, in our view, if a particular reaction of iron were considered a corrosion by one chemist and not by another.

There is a tendency to extend the scope of a word to include phenomena which were formerly excluded. This has happened in the past; for example, in the case of the word 'oxidation'. The term, originally applied to processes such as the change of ferrous oxide to ferric oxide, was extended to include the change of ferrous chloride to ferric chloride. This extension took place so long ago that it causes confusion now to none except beginners (to whom it is still a stumbling-block), and it would probably be futile to suggest a change. It seems to us, however, that it would have been better, when it was realized that there was a similarity between oxidations proper and other processes in which the proportion of electronegative element or radical is increased, to coin a new term (say, 'adduction') to cover both sets of phenomena, while keeping 'oxidation' for changes involving oxygen. All 'hydrogenations' are 'reductions', but not all 'reductions' are 'hydrogenations'.

It is impossible to extend the scope of a word to include more phenomena without diminishing its sharpness. In the language of the logicians, increase in the extension of a term leads inevitably to decrease in its intension. The term 'oxidation' now conveys a less precise meaning than 'hydrogenation'.

If this were the only example of the phenomenon it would not be worth while writing a letter about it; unfortunately the process is still at work. There was little disagreement among early chemists about the scope of the words 'acid' and 'base'. When hydrogen ions were discovered the words acquired a fuller meaning, but were still applied to cover approximately the same range of substances.

In the last twenty years, however, the recognition that there is a similarity of action between all substances capable of giving up protons or taking up electrons during reaction has led to the extension of the term 'acid' to include all such, and we have now reached the very undesirable position that, while A and B are agreed that hydrochloric acid in aqueous solution is an acid, A applies the word to $NH_4^{\cdot}$ and water also, while B thinks of $NH_4^{\cdot}$ as the electropositive ion of an important series of salts and of water as the most typically neutral substance in existence.

In a recent paper[1] the following sentence occurs, "We conclude that almost any substance may behave as an acid or a base". The extension of 'acid' and 'base' has become so great that the intension has become practically nothing at all.

We think it is probable that a majority of chemists feel uncomfortable at the application of the term 'acid' to water or 'base' to the chloride ion. Perhaps it is not too late to recognize the undesirability of the process and to agree upon the use of some pair of terms (such as 'proton donor' and 'proton acceptor', or 'electrophilic' and 'electrodotic', or others suggested from time to time) to describe all substances (including acids and bases) which can give up or receive protons (or attract or supply electrons), while preserving 'acid' and 'base' for the compounds which have been described by these words for centuries.

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[1] Luder and Zuffanti, *Chem. Rev.*, **34**, 346 (1944).

Thermal Expansion of Diamond

THE measurements of the thermal expansion of diamond made by Dembowska, which according to Grüneisen[1] appeared to support his well-known formula connecting the specific heat and thermal expansion coefficient of simple solids, covered only a rather small range of temperature. A satisfactory test of the Grüneisen relationship appeared to require data over a wider range of temperature. I have accordingly measured the change in the lattice spacing of diamond with temperature over the range 25°–650° C.

The X-ray method has been employed, but the technique is rather different from that usually adopted, being designed to enable the rather small expansion of diamond to be measured accurately. It is based on the use of a beam of monochromatic X-rays from a copper target diverging from a fine slit and reflected at the surface of the crystal, the photographic film recording the reflexions being at a considerable distance (80 cm.) from the latter. The octahedral cleavage plate employed is held firmly in a slot at the end of a drawn-out tube of fused quartz, being fixed therein with a suitable cement. The quartz tube is long enough to ensure that its lower end is not sensibly heated up, while the diamond itself is raised to the temperature desired by being enclosed in a small electrically heated chamber. Using a Hartmann diaphragm, three sets of X-ray reflexions are recorded in juxtaposition on the same film, the middle one with the heated crystal and the top and bottom ones as controls at room temperature. From the observed displacements of the $K\alpha_1$ and $K\alpha_2$ reflexions, which appear as sharp and widely separated lines on the film, the relative change in crystal spacing can be readily evaluated. As a further control, the expansions are redetermined with the crystal holder and heating chamber turned round through twice the Bragg angle.

The results of the measurements are shown in the second column of the accompanying table below the line, those above it being the determinations by Dembowska quoted by Grüneisen[1]. The values of the atomic heat have been tabulated from the data of Pitzer[2] below 273° K. and from the data of Magnus and Hodler[3] above that temperature.

Temperature range	Mean value of the coefficient of cubic expansion (α)	Mean value of atomic heat (C_v)	γ
84·8–194·1° K.	0·54 × 10^{-6}	0·233	1·19
194·1–273·2	1·74	0·866	1.03
273·2–296·2	2·91	1·351	1·10
296·2–328·1	3·51	1·605	1·12
328·1–351·1	4·35	1·870	1·19
298–378 °K.	4·50 × 10^{-6}	1·870	1·23
378–478	6·70	2·627	1·31
478–573	8·58	3·307	1·32
573–673	9·81	3·874	1·30
673–773	10·70	4·310	1·29
773–873	11·55	4·643	1·27
873–923	12·30	4·829	1·30

The fourth column of the table shows the Grüneisen number γ, which is the ratio $\alpha V_0/\chi_0 . C_v$, where V_0 is the atomic volume and χ_0 the compressibility of diamond. It is clear that γ is not a constant, but increases steadily from about 1·1 to 1·32 and then falls again as the temperature is raised. The theoretical significance of the failure of the Grüneisen law which is revealed by these studies will be dealt with in another communication.

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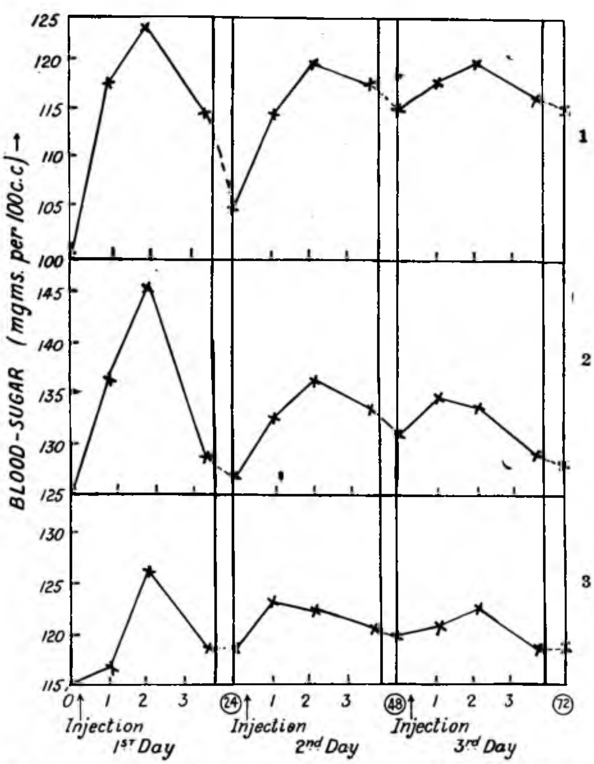
[1] Grüneisen, "Handbuch der Physik", 10, 42 (1926).
[2] Pitzer, *J. Chem. Phys.*, 6, 68 (1938).
[3] Magnus and Hodler, *Ann. Phys.*, 80, 808 (1926).

