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LEADERSHIP IN WORLD RECONSTRUCTION

THE agreement which has recently been signed by the Governments of Jugoslavia and Greece, establishing a Balkan union, like the subsequent announcement that the Czechoslovak and Polish Governments in London had reached agreement on certain basic principles of the confederation to take place after the War, is a reminder that the shaping of the New Europe is already taking place. The extent to which these agreements, clearly regarded both as the nucleus of a wider federation and as steps towards the consolidation of fluid national structures and anarchic political and economic conditions, embody the principles enunciated in the Atlantic Charter, no less than the fact that they have been reached in London, is a token of an inevitable measure of Anglo-American leadership in the New Europe.

It is for this reason that the question of Great Britain's relation to Europe calls for such careful study at the present time. There is, moreover, a further reason, stressed by Mr. P. J. Noel-Baker in the recent debate on the War in the House of Commons. Among our other vital needs, he said, is a European Council or some new and better machinery of European collaboration, because of what might happen in 1942. If we are to deal a mortal blow at the Axis through one of its main weaknesses—its moral bankruptcy—we must make a tremendous effort at political education to show the enemy peoples that our victory is in their own true interests.

That effort involves a careful study of the relation of Great Britain, and indeed of the United States also, to Europe, and gives pertinence to the able analysis already prepared by the Reconstruction Committee of the Royal Institute of International Affairs. Much more indeed is involved. We cannot expect to achieve moral ascendancy and victory without setting our own house in order. There is a sense in which, as Dr. C. H. Gretton argues ably in his recent volume under that title, victory begins at home, and the moral basis of victory, overshadowed in most, though not in all discussions of war aims—Barbara Wootton's "End Social Inequality", in the Democratic Order series of pamphlets is a further example—may well prove to be the decisive factor in either a long or a short war. Decisive victory even over an unjust foe may be delayed until we have cast out our own social injustices and planned our national economy on a rational and just basis. Only the most superficial thinking can dismiss the examination of reconstruction as irrelevant to the mobilization of our full war effort, apart from the necessity of being prepared for the task of reconstruction after the War.

Granted the necessity of a moral basis for reconstruction and its value as a weapon in the supremely important political offensive, the great need, as Dr. J. A. Bowie points out in a Saltire Pamphlet*, is

* The Basis of Reconstruction. By Dr. J. A. Bowie. (Saltire Pamphlet No. 1.) Pp. 38. (Edinburgh and London : Oliver and Boyd, 1941.) 1s.

for factual knowledge. A clear picture of the problems involved is a first essential to further investigations, and the great value of the P E P broadsheet, "Britain and Europe", and the Democratic Order pamphlet, "Reconstruction and Peace", by "Balbus" *, and the programme outlined by the Reconstruction Committee of the Royal Institute of British Architects, lies in the contributions offered to that end. The objectives thus visualized and alternative lines of policy outlined lose none of their value by being based on such assumptions as the military defeat of Germany, the continued co-operation of the Dominions and of the United States after the War, and sufficient unity and steadiness in the public mind to permit the effective application of a consistent and reasonable policy.

It is a common feature of all the pamphlets referred to above that they recognize the necessity of distinguishing between the measures to be adopted immediately after the Armistice and those more permanent measures or policies required later. To some extent they all also recognize that the purpose of Britain's European policy and her general conception of her relation to other European policy must be determined on the basis of the essential facts governing our relations to Europe—geographical situation and communications, population and social standards, industrial and economic potential, political ideas and institutions.

Short-term measures and long-term policy cannot be determined in complete separation, and the British and the American peoples must make an early decision as to whether or not they will accept their responsibilities for leadership in Europe. If an affirmative decision is to command the support that alone can make it effective and win the confidence of the European peoples, it must be based on a full survey of the situation. Moreover, the existing Inter-Allied Council is in itself a guarantee that the measures calling for immediate consideration or action immediately the War ends, such as the occupation of Germany or other territories, the economic and social needs of Europe, such as relief food supplies, prevention of disease, housing, the refugee problem, credit and currency measures, the establishment of orderly government and of civil and political rights wherever required on the Continent, will be dealt with in collaboration with other Governments and with regard for their contribution.

What is essential is that these immediate measures should not be framed without regard to the long-term problems. Here the governing question is that of our relations with Germany and the measures to be adopted to remove the risk of future German aggression. A sound choice between the two alternatives of a policy of co-operation designed to create among the German people a real interest in, and will towards, peace, and a policy of enforced subordination of Germany designed to remove her power to disturb the peace, must be based not alone on a study of the facts and of the implications of those alternatives, the risks implicit in them, the demands each policy would make on us, and the machinery of political co-operation required to give it effect. It must also be based on thinking in terms of Europe and of the role of the German people within the European whole. Only so can we avoid the dilemma of two irreconcilable propositions, which at first sight the German question appears to present.

It is in the long-term economic and social problems that the way of escape from the German dilemma appears to open before us, as is well shown by "Balbus". Here we must first seriously consider the possible choices: a return to the ideal of a great commercial republic, with the implication that the possibility of any country having an autonomous policy is severely limited, or an economy more or less planned to secure economic or social security. That again involves examination of such questions as the practicability of insulating national economy and of running a social security policy on a truly international basis. At this point we link up once more with the question of internal reconstruction, and of the extent to which effective British leadership is possible unless we can show definite domestic achievement in the field concerned.

These questions, indeed, rather than the form of the international machinery required, are the immediate live issues. Much of the machinery created for co-operation in war may serve equally well the immediate purposes of post-war relief, practical reconstruction and the planning of Europe's agricultural and industrial life. Out of the experience of such work, as Dr. Bowie suggests, may develop the political forms necessary to sustain and extend it. By such association for common ends, and the deliberate promotion of understanding of cultural and political values, will come faith and vision widely held, on which it will be possible to base such specific organizations as a European or world federation.

Much the same approach is found in the P E P broadsheet. There the task of building a European commonwealth is seen as consisting of two parallel processes. First, the establishment by Britain and the Allies of a permanent ascendancy over the aggressors, providing the framework of order and security within which the New Europe can begin to grow. Simultaneously with this is the second process of reconstructing and developing European life in the direction of a social and economic and cultural community, which all its citizens have a common interest in maintaining and furthering, and to which all of them, Germans and Italians as well as Danes, Dutchmen, Spaniards and the British, will come to feel a loyalty commensurate with their loyalty to their own countries. To give the New Europe the flesh and blood which alone can make it a living and lasting reality, the peacemakers must set out consciously and boldly to build a European community into which the national communities will slowly merge.

As to the measures by which such broad objectives are to be achieved, in the first stage the broadsheet visualizes a programme of first-aid relief with the necessary organizations, all plans for this emergency period being drawn up as integrated parts of a general

* Reconstruction and Peace: Needs and Opportunities. By "Balbus". (The Democratic Order, No. 10.) Pp. 64. (London: Kegan Paul and Co., Ltd., 1941.) 1s. net.

plan, related to a clearly formulated pattern of the future Europe. Both the planning and the execution of the programme should be put in the hands of a unified authority or European reconstruction commission, created with wide autonomous powers for the purpose and not left to independent action by the British or any other Government. The second stage will be the development of a new, more coherent, economic and social system in Europe. On the economic side, the system must be directed to the welfare of the peoples of Europe and the progressive raising of their standards of living, and the use of Europe's resources for that purpose should be planned for Europe as a whole and for five- or ten-year periods at a time, not on a year-to-year basis.

On the social side the problem of restoring order out of the disintegration following the collapse of Nazism and Fascism will be urgent, and out of the emergency institutions improvised may grow new social forms of lasting value in European life. Indeed, the key to the restoration of social stability may well be the rebuilding and development into new forms of those cultural and other institutions which are the life-blood of a free community, but which have been persecuted or suppressed in totalitarian Germany—the universities, churches, trade unions, professional organizations, the free Press and the radio. It is here that the long experience of the British people of the value of these institutions in the life of the community gives them such a great opportunity for moral leadership, and, while in the early stages British, Dominion and American personnel are bound to play a leading part in the development of individual leaders, the contribution of the free peoples already represented in Great Britain, whether as émigrés or as refugees from the Nazi tyranny in Europe, will be of the utmost importance in building up a European *élite*. The broadsheet indeed includes a notable suggestion for a special European staff college for training European personnel, possibly linked to the universities as a centre of post-graduate training and research.