Experimental Hyperglycæmia by Injection of Intermediary Fat Metabolism Products in Rabbits

BEST and his associates[1] recently reported hydropic degeneration and degranulation of the β-cells through the injection of anterior pituitary extract similar to those observed in the remnants of Allen's partially depancreatized dogs and ascribe those to overwork. The recent findings of Dunn and his associates[2,3] on experimental alloxan diabetes have created great interest in the subject. Though this substance may bring about conditions of glycosuria and hyperglycæmia in animals, the nature of degeneration in the β-cells has been shown to be different from that caused by anterior pituitary injection or through clinical diabetes and the physiological significance has not been known as yet. Adams[4] and Joslin[5] regard obesity as a precursor of diabetes, and it is reasonable to believe that the intermediary metabolism products formed during improper oxidation of fat might be concerned in causing hyperglycæmia and other associated troubles in an individual. It may be recorded here that repeated injection of these types of chemical substances (for example, β-hydroxy-butyric acid, acetoacetic acid, pyruvic acid, etc.) have been found to cause hyperglycæmia in rabbits.

The experiment was made as follows: Adult rabbits weighing about 2 kgm. were selected and injection was given after the animals were allowed to fast for eighteen hours. Blood sugar was estimated initially before injection and after regular intervals for about 4½ hr. according to the method of Hagedorn and Jensen[6]. The animals were fed after this period with usual gram diet and again allowed to fast for



1, Aceto-acetic ester; 2, β-hydroxybutyric acid; 3, pyruvic acid.

Fig. 1.

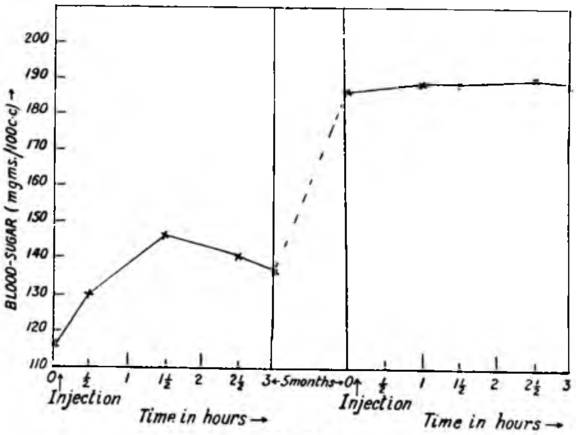


Fig. 2.

eighteen hours. The experiment was repeated for three days in succession on the same rabbits. The nature of change of blood sugar (average from two animals), during the period of experiment, is represented graphically in Fig. 1. It will be seen that in all cases the initial concentration of fasting-sugar on the third day is definitely higher than that on the first day and the nature of the curve is greatly changed. It is also interesting to record that when the set of animals receiving ethyl aceto-acetate for three days was allowed to rest for about one month and the experiment repeated, the fasting blood sugar level was found to be lower than that obtained initially (that is, one month before) and a far greater hyperglycæmic effect was observed on injection of the same substance. This lowering of blood sugar level may indicate the mechanism of natural adjustment, possibly by causing hyper-secretion of internal insulin. Two rabbits (male) were then injected daily, beginning with 10·0 mgm. of β-hydroxy-butyric acid and gradually increasing to 400·0 mgm. and the blood sugar curves of the animals were obtained on the very first day of injection and after the injections were continued for 150 days. The initial blood sugar value after such period of injection was found to be very high (187·0 mgm. as against 116·0 mgm. recorded on the first day) and the nature of the curve (Fig. 2) was found to be greatly changed. This curve was almost a straight one, indicating severe damage to the insulin-secreting mechanism.

It may be suggested that these intermediary fat degradation products might first stimulate the pancreatic cells, which gradually become fatigued through excessive work, possibly through lesions of these cells in the long run. Further investigations which are in progress may throw more light on the matter.

Our best thanks are due to Prof. J. K. Chowdhury and Prof. B. C. Guha for their kind interest in this work.

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[1] Best, C. H., Campbell, J., Haist, R. E., and Home, A. W., *J. Physiol.*, **101**, 17 (1943).
[2] Dunn, J. S., McLetchie, N. G. B., and Sheehan, H. L., *Lancet*, i, 484 (1943).
[3] Dunn, J. S., McLetchie, N. G. B., *Lancet*, ii, 384 (1943).
[4] Adams, S. F., *J. Nutrition*, **1**, 339 (1929).
[5] Joslin, E. P., *New Eng. J. Med.*, **209**, 519 (1933).
[6] Hagedorn and Jensen, *Biochem. Z.*, **135**, 46 (1923).

Toxicity to Flies of Derivatives of Eugenol and *Cis-* and *Trans- Iso*eugenol

IT appears that any modification in the pentadienyl side-chain of the pyrethrin molecules induces a profound depression in the insecticidal activity[1]. Although the distribution of the double bonds in the side-chain of pyrethrolone is not yet fully established[2], there seems to be little doubt that there is either a terminal $=CHCH_3$ grouping or—less probably—the $=CH_2$ group. Allyl phenols have been found to possess insecticidal properties[3], and it appeared of interest to compare the toxicity in fly sprays of corresponding derivatives of the isomeric phenols eugenol (which contains the allyl grouping) and *iso*-eugenol (containing the propenyl grouping).

The initial tests showed that when sprayed against flies under exactly comparable conditions in kerosine or kerosine-acetone solution alone, or as adjuvants to the pyrethrins, compounds such as ethers of eugenol were usually more effective than solutions of the corresponding *iso*eugenol derivatives; but some of the results led to comparison of the *cis-* and *trans-* forms of the compounds derived from *iso*eugenol. It was then found that solutions of the *cis-* forms of the *iso*eugenol compounds approached the toxicity to houseflies shown by solutions of the corresponding eugenol compounds, whereas the *trans-* forms were noticeably less toxic in solution alone and when included with small quantities of pyrethrins.

This observation appears to be of some interest in view of the fact that comparison of the effect, as pyrethrin synergists of sesamin, of *iso*sesamin and asarinin against houseflies indicated[4] that the nature of the substituents on the benzene ring was the determining factor on the synergistic action of this class of compound, spatial configuration being of little or no importance.

The preparation and physical properties of the pure *cis-* and *trans- iso*eugenol derivatives employed will be described elsewhere.

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[1] West, T. F., *Nature*, **152**, 660 (1943).
[2] Gillam, A. E., and West, T. F., *J. Chem. Soc.*, 671 (1942); 49 (1944). West, T. F., *J. Chem. Soc.*, 51 and 239 (1944). LaForge, F. B., and Acree, F., *J. Org. Chem.*, **7**, 418 (1942). Cf. LaForge, F. B., and Barthel, W. F., *J. Org. Chem.*, **9**, 242 (1944).
[3] Harvill, E. K., and Arthur, J. M., *Contrib. Boyce Thompson Inst.*, **13**, (2), 79 (1943).
[4] Haller, H. L., LaForge, F. B., and Sullivan, W. N., *J. Econ. Ent.*, **35**, 247 (1942). Cf. Parkin, A. E., and Green, A. A., *Nature*, **154**, 16 (1944).

Function of Plant Vacuoles

PREVIOUSLY[1], I put forward the view that pinkish vacuoles are receptacles of enzymes for synthesis of various food reserves in plants, lower as well as higher; in support of this I produced evidence of synthesis of food reserves around the pinkish vacuoles of pyrenoids in *Spirogyra* and of synthesis of oil drops around pyrenoids in two diatoms. Additional evidence in favour of the view that pinkish vacuoles are receptacles of enzymes is now brought forward from two sources: (1) synthesis experiments; (2) plasmolysis experiments, in some fungi.

By growing fungi (*Polyporus durus* and *Phomopsis* sp.) in fatty acids and glycerine medium, the first formation of oil drops was noticed around the vacuoles in the course of two days, and by growing them in

4 per cent sucrose or glucose medium the formation of glycogen granules appeared in the same position. In a living cell intracellular enzymes never come out of the vacuoles, but remain enclosed within the vacuolar membrane; starch, glycogen, fats and proteins are synthesized just on the external surface of the vacuolar membrane, and they are also hydrolysed at the surface on account of the superficial secretion of enzymes from the vacuoles; then they are absorbed into the vacuolar cavities. But extra-cellular enzymes in fungi come out by way of exudation from the growing tips of hyphæ. Vacuoles are, thus, the seats of phenomena of synthesis as well as of hydrolysis, all reactions taking place at the surface external to the vacuolar membrane. They are not merely passive accumulators of diverse metabolic products and secreted substances soluble in water, but are the principal sites of chemical affinities in the cell due to the accumulation of enzymes.

From plasmolysis experiments in glucose, sucrose and sodium chloride solutions, it follows that when the perivacuolar membrane is damaged, there is leaking out of enzymes (proteases, diastases and lipases) which act on the protein and glycogen granules and fat drops, and transform them into soluble substances, and the mitochondria become vesiculized; their lipo-protein complex breaks down with liberation of lipides. Thus, a gradual liquefaction of the cytoplasm is brought about. The liberated lipides increase in number, some of them fuse into large globules, leading ultimately to a fatty degeneration of the hyphæ.

Experimental facts lead to the conclusion that the plant vacuoles function as storehouses of enzymes.

Details of these experiments with discussion of current theories and with illustrations are expected to be published soon elsewhere.

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[1]Bose, S. R., *Bot. Gaz.*, **104**, 633 (1943).

Paracrinkle Virus and Inheritance

IN a recent article[1], I have argued that viruses and what I call plasmagenes[2] are derived from cell proteins. On my view, these undifferentiated proteins may come to acquire the properties either of infection or, alternatively, of inheritance, by processes of adaptation which I attempted to describe. I also represented these processes in a diagram (Fig. 3) in which arrows showed the conceivable and, to me, probable directions of evolutionary change.

Four workers in plant breeding and virus research now raise objections to this view[3]. They take the case of the paracrinkle determinant of the King Edward potato to which I referred and point out, on one hand, that it is a virus since it shows the 'carrier' as well as 'susceptible' reactions with different potato clones, and on the other hand that it is not a plasmagene.

That paracrinkle behaves as a virus was fully demonstrated by the work of Salaman and Le Pelley, to which I directed attention. In their original account they described not two but four reactions of potato varieties with paracrinkle, and a reaction of *Datura*, all fully consonant with its description as a graft-transmitted virus. I consequently referred to it as a virus and I used its behaviour as the strongest evidence, on the plant side, for my argument that viruses can arise from cell proteins and for the arrows that I drew to indicate this origin.

If, on the other hand, paracrinkle had behaved as a plasmagene I should indeed have been surprised. The possibility of so dangerous a particle being transmissible (and therefore having been transmitted) by the seed seems to me, for reasons which I gave, a remote one. I would not exclude it but I would certainly not expect it. For this reason I showed no arrows joining plasmagenes and viruses.

My critics therefore have their facts right so far as they go, but they have overlooked one enormous fact. They say, "There thus seems no fundamental difference in the reaction of King Edward to paracrinkle virus from that of any other 'carrier' variety to the virus 'carried' ". Only one fundamental difference, to be sure, namely, that King Edward *made* it, just as, I am supposing, the fowl and the mouse *made* their viruses.

It occurs to me that what my critics have not understood is the notion (which is perhaps a new one, although it seems fairly obvious) that cell proteins, characteristically produced by a nucleus of a particular new genotype, may have the capacity for indefinite self-propagation even when subject to other nuclei. Such proteins will sometimes have the potentiality of developing, either into plasmagenes or into viruses, according to their distributions in development or their opportunities in infection. They may even, by mutation and otherwise, cause cancer in the examples I have quoted.

A careful study of my article, and if necessary of the book to which it is a footnote, would, perhaps, make my premises and argument clear and leave no ground for the misunderstanding of particular phrases.

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[1] *Nature*, **154**, 164 (1944).
[2] "The Evolution of Genetic Systems" (Cambridge, 1939).
[3] Carson, G. P., Howard, H. W., Markham, Roy, and Smith, Kenneth M., *Nature*, **154**, 334 (1944).

Plant Nutrients in the Sea

IN a recent issue of *Nature*[1], Prof. J. Ritchie speculates "upon a day . . . when the International Fisheries Commission of the nations bordering the North Sea may discuss, along with its programme of researches, the allocation of sums to be contributed by each nation for chemical nutrients in the assurance that these will support a larger fish population and an increased fishing fleet in the North Sea". Prof. Ritchie surely does not realize the vast quantities involved. The English Channel is not a specially rich fishing ground, but calculations based upon the annual phosphate cycle show that the minimum value for the phytoplankton crop is about 1,400 metric tons wet weight per square kilometre each year[2]. The annual phosphate cycle involves the complete removal of this substance from the surface waters and a lesser removal in the deeper water, on account of the reduced illumination. But under each square metre the water column yields to vegetation about 1 gm. of phosphorus, equivalent to about 7 gm. of calcium phosphate. Thus each square kilometre of sea has an annual turnover of about seven tons. To put any appreciable fraction of this quantity into the English Channel would involve a vast expenditure. Moreover, such addition would soon be dissipated into the ocean.

H. G. Wells is right in laying emphasis on the importance of phosphorus in limiting the fertility of the ocean, but his recent statement[3], that though "fisheries intercept a fraction of this phosphorus, the greater part of it forms insoluble compounds with other substances, bones, shells and so forth, and sinks slowly into the abyss beyond recovery", is incorrect. Actually the phosphate taken up is largely regenerated by excretion and decay; also the vertical circulation of the water column, which begins as the surface cools in autumn and continues until spring, brings phosphate and other nutrient salts to the well-illuminated regions again. A certain amount does sink to the abysses of the ocean. But much of this is brought up again when the oceanic currents impinge on banks and continental shelves. In this circulation, drainage from the land plays a very small part and cannot possibly account for differences observed between one year and another in such a body of water as the North Sea.

Phosphate is, of course, only one of the plant nutrients that would require to be added.

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[1] Ritchie, J., *Nature*, **154**, 275 (1944).
[2] Atkins, W. R. G., *Science Progress*, No. 106 (Oct. 1932).
[3] Wells, H. G., "Man's Heritage" (London, 1944).

Temporary Ponds, a Neglected Natural Resource*

Natural pools which contain water for a few months in spring, and are dry for the remainder of each year, are found in many parts of the world. I have examined them in Great Britain, Denmark, Sweden, Siberia[1], Canada[2], Australia and Africa. In the past little attention has been paid to ponds of this kind, except by specialists. Since they are potentially useful to man a short account of them may be of interest.