The ways and means thus outlined, like the broad objectives they are intended to secure, do not differ greatly except in detail from the broad proposals of "Balbus", who lays first emphasis on reconstruction as insurance against chaos and bloody revolution. His careful analysis of needs and of the mistakes made after 1918 is dominated by a sense of the opportunities which are ours if we are bold and imaginative enough to seize them. The mistake of allowing private finance to dominate reconstruction work must not be repeated, and one of our first aims must be the organization of the State as an instrument of service to society. This responsibility for providing adequate security and freedom to the individual carries as corollary the obligation of a comprehensive scheme of national service from the individual.

"Balbus" sees in the schemes for relief already being mapped out by the Leith-Ross Bureau and elsewhere the stepping-stones to schemes for the development of the backward areas of Europe and Africa and the stimulation of a high level of world trade and production by raising the standard of life and the level of purchasing power in such areas. He stresses the health services and medical work, including the full utilization in Europe of all available medical personnel, notably the considerable number of refugee medical men in Great Britain and in the United States. He urges a reconstruction commission backed by international authority and armed with sufficient powers of control to ensure that neither the profit motive nor political considerations interfere with the task of re-equipping Europe. The problem must be worked out in concrete terms of needs, materials and man-hours. While he would defer the discussion of political reconstruction, he utters a warning against staking too much on economic planning and unduly neglecting political organization.

By placing all relief and reconstruction under an official reconstruction commission, priorities could be enforced which would raise the standard of life in Europe as rapidly as possible, help to develop backward areas, and impose an industrial structure which would cut across national boundaries and place grave difficulties in the way of economic autarchy. The foundation of a raw materials union should be laid in a scheme with adequate consumer representation; and by utilizing the reconstruction commission as its European agency, reconstruction could be linked with development. Moreover, the more effective these economic institutions the less paramount will become the purely political organs of power in Europe.

Such an empirical approach is in accordance with the experience of the British Commonwealth, but the acceptance by Britain of a leading position in Europe means the acceptance of responsibilities on a scale we have scarcely begun to realize. It is not merely a question of keeping an army and air force in Europe perhaps for years to come—which, as the broadsheet observes, may well entail the continuance of conscription at home and of the great Empire air-training effort in the Dominions. It is not merely a question of finding and training the extensive administrative personnel needed for the task—itself scarcely to be achieved without a drastic overhaul of the existing machinery of government and methods of selection of personnel. It is also a question of effecting a revolutionary change in our whole outlook and way of life.

First, there must be a new attitude towards Europe, both among statesmen and people. Only those statesmen can be leaders in Europe who look at things through European and not through parochial eyes, and are prepared to sacrifice what appears to be their own immediate national interests when they conflict with the true interests of Europe. Such an attitude involves a corresponding attitude among the British people and an intensive development of British education in foreign affairs to ensure that the British people regard the affairs of Europe with a more informed and realistic view.

Secondly, since the only enduring leadership is leadership by example, part of our effort for victory should consist not only in framing a vision of a world more acceptable to ourselves and to the people of Europe, but also in giving an earnest of our faith by beginning its application here and now. It is certain that Britain cannot even be the agent of Anglo-Saxondom in Europe, and promote that vital American interest in the emergence from this War of a stable and prosperous Europe, integrated into the economic life of the world, and led by statesmen who share the fundamental beliefs and values of the American peoples, unless those statesmen see in the peoples of Great Britain and the United States a dynamic and forward-looking society. To set our own house in order, and at the same time to work out for ourselves and for Europe a new and more satisfying social philosophy than either we ourselves have possessed in the past or than Europe has been offered in the existing Continental ideologies is one condition of our retaining our position in Europe. It offers not merely one of the surest prospects of continuing accord in Anglo-American relations, but also an opportunity of seizing the great opportunity that has opened in Anglo-Soviet relations.

Stimulating and suggestive as are the pamphlets referred to above, they are still more welcome for the evidence that constructive minds are already at work probing the problems and seeking to mould the mind of the nation to grasp its opportunities, and to uphold the affirmation of the Atlantic Charter that we will not once again leave unfinished the job we have taken in hand.