The annual history of a temporary pond in the north temperate and sub-arctic zones is as follows: With the coming of spring, and the melting of the snow which has accumulated during the winter, water collects in shallow grassy depressions and remains there for two months or more. A large number of invertebrate animals emerge from the resting condition in the soil on the bottom of the pond site, and become active within a few hours of the filling of the pool. Some animals, such as the Entomostraca, over-winter as eggs, while others, including the snails, spend the winter in the adult condition. Within one month of the formation of the pond each spring, a very great abundance of life of many kinds is found in the water, and it is in this that the usefulness of these habitats lies. When the pond dries in early summer the aquatic fauna and flora resume a resting condition, and the pond site becomes a land habitat. Because of the presence of the excrement of the water animals, the pond sites are well fertilized, and therefore support a luxuriant growth of land plants during the terrestrial phase. The leaves and stems of these land plants serve, in turn, the following spring, as food for the aquatic animals, and in that manner fertilize the aquatic phase of the pool.

In at least one respect the immediate utilization of temporary ponds is possible. In the year 1928 I was engaged in scientific work at a fish hatchery on Lake Winnipegosis, in central Canada. At this place there was need for the feeding of the fry of whitefish (*Coregonus clupeformis*) before they were planted in the lake, in order that they should have a surer start in life; in other words, in order to reduce the wastage among the fry planted in spring when there is little food in the lake waters. A suitable food supply for the fry was found in temporary ponds on shore near the hatchery. It might be assumed that once the warmer weather had come, there would be a development of fish food in the waters of the lake at an equal rate as in the temporary ponds on the shore. In practice things do not happen in that way. In the lake there is a time-lag, due in the first instance to the fact that before the biological food-producing processes can really get under way two to three feet of ice must be melted by the sun. In contrast to this, there is a very rapid development of many organisms in the temporary ponds, because those sites have been dry during the winter and so have no covering of ice; in practice it was found that the collection of plankton and organic detritus in the temporary ponds, and the feeding of it to whitefish fry, is feasible, and results in the rapid growth of the fry.

Taking a long view, it is possible to think of the efficient utilization of the plant and animal proteins and carbohydrates which are available in temporary ponds in a rationalized agriculture. Under those conditions an aquatic crop, such as plankton or fishes, could be reaped from a given piece of ground, and be followed by a field crop, such as oats. A rotation of that sort is said to be followed in carp ponds in Central Europe. Another possibility is that the site, after the drying of the pond, could be used for intensive protein-rich grazing.

In many parts of the world temporary ponds are undesirable as being a wasteful hindrance to the agriculturalist, or they may be dangerous, as breeding places of disease-carrying mosquitoes and snails. The purpose of the present note is to point out their useful possibilities. In other words, temporary ponds, so often regarded as a nuisance, are in reality a neglected natural resource.

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[1] Mozley, Alan, *Trans. Roy. Soc. Edin.*, **58**, 605 (1935).
[2] Mozley, Alan, *Amer. Nat.*, **66**, 235 (1932).

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Surface Area of Small Objects

The determination of the surface area of objects such as small particles or stones is of importance in many fields of research. These particles are usually convex in shape, but it seems that the mathematical theory of convex bodies is not widely known among experimental workers in this subject.

If a body is convex and has area A, it was proved by Cauchy that A is equal to four times the mean of the area of the projection of the body on a plane for all orientations of the latter. This result has a limited application in the estimation by photographic or photometric means of the average surface area of a number of small particles suspended in a liquid. With larger particles such as stones, however, it suggests that the area of projection should be measured in a number of different directions by some such optical method. The average of these multiplied by four will give the surface area. In order to give equal weight to each observation it is desirable to choose the directions of projections to be those of the normals to a dodecahedron or an icosahedron.

The question then arises as to how good an approximation this is to the true mean. If A is the true area and A_1 the area estimated by this method

$$0{\cdot}918 \leqslant \frac{A_1}{A} \leqslant 1{\cdot}079$$

for a dodecahedron, and

$$0{\cdot}955 \leqslant \frac{A_1}{A} \leqslant 1{\cdot}047$$

for an icosahedron. These limits are the approximate numerical values of certain trigonometrical expressions which can be evaluated exactly. They are, moreover, the best possible limits.

Proofs of the above results and some analogous theorems will appear in the *Annals of Mathematics.*

P. A. P. MORAN.

St. John's College,
Cambridge.
Sept. 1.

A Solar Halo Phenomenon

A DISPLAY of mock suns was seen here on the morning of August 9. Descriptions of similar displays seen at Cambridge and Godalming have been published[1] and these notes are supplementary to them.

The Farnborough display occurred in cirrus caused by aircraft trails at a height of 20,000 ft. At 12.15 a.m. (D.S.T.) it consisted of a complete parhelic circle, about one third of a complete tangent arc, left-hand and right-hand coloured parhelia near the 22° halo, two white parhelia situated on the parhelic circle and an anthelion. The colours were exceptionally brilliant.

The shape of the tangent arc was similar to that expected theoretically[2] for the sun at an altitude of 48° 07′ (its altitude at 12.15 a.m.). The colour bands in the left-hand parhelion were not perpendicular to the parhelic circle, but were inclined to the vertical at an angle of about 30°. They also extended slightly below the parhelic circle in a manner similar to the arcs of Lōwitz. Some photographs taken by Mr. Brock show this inclination. They were made on Ilford Standard Panchromatic film with a tri-red filter: the range of wave-lengths recorded was from 5800 A. to 6700 A. A measurement on the best of the photographs gives, as the distance from the inside of the 22° halo to the inside boundary of the left-hand parhelion, 8° 44′ ± 30′ (extreme error). This distance has been calculated to be 9° 31′, assuming a refractive index of 1·307 for ice (corresponding to a temperature of − 10° C. and a wave-length of 6700 A.) and a solar altitude of 48° 07′. As it has been assumed that the sun is a point source, the agreement seems satisfactory.

The bands seen by Mr. Archenhold were also seen here; but according to our notes they were coloured, even when they passed through the sun. This indicates a diffraction origin for the colours. Unfortunately, it was not noticed whether the red or violet was nearer the sun; such an observation would have distinguished a refraction origin from a diffraction origin. We think that Mr. Archenhold's explanation is too simple, since it is geometrically impossible for a collection of reflecting and refracting elements between earth and sun to produce a straight band of light not passing through the sun, except for unlikely distributions of orientation.

It is evident that knowledge of atmospheric optics is still in an elementary state, and that many more careful (preferably photographic) observations are required. That England is not an unsuitable country for these observations is shown by the fact that, during the five weeks following the display, we have seen fifteen 22° solar halos, three brightly coloured parhelia, one isolated upper tangent arc (probably often mistaken for part of a 22° halo) and one 17° solar halo.

D. E. BLACKWELL.
J. C. W. DE LA BERE.

11 Victoria Road,
Farnborough,
Hants.

[1] *Nature*, **154**, 433 (1944).
[2] Pernter-Exner, "Meteorologische Optik".

Prof. A. E. Conrady

I AM indebted to Mr. Cyril Young, of Sir Howard Grubb, Parsons and Co., Ltd., for directing my attention to a mis-statement in my obituary notice of the late Prof. Conrady[1]. I had been informed from a source which I believed trustworthy that, prior to the War of 1914–18, the periscopes fitted to British submarines had been obtained from foreign sources. Mr. Young, supported by other correspondents, assures me that almost all the periscopes of this period were made by the firm of Sir Howard Grubb and Sons, Ltd., in Dublin; and this firm produced the majority of the periscopes used during the War. Even before 1914, periscopes were the main product of the firm, though it was probably better known in scientific circles for its astronomical telescopes. Sir Howard Grubb took out a number of patents in connexion with submarine periscopes from the year 1901 onwards. The firm's workshops were removed from Dublin to St. Albans when the enemy submarine menace became acute.

This does not, of course, detract from the merit of Prof. Conrady's original work in the design of such complicated systems (his designs were not of the 'Grubb' type) and his efforts, together with those of the optical staff of the National Physical Laboratory, Messrs. W. Watson and Sons, Ltd., and Messrs. Kelvin, Bottomley and Baird, Ltd., must have contributed very largely to the adequate supply of these essential parts of submarine equipment. Their manufacture was later taken up by Messrs. Barr and Stroud, Ltd.

It is clear that Great Britain owes a great debt to the late Sir Howard Grubb in this connexion.

L. C. MARTIN.
Imperial College of Science and Technology,
London, S.W.7.

[1] *Nature*, **154**, 173 (1944).

THE BEECH TREE

By ALEXANDER L. HOWARD

Hinc olim juvenis mundi melioribus annis,
Fortunatarum domuum non magna supellex
Tota petebatur ; sellas, armaria, lectos,
Et mensas dabat, et lances, et pocula Fagus.

Hence, in the world's best years, the humble shed
Was happily and fully furnished :
Beech made their chests, their beds, and the join'd-stools :
Beech made the board, the platters, and the bowls.

COULEIUS.

JULIUS CAESAR, after visiting Britain, returned home and reported that he had seen vast forests containing oak, ash, elm, and other trees in great abundance, and as he mentioned the trees by name, omitting the beech, it was thought that this tree was not indigenous to the country. C. A. Johns suggests that like some other explorers Julius Caesar was given to exaggerate the importance and extent of his travels, and conveyed the impression that he had penetrated farther into the country than was actually the case. Since he only traversed part of Sussex and Kent, and was in England only a few days, his report was of little account. Elwes, in "Timbers of Great Britain and Ireland", dismisses the subject once and for all by his pronouncement as follows :

"The beech is indigenous to England. Remains of it have been found in neolithic deposits at Southampton Docks ; Crossness, in Essex ; in Fenland ; in pre-glacial deposits in the Cromer forest bed ; and at Happisburgh, Norfolk. Names of places of Saxon origin, in which the word beech occurs, are very common, as Buckingham, Buxton, Boxstead, etc. . . . The beech is not believed to be indigenous in Scotland and Ireland, and no evidence is forthcoming of its occurrence in prehistoric deposits in those countries."

Johns, telling a story which he considers may be a fabrication, says :

"Among the many anecdotes connected with the history of printing which have come down to us, that related by Hadrian Junius deserves to be noticed in this place. About the year 1441, Lawrence Koster, a citizen of Haarlem, 'walking in a suburban grove, began first to fashion Beech-bark into letters, which being impressed upon paper, reversed in the manner of a seal, produced one verse, then another, as his fancy pleased, to be for copies to the children of his son-in-law'. This hint he subsequently improved upon, and finally invented blocks of lead and tin, and printed books. Among his workmen was John Faust, who, having been initiated in the art, although sworn to secrecy, decamped, carrying with him his master's stock in trade, and set up as a printer on his own account at Mayence. I should add that, although many literary men have credited this account, it bears, on close examination, internal evidence of being a fabrication, either of Hadrian or his informant."

The beech tree (*Fagus sylvatica*) with a smooth green trunk and a massive crown, covered in the early spring with vivid light green leaves, which darken as the year advances, changing in the autumn to a golden tint, is one of the most beautiful of all our forest trees.

The shade which it provides has been gratefully accepted by all people for two thousand years, and probably longer.

Pliny says :

"There is a little hill named carne within the territorie of Tusculum, not far from Roman Citie side, clad and beautiful with a goodly grove and tuft of Beech trees, so even and round in the head, as if they were curiously kept cut and shorne artificially with garden sheares : . . . In it there was one especiall faire tree above the rest, which Pabienus Crispus ; a man in our daies of great authoritie . . . cast a fancie and extra ordinarie liking unto : insomuch as he was wont not onely to take his repose and lie under it, to sprinkle and cast wine plentifully upon it, but also to clip, embrace and kisse it other whiles."

Strutt says :

"The Beech will grow in the most stoney and barren soil. In sheltering exposed situations it is particularly desirable on account of its retaining its leaves until the very end of Autumn, and indeed many of them throughout the winter. Their delicate green gradually fading to a modest brown, then to golden orange and at last to the more appropriate red."

In France it has been no less highly esteemed. Elwes says :

"in the North of France it attains perfection and forms very large forests . . . the finest beech forest in France is that of Retz which contains 37,000 acres . . . the beeches contain 329,433 c. ft. of timber, and reach a height of nearly 150 ft. with clean stems of 80 to 90 feet. Their age in 1895 was 183 years, and they were considered (then) to have reached their maximum development."

Later he mentions one of the finest beeches in France called "La Bourdigalle" in the Forêt de Lyons, which is supposed to be 375–575 years old. It is generally considered that in England the beech tree lives for about 250–400 years, probably reaching its prime in less than 200 years, after which time it gradually declines, invariably, as in the case of many trees, becoming hollow.

Strutt mentions the King Beech, in Knole Park, which in 1830 was "105 ft. high, 24 ft. in girth at 13 ft.", and it is interesting that Elwes mentions the same tree as follows : "in 1905 100 ft. by 30 ft. in girth at 5 ft. It has the largest girth of any beech I know of now standing in England". Mr. Mason, kindly instructed by Lord Sackville, has sent me the following note under date of May 18, 1944, regarding this tree :

"The Beech is now very much the worse for wear, only one of the main arms now being left. I have measured this at 13 ft. and it measures 37½ ins. quarter girth (150 in. circumference), I have also measured the main bole at 5 ft. ; this now measures 32 ft. in circumference. The height of the remaining portion of the tree is about 90 ft. It is now in full leaf."

It is interesting to notice that Pliny, 1,500 years ago, records the practice of the Greeks and the Romans who found themselves unable to resist the temptation of carving their names on the beech trees, and that the same habit is continued up to the present day.

While the beech, with its dense overhead crown, affords a welcome shade and a cooler temperature on hot summer days for the traveller, it is a greedy occupant of the surrounding ground. Unlike the plane, and the alder, its dense shade prevents flowers or grass from growing under it. The only compensation is one of which advantage is taken by the more thrifty people in Europe, extending from France to the confines of Italy and Greece. This consists of the truffles and morels which thrive beneath the beech tree. In Germany and France these fungi are eagerly collected and form an important food. Truffles were originally valued in England, and dogs were especially trained for finding the fungus, which grows somewhere under the surface of the ground ; a practice which, of late years, seems to have almost completely disappeared. On the Continent, especially France, pigs are still used for this purpose.

Johns, speaking of the truffle, says:

"It possesses a strong but agreeable smell, and is generally found by dogs and pigs trained to search for it: but, in those countries where truffles abound, in October (which is their season for ripening) all the inhabitants repair to the woods, slightly stirring, or rather scratching the ground in those places which experience points out to them as the most likely to contain the tubers. The high price of, and constant demand for truffles, both in France and other countries, renders this a very lucrative employment, and experienced hunters are rarely deceived in the places where they make their search."