FORM AND CHARACTER

Why Men Behave Like Apes and Vice Versa

Or Body and Behavior. By Earnest Albert Hooton. Pp. xxv+234+22 plates. (Princeton, N.J.: Princeton University Press; London: Oxford University Press, 1941.) 18*s*. 6*d*. net.

THE present eclipse of anthropology as an active science, while no doubt partly a result of the War, is very largely an outcome of the growth of nationalist doctrines in Europe during the past decade. Ever since the rise of Hitler, reputable anthropologists have been abandoning orderly scientific work in order to devote more and more of their energies to refuting *a priori* doctrines of race—for example, those which form part of the foundation of Nazi political philosophy. The immediate result has been the transformation of the international anthropological scene into one camp of propagandists which supports such doctrines, and another the main purpose of which is to expose their lack of scientific basis. A more serious consequence of the politico-racial 'red herring' is that human biology, which may be conceived as the discipline the responsibility of which is to co-ordinate studies of the biological history and relationships of different peoples, as well as studies of their genetic make-up and behaviour, has been largely side-tracked into unprofitable polemics. These fields of inquiry will have to be explored again if there is to be any sustained rational approach to the wider social problems, not least of which are the Colonial problems, which must be faced at the end of the War. That they will emerge in full vigour is certain, not only because of necessity, but also because of the enthusiastic faith shown in this field of correlated studies by a small band of devoted anthropologists and social biologists.

Prof. Hooton is one of this band in the United States. In Great Britain he is already well known for a popular exposition of human evolution entitled "Up from the Ape". Like his earlier work, "Why We Behave like Apes and Vice Versa" is wittily and vigorously written in terms understandable to the general reader, and is in scope wide enough to include both factual statements about a mass of recent findings in various fields of study and provocative opinions on a number of current topics. Its purpose is to inquire into the extent to which differences in the physical make-up of different peoples determine differences in behaviour. Perhaps it would be more correct to say that its purpose is to disclose Prof. Hooton's profound conviction that the one does influence the other, and that "environmentalists" are incorrect in attributing differences in social behaviour of different groups entirely to differences in social surroundings, habit and opportunity. For, if anything, Prof. Hooton overstates a case which few students would care to dispute. He himself would be the last to deny the view that external factors do influence behaviour, yet the polemical form of the discourse frequently makes one feel that, to prove his own point, he would go very far in disregarding them.

The book opens with an account of the functional relationships and differences in behaviour of different types of monkey and ape. This leads to the conclusion that in the sub-human categories of the order of Primates "behaviour is probably as diversified as organic structure and indissolubly associated with it" —although probably conditioned and altered by environmental adaptation. From this conclusion Prof. Hooton passes to a brief consideration of the essential differences between the human and sub-human primate, and then to a discussion of the physical and cultural diversity of prehistoric man. Again the conclusion is drawn that two types of fossil man, the Sinanthropus-Pithecanthropus group and the Neanderthal group, were almost as differentiated in behaviour as in anatomical characters.

The discussion then moves to existing man, who culturally is broadly classified according to whether his method of subsistence is "artificial" or natural, that is, food-gathering and hunting. The "artificial" group is again subdivided into "civilized" and "uncivilized" sections, which distinguish a stage of urbanization from a predominantly rural and agricultural phase of life. Prof. Hooton believes that the cultural differences between savages and countrymen on one hand, and urban dwellers on the other, are paralleled by physical differences mostly imposed by differences in motor habit arising out of their different ways of life. More detailed racial differences are also posited by Prof. Hooton, who then proceeds, by a consideration of examples from the main divisions of the human species—the Australoid, Negroid, Mongoloid and the White—to show that race may be coterminous with culture, as well as that the two are sometimes mutually independent. Their association seems well marked in such 'primitive' types as the Australian aboriginal and the South African Bushman. Their independence is, of course, usual in large mixed populations. Prof. Hooton concludes his dissertation with a vigorous statement of his belief in the existence of distinct physical types in mixed white populations and in their association with specific forms of behaviour.