Berkeley quotes an instance of a poor crippled boy who could detect truffles with a certainty superior even to that of the best dogs, and so earned a livelihood. And as regards morels:

"In England they are comparatively rare, but Mr. Berkeley states that he has known them to be so abundant in Kent, as to be used for making a sort of catsup."

Forty-four years ago, in Norfolk, Sir Hugh Beevor took me with him on a search for truffles, which proved successful.

The great importance of the beech tree is not limited to its beauty and shade or even to its immense value for timber, but in addition it is recognized as one of the most important of those trees which help and foster the growth of all other forest trees. Step, who refers to the beech by the title of "Mother of Forests", very mistakenly says that "the timber has little importance", but he is quite correct in acknowledging "his heavy indebtedness to this Nursing Mother". Curiously, however, in later life, it is aggressive and overbearing, so that any woodland of mixed trees, even including oak, will be dominated and eventually expelled by the beech.

Of late years demand for this timber has exceeded all bounds, and among the forests and woodlands of England no tree has been more ruthlessly cut down.

Only a few years ago the country around High Wycombe seemed to provide an inexhaustible supply of beech trees suitable for chair and furniture manufacture. The industry is so old that it is difficult to discover when it first started, but until quite lately the early primitive pole lathe could be seen turning the chair legs in the beech woods, exactly as it was used hundreds of years ago. The pole lathe, together with the other tools employed in the work, was well illustrated in the issue of the *Woodworker* of May 1939. This consists of an upright or similar stake, to which a pole is attached at right angles. Thonging is attached to the pole and this is taken to the lathe. "The thonging passes round the work and causes it to revolve as the treadle moves downwards. The spring of the pole causes the treadle to be drawn up again ready for another stroke. The cut is made on the down stroke only." The supply of beech trees at High Wycombe which seemed at one time to be inexhaustible has vanished, and for some years past those engaged in the trade have had to go farther and farther afield for their timber, and even to import immense quantities from southern Europe.

Among many large sales, especially during the War of 1914–18 and up to the present, in every district where beech trees were available, one transaction stands out noticeably. This concerned one single sale of beech trees at Goodwood, when no less a sum than £55,000 was paid by the purchaser. I have been informed that most of this timber was sold in High Wycombe. I have also been informed that the destruction of these glorious woodlands was necessitated by the incidence of taxation to meet death duties. While this may be perhaps the largest single case on record, it is in no manner the only case, as the same thing has been happening in every part of Great Britain for a great many years past. Successive Governments, while wholly neglecting to make any provision for the reafforestation of the country, have at the same time brought about the deforestation year by year, so that to-day the situation has become dangerous to the welfare of the community.

Every account during 1,500 years has emphasized the usefulness and good qualities of the timber of beech, and for the last hundred years it has perhaps been only second or third in importance in our woodworking industries.

The wood is of a light brown colour, tough but soft, with a straight grain, easily worked, and presenting a smooth surface from both machine and hand tool, whether on the transverse, longitudinal, or across the grain. The extensive fine medullary rays, radiating from the centre to the outside, show when cut in multitudinous flecks. The shrinkage in seasoning is moderate, and with good air or kiln-drying presents even surfaces. Although beech when properly ventilated is fairly durable, if unventilated it rapidly decays, but under water, or ground where there is moisture, it is very durable. About thirty-five years ago, when the underpinning of Winchester Cathedral was necessary, round beech trees and oak were removed which were perfectly sound. The trees had been secured with pegs, some of beech wood, which were sound after more than five hundred years in position. Round piles of beech were taken up from the foundations of Waterloo Bridge, sound after sixty to seventy years of immersion in the bed of the Thames.

Beech has been a favourite wood with chair-makers for two hundred years and perhaps more. The higher-class makers working with walnut, oak, or mahogany, satinwood, etc., generally used beech for the frames; but it is noticeable that Chippendale never employed it. Many fine specimens of artistic design and clever craftsmanship have been lost as the beech framework used was attacked by the *Lyctus* or *Zestobium* beetles, or both, the framework rapidly turning to dust, and the chairs breaking up. The Master's chair, presented to the Glass Sellers Company in 1702, is a superb specimen constructed of walnut and beech; it is still in perfect preservation; but the beech framework had to be replaced this year to prevent collapse. Three other Jacobean chairs of exquisite English marquetry were similarly affected.

Immense quantities of the wood have been used for making a cheaper class of chair for halls, kitchens, and the well-known wheel-back chairs. This trade has been carried on extensively at High Wycombe and elsewhere. Innumerable articles have been made of beech, such as brush-backs, bowls, bread trenchers, and all kinds of domestic utensils. Many of these and also bedposts have been carved with the wheat-ear and other designs. Indeed, throughout the ages civilized man has recognized the merits and usefulness of this wood, for Pliny tells us:

"As touching the beech, the grain of it runneth crosse two contrarie waies like combe teeth; but in old time the vessels made of that wood, were highly esteemed. As for example Marius Curius having subdued his enemies, protested and bound it with an oath, That of all the bootie and pillage taken from them, he hath not reserved anything for himselfe, but only a cruet or little ewer of Beeche wood, wherewith he might sacrifice unto the gods."

Since the present War, the beech tree has come into prominence for the manufacture of ply-wood, with such success that the demand is likely to increase beyond expectation. The Ministry of Supply has now given instructions that all beech being felled in the British Isles shall first be inspected and suitable butts reserved for this purpose.

The very beautiful and ornamental tree generally known as the copper beech is a variety of the purple beech (*Fagus sylvatica* var. *purpurea*). The origin of this tree is doubtful. Elwes says:

"Mention is made of a beech wood at Buch, on the Irchel mountain in Zurichgau (commonly called the Stammberg) which contains three beech trees with red leaves, which are nowhere else to be found . . . and the legend is stated that according to popular belief five brothers murdered one another on the spot where the trees sprang up. Offspring of these trees were carried into a garden, where they still retained their purple colour."

As to the romantic origin above-mentioned, there may possibly be a difference of opinion. This tree can be found widely distributed and is highly prized in innumerable places throughout Great Britain and on the Continent. Its highly decorative appearance in parks and gardens should ensure its future success and planting. Within the last twenty-five years, on two separate occasions I have heard of the successful transplantation of two splendid fully-grown trees—a significant illustration of its appreciation by the respective owners. Elwes mentions that the largest tree which he had found was in the park at Dunkeld, Perthshire, which measured 86 ft. high, with a girth of 15 ft. 3 in.

Nor must we overlook among numerous varieties of this beautiful tree the fern-leaved beech, sometimes called the 'cut-leaved' beech, for which a number of different botanical names have been used, but which Elwes names var. *heterophylla*: the origin of this variety is unknown. This tree is far too little known; but its ornamental character and the decorative beauty of its foliage should recommend it for more general cultivation.

CHEMICAL RESEARCH IN THE U.S.S.R.

RECENT Russian publications received contain many papers of considerable interest dealing with chemical and physico-chemical subjects. Only a small number of them can be mentioned here.