It is here that the more cautious student may be inclined to find Prof. Hooton's conclusions somewhat too far in advance of the facts, and his advocacy of certain points too vigorous. The general view that physically similar individuals behave alike he has answered—as he puts it, to his own satisfaction and to the "frenzied disapproval" of others—by a study of the correlation between types of criminal offence and different physical characteristics. The original data are not discussed in the book under review, but, neglecting altogether for the moment the question of the possible correlation between crime and social and economic status, one may be permitted to make the general observation that, since conventions of 'crime' differ between different peoples and at different times, the correlation suggested by Prof. Hooton might not hold in a social environment different from the one in which he studied it.

Furthermore, while a definition of constitutional types is broadly possible, and in general referable to certain psychological distinctions—a relation which even the non-scientific man has for centuries recognized—the detailed classification of physical types which Prof. Hooton accepts presents too many anatomical shortcomings (many of which he himself points out) to justify wide generalization.

A further difficulty is that Prof. Hooton often gives the appearance of confusing the question of racial differences with that of the correlation in a mixed population of different patterns of behaviour with specific physical types. Both problems are immensely important, but they are largely distinct—even though they may overlap. Racial types cannot be created *a priori* by the anthropologist—notwithstanding Prof. Hooton's assertion that in classifying men on the basis of physical resemblance he would be prepared to put siblings, if necessary, in different racial groups.

The anthropologist's responsibility is to define the physical and psychological characteristics of declared racial groups the individuals of which are linked in blood-ties—and to do this not only in the isolated pockets of humanity where a correlation may be found between racial type and behaviour, but also in regions where a declared racial type has spread into an environment in which specific patterns of behaviour, and even specific physical characteristics, no longer remain immediately obvious. Isolation—either physical or psychological—and conversely the opposite of isolation, may be far more potent determinants of social behaviour than racial physical characters. Until the relative strength of the two factors has been decided by the most rigorously controlled observation, wide generalizations such as "human evil is not a product of human institutions but of human beings" will continue to be dangerously double-edged.

So, too, it is perhaps premature to follow Prof. Hooton in his far-reaching eugenic predictions about the possible effect of family limitation on the physical and social character of future populations. If indeed we knew enough about human biology to produce the 'better' men to whom he looks forward, why limit their number as he would have us do ? Why not fill the world with them ? The manner in which these particular views are put forward suggests, however, that some of them are Prof. Hooton's demonstrations of kite-flying, while others are Aunt Sallies, which he occasionally knocks down before the reader has a chance to get at them.

The total effect which Prof. Hooton has produced is a readable, stimulating and amusing book which demonstrates the scope of the conclusions that could be reached with fuller knowledge.

S. ZUCKERMAN.

AGRICULTURE ON A NATIONAL SCALE

Agriculture's Challenge to the Nation

By Arthur Smith. Pp. x+236. (London and Toronto : William Heinemann, Ltd., 1942.) 8*s*. 6*d*. net.

ONE of the hopeful features of our national life to-day is the widespread interest now being taken in our agriculture. Rarely have so many policies been propounded or books issued, which clearly the public is prepared to buy. There is a growing tendency to expect the State to take a larger and larger part in the business, though how far this would survive in actual practice would remain to be seen.

In the present book Mr. Smith goes further than most of his predecessors, and almost makes the farmer and the farm worker into salaried officials ; at least the risks are to be more heavily shouldered by the State and the returns both to farmers and workers are to be increased.

The author sets out to bring into use some forty-seven million acres in the United Kingdom, sixteen million being arable and thirty-one million grass. This is, of course, considerably more land than is in agricultural use at present, and the scheme necessitates a good deal of reclamation and development of rough grazings and deer forests. The main arable crops would be oats, of which there would be four million acres, half for human consumption and half for poultry and other livestock ; next would come wheat and lucerne in the dry areas ; and then enough sugar beet to provide our pre-war sugar allowance and sufficient barley to give a "reasonable drink allowance". Haymaking would be replaced by ensilage and grass drying. Beef production would be eliminated as too costly in feeding-stuffs, but as milk production is to be increased it is not at all clear what use is to be made of the bull calves inseparable from that activity. For you cannot have milk until the cow has produced a calf, and she has to go on producing a calf annually if her milk yield is to continue. Approximately half her calves are males useful only for conversion into beef. Sheep, pigs and cattle would be pastured on the hill lands, the cattle being used for butter production.

Prices would be such that the men workers would receive a minimum wage of 60*s*. a week for forty-eight hours and the women and youths would receive 48*s*. There would be processing factories in the villages at which other members of the family could work. A family might as a whole be drawing £15 weekly. The farmer would be paid according to the area of land he occupied. He would live free of rent, rates and taxes on the land he farmed. He would receive free of charge all implements and machinery, seeds, fertilizers, stock, etc., necessary to his farming, and in addition a salary of £4 per acre on the first fifty acres, £3 per acre on the next 150 acres, £2 per acre on the next 150, and £1 per acre on all acres above 350. In return, the produce would belong to the nation.

There is little doubt that farmers in Great Britain would be interested in a scheme of this sort which goes far beyond their most sanguine hopes. But the crux of the problem is this : Would the nation ? Until some big national pronouncement is forthcoming, policy-making remains uncertain.

E. J. RUSSELL.

PHYSIOLOGY OF THE AMINO ACIDS*

By DR. DONALD D. VAN SLYKE
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THE number of proteins in the animal and vegetable world appears to be infinite. Yet they are all constructed of a relatively few units, namely, the amino acids. These amino acids in number are about equal to the letters of the alphabet. They have an extraordinary facility for being joined in chains; each amino acid has the same head and tail, so that the tail of one can link with the head of another, and the linking can be repeated apparently times without limit. Each amino acid has an H_2N, or amino group, which has an alkalinity about equal to that of ammonia; and each has a COOH or carboxyl group, which has an acidity about like that of citric acid. There is also a chemical group, *R*, which is different in each amino acid, and gives it its character as an individual. Hence we may call the *R* group the *individualizing* group of each amino acid. The amino and carboxyl groups neutralize each other, so that if the individualizing group is neutral the amino acid is neutral; such are alanine, glycine, leucine. However, if the individualizing group is alkaline the amino acid is alkaline; such are lysine, arginine, and histidine.

Aside from its acid or basic properties, each individualizing group bears other chemical properties. In serine, threonine, and hydroxylysine, for example, the individualizing group bears a hydroxyl with all the reacting powers of an alcoholic hydroxyl. Again, the individualizing group may carry a second carboxyl; then the amino acid is strongly acidic: such are aspartic and glutamic acids.

In cystine and methionine the individualizing group has a sulphur atom. The cystine sulphur can take up a hydrogen atom to form cysteine, and when this occurs to cystine in a protein molecule the entire character of the protein is changed. In wool and hair the sulphur is in the oxidized -C-S-S-C- form of cystine, and the proteins are utterly insoluble and indigestible. If the -C-S-S-C- is reduced to two -C-SH groups, forming cysteine, the wool is changed into proteins which are easily digested.

In proteins Emil Fischer demonstrated that the amino acids are joined, head to tail, by what he termed peptide linkings, each NH_2 group condensing with the COOH of another amino acid, with elimination of the elements of water. Simple chains of a few amino acids Fischer termed peptides. The dipeptide glycolalanine still has a free NH_2 group and a free COOH, where two more amino acids can be linked on, and the process can be repeated *ad infinitum*.

The proteins are peptides of tremendously long chains. These chains seem usually to be rolled into balls, like balls of yarn, or otherwise made to take globular or ellipsoid shape, for their rates of diffusion were found by Northrop and Kunitz to approximate to those calculated for spheres. Exceptions are the fibrous proteins, silk and wool, of which the molecules themselves appear to be extended into fibres.

In the human stomach the protein molecules meet the pepsin of the gastric juice, which unrolls the balls and breaks the overgrown chains into shorter ones, which are still fairly long, and go under the general name of 'peptones'. The chief visible change in the stomach, as noted a century ago by Beaumont in the stomach of Alexis St. Martin, is that proteins which enter the stomach as insoluble matter, such as meat or coagulated egg white, leave the stomach and enter the intestine largely changed to soluble material.

We may pause here to point out one fallacy that has crept into the practice of medicine through a perfectly correct observation by Beaumont. He noted the times necessary for various foods to remain in the stomach before they were turned into soluble material and passed on into the intestine. He found that raw egg albumin was one of the quickest protein foods to pass through. From this it has been concluded that raw egg