Although polonium belongs to Group VI in the Periodic System, no compounds in which it shows a valency of six were known, although compounds of lower valencies have been described. A. G. Samartzewa[1] examined the co-precipitation of polonium with salts of telluric acid, containing 6-valent tellurium, and found that polonium crystallizes isomorphously with salts of orthotelluric acid. This suggests that polonium forms an ion PoO_4'' in which it is hexavalent.

The Debye formula for the dipole moment of a molecule in terms of the dielectric constant is restricted to gases and to very dilute solutions of polar substances in non-polar solvents. In the case of pure polar liquids the effective orientation polarization is less than the ideal orientation polarization,

$$P_i = \frac{4}{9}\pi N \frac{\mu^2}{kT},$$

which, if known, would give the dipole moment μ. The difference is probably due to the internal local field in the liquid. J. K. Syrkin[2] has found two formulæ which give the relation between effective and ideal polarizations, from which the dipole moment μ for a pure liquid can be determined if its refractive index n, density d, and dielectric constant ε are known (N is Avogadro's number, k is Boltzmann's constant, M is molecular weight, T is absolute temperature):

$$\frac{4}{3}\pi N \frac{\mu^2}{3kT} = \frac{(\varepsilon-n^2)(\varepsilon+2)}{(n^2+2)(2\varepsilon-1)}.$$

A formula for mixtures is also given, and can be used when the substance is soluble only in a polar solvent.

The relation between colour and structure of organic compounds has often been dealt with both theoretically and experimentally. A theory based on quantum-mechanical resonance was proposed by Sklar[3]. An increase in the number of conjugated bonds is accompanied by an increase in the number of resonance structures, which probably tells upon the absorption spectrum and colour. M. A. Kovner[4] has considered quantitatively the energy-levels and spectrum of hexatriene, and gets good agreement with the known absorption band.

Among the many suggestions for the structure of boron hydrides, one by M. E. Dyatkina and J. K. Syrkin[5] supposes that there are no single electron bonds but resonance between the states $>B^+$ and $>\overline{B}<$, and the structure of B_2H_6 is represented as follows. Two atoms of boron and four of hydrogen are in one plane and the remaining two hydrogens are on a line perpendicular to this plane and passing through the middle of the line B—B at equal distances from the plane. This model represents two distorted tetrahedra having a mutual edge. The model is discussed in the light of the electron diffraction measurements of Bauer and, in the opinion of the authors, is consistent with them. Structures for metal borohydrides are also proposed.

The mechanism of discharge of hydrogen ions has, as is well known, attracted a considerable amount of attention in recent years, and different theories have been proposed. A paper by A. Frumkin[6] gives a survey of his experiments. The lack of agreement of data on the over-voltage on mercury is traced to the deposition of impurities, especially near the electro-capillary maximum. The results with high current densities obtained by other workers are critically considered and shown to be really in agreement with Tafel's equation. Measurements with very low current densities are very difficult, on account of the possibility of depolarization by dissolved oxidants, and the danger of adsorption of surface-active substances. For very low current densities the time lag in charging the double layer also comes in. There is some disagreement with Bowden and Kenyon's results, but not much. The results with dropping electrodes are considered in detail. The shift of half-wave potential with concentration found by Tomeš was not confirmed. A very detailed discussion of the structure of the double layer is given, and, among other conclusions reached, it is shown that results cannot be explained on the assumption that the potential depends only on the distance from the mercury surface.

[1] *Compt. Rend., U.R.S.S.*, **33**, 498 (1941).
[2] *Compt. Rend., U.R.S.S.*, **35**, 43 (1942).
[3] *J. Chem. Phys.*, **5**, 669 (1937).
[4] *Compt. Rend., U.R.S.S.*, **35**, 51 (1942).
[5] *Acta Phys. Chim., U.R.S.S.*, **14**, 547 (1941); *Compt. Rend., U.R.S.S.*, **35**, 180 (1942).
[6] *Acta Phys. Chim., U.R.S.S.*, **18**, 23 (1943).

WORK OF THE LA PLATA ASTRONOMICAL OBSERVATORY

BERNHARD H. DAWSON has a paper with the title, "Observaciones De Planetas y Cometas", published at the La Plata Astronomical Observatory, which deals with his observations during the years 1940–41 (*Obs. Ast. Univ. Nac. de la Plata*, **6**, No. 7). The work was carried out with the equatorial instruments of the Observatory, and the visual observations were effected with the filar micrometer of the refractor with aperture 433 mm., using a dark field illuminated with red light. A brief description of certain methods and precautions to ensure accuracy is given. On several occasions it was found necessary to use relatively faint stars as reference points owing to the limited field, but no difficulty was experienced in this procedure, thanks to the "Astrographic Catalogue".

Photographic observations during the first years of earlier observations at the Observatory were carried out entirely by means of the "Astrographic" objective, aperture 342 mm. and focal length 3,417 mm., but more recently the "UV" objective, aperture 160 mm. and focal length 1,500 mm., has come into general use. It was found that the smaller aperture was largely compensated by the greater clarity of the images, and in addition to certain advantages, its larger field is of assistance in the search for planets of uncertain position, and in other ways as well.

In the photometric work on Eros, compensation of half the apparent motion of the planet was effected during the exposures, so that the images of the planet should present the same aspect as those of the stars, and thus could be compared photometrically. Unfortunately, the atmospheric conditions were not favourable for this work, clouds intervening on many occasions. A table shows the positions of Eros during May 28–September 26, 1940, and another table supplies details of the photometric observations during June 11–August 23 in the same year.

Positions of Comets Cunningham, 1940 *b*, Whipple, 1940 *d*, van Gent, 1941 *d*, and Schwassmann-Wachmann, 1941 *f*, are also supplied for a number of dates.

Gualberto M. Iannini has published three papers with the titles, "Medidas Micrometricas De Estrellas Dobles"; "Posible Movimiento Rectilineo De β 311"; and "Una Nueva Determinacion De La Orbita De Ψ Argus" (*Obs. Ast. Univ. Nac. de la Plata*, **6**, No. 8). The first of these papers describes the author's measurements of double stars. The micrometer was used in connexion with the equatorial refractor, aperture 433 mm., and the measurements were generally made when the hour angle was less than two hours. Six readings of the position angle were taken, three with the eyes parallel to, and three with the eyes perpendicular to, the micrometer wires, thirty-six stars in all being dealt with. Details of the results are set out for each star in columns which supply the year and fraction of a year of the observation (1900 being taken as the basis), position angle observed, mean distance, etc.

The second paper deals with the possibility of rectilinear motion of the system β 311, the components of which are of magnitude 6·7 and 7·0. The equations expressing the movement of the system in right ascension and declination show that there is an annual relative movement of 0·0182″ in a direction 130·25° and a minimum distance of 0·336″, with an angle of 40·25° for the year 1941·5. A table gives the relation between observation and calculation, from 1875·92 to 1937·08, and with two exceptions, it shows that the hypothesis of rectilinear motion is satisfactory. A definitive solution of the problem, however, cannot be effected at present.

In the third paper the elements of the orbit of Ψ Argus are re-determined from forty-one observations. The companion having made considerably more than a revolution since its discovery in 1883·3, the two dynamical elements can be determined by means of a graphic method, and the other elements were obtained by the method of Zwiers. Residuals revealed the presence of a systematic error, and corrections were applied which gave a new orbit. It is interesting to know that Van de Bos had also revised the orbit and his results, not yet published, were brought to the notice of Iannini after the completion of his work. With the exception of *a*, the two sets of elements differ by amounts which do not exceed 2½ times Iannini's mean errors.

MAN: THE FIRE-USING ANIMAL

ON March 8 last the Association of Czechoslovak Scientists and Technologists was addressed by Dr. G. W. Himus on "Man: The Fire-Using Animal". Although the lecture started with an account of the origin and the rise of the use of fire by mankind—or as suggested 'fuel squandering'—in the main it surveyed the present state of fuel supplies and prospective fuel technology in Great Britain. Noteworthy is the slowness with which Great Britain became conscious of the importance of efficiency in getting and consuming coal—doubtless owing to the abundance, high quality and cheapness of British coal together with the slender scientific outlook. Without this, waste cannot be recognized, still less corrected. Moreover, in some industries, the cost of fuel is a relatively small item of the cost of production and consequently failed to arouse the attention of the management.

Nevertheless, a time arrived when the importance of a more rational use of coal came to be recognized. It was even found worthy of a place in university studies—at Leeds in 1906, at the Imperial College in 1912, while the Fuel Research Board was established during the War of 1914–18. The two Wars which followed shook the complacency of the State and industry, by the scarcity and steep rise in prices, and in the present War, by the development of acute scarcity.

Although, during the past, knowledge of efficiency in the use of fuel has advanced, experience in the national campaign for fuel saving has revealed a lag in the application of this knowledge. The author illustrates the advance in fuel efficiency by the performances of large industries accustomed to employ considerable technical assistance. These include the public utilities, iron and steel industries and the coal mines. The net saving of coal of these in the period between the two Great Wars is estimated by the author to reach thirty-two millions of tons of coal per annum, while the total saving may be considerably higher. This is a very large quantity of fuel, to supply which would have been a great embarrassment to the Ministry of Fuel and Power to-day.

Some matters of importance, both topical and future, are examined. Emphasis is given to the need for greater application of technical training for the smaller industrial units—possibly by co-operative effort. The sale of solid fuel in small quantities by weight without allowance for calorific value is criticized. It must, however, be recognized that there are peculiar difficulties, and in some countries solid fuel is sold by volume. The heating value of gaseous fuels in public supply can be easily controlled, whereas it cannot vary appreciably in the case of liquid fuels of given chemical character. Moreover, coal as mined contains variable proportions of incombustible matter, sometimes hard to separate. It is often overlooked that the cleaning of coal involves the production of considerable quantities of coal 'fines' or 'slurry' of little or no commercial value, while accumulations of small coal, if ignited, may become a public nuisance. For steam raising, it is considered possible that consumers will have to adapt themselves to the use of a lower grade of coal. Already the need for widening the range of fuel in use has caused official encouragement to be given to the installation of suitable mechanical equipment.

The lecture mentions a number of fuel problems still in the more speculative stage, and in all gives an interesting survey of the questions now in the minds of modern fuel technologists. H. J. HODSMAN.

FORTHCOMING EVENTS

*(Meeting marked with an asterisk * is open to the public)*

Saturday, October 14

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—Mr. H. Emmett: "Cinemicrography of Crystal Growth"; Mr. R. McV. Weston: "Cinemicrography in Biological Research".

Monday, October 16

INSTITUTION OF ELECTRICAL ENGINEERS (LONDON STUDENTS' SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—"Brains Trust" Meeting.

ASSOCIATION OF AUSTRIAN ENGINEERS, CHEMISTS AND SCIENTIFIC WORKERS IN GREAT BRITAIN (at the Austrian Centre, 69 Eton Avenue, Hampstead, London, N.W.3), at 7.30 p.m.—Mr. E. Pribram: "Jet Propulsion, Rocket Propulsion".

Tuesday, October 17

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 2 p.m.—Mr. Cornelius Davies: "Harvesting Machinery".

SOCIETY OF CHEMICAL INDUSTRY (AGRICULTURE GROUP) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. H. C. Gough: "Soil Insecticides".

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. Innes H. Pearse: "The Health Centre and the Family".

CHEMICAL SOCIETY, the ROYAL INSTITUTE OF CHEMISTRY, and the SOCIETY OF CHEMICAL INDUSTRY (EDINBURGH SECTIONS) (joint meeting with the EDINBURGH UNIVERSITY CHEMICAL SOCIETY) (in the Medical Chemistry Lecture Theatre, The University, Teviot Place, Edinburgh), at 7 p.m.—Prof. G. F. Marrian, F.R.S.: "Some Aspects of Heroid Metabolism".

Wednesday, October 18

INSTITUTE OF FUEL (NORTH-WESTERN SECTION) (at the Engineers' Club, Albert Square, Manchester), at 2.30 p.m.—Mr. G. N. Critchley: "The Economics of Saving Fuel, with particular reference to the Insulation of Steam Ranges".

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. H. W. Grimmitt: Inaugural Address as Chairman.

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at Wigmore Hall, Wigmore Street, London, W.1), at 6.30 p.m.—Discussion on "The Safeguarding of Key Industries" (to be opened by Mr. Norman Sheldon).*

IRON AND STEEL INSTITUTE (joint meeting with the MANCHESTER METALLURGICAL SOCIETY and the INSTITUTE OF METALS) (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Prof. H. W. Swift: "Deformation of Metals".

Thursday, October 19

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. Wilson Baker: "Non-benzenoid Aromatic Hydrocarbons" (Tilden Lecture).

INSTITUTE OF FUEL (EAST MIDLANDS SECTION) (in the Lecture Theatre of the Nottingham Corporation Gas Department, Parliament Street, Nottingham), at 3 p.m.—Dr. E. W. Smith and Mr. Theodore Turner, K.C., will speak at a Conversazione.

SOCIETY OF CHEMICAL INDUSTRY (ROAD AND BUILDING MATERIALS GROUP) (at Gas Industry House, 1 Grosvenor Place, London, S.W.1), at 5 p.m.—Mr. D. C. Broome: "The Substitution of Coal Tar Pitch for Asphaltic Bitumen in Building Mastic".

SOCIETY OF CHEMICAL INDUSTRY (NEWCASTLE SECTION) (at the King Edward VII School of Art, King's College, Newcastle-upon-Tyne), at 5.45 p.m.—Mr. J. Brown: "Assay of Coal for Carbonisation Purposes".

Friday, October 20

INSTITUTION OF ELECTRICAL ENGINEERS (MEASUREMENTS SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. W. G. Radley: Inaugural Address as Chairman.

INSTITUTION OF MECHANICAL ENGINEERS (at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Dr. H. R. Ricardo, F.R.S.: "Applied Research" (Presidential Address).

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Lecture Theatre of the Literary and Philosophical Society, Newcastle-upon-Tyne), at 6 p.m.—Annual General Meeting. Sir Summers Hunter: Presidential Address.

Saturday, October 21

BRITISH RHEOLOGISTS' CLUB (at the University, Reading), at 2.30 p.m.—Annual General Meeting. Discussion on "The Measurement of Tack" (Introductory Papers by Dr. N. A. de Bruyne and Dr. R. F. Bowles).

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield, 1), at 2.30 p.m.—Mr. A. Preece: "The Oxidation of Steels in Furnace Atmospheres".

QUEKETT MICROSCOPICAL SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Dr. Nellie B. Eales: "Some Aspects of the Malaria Problem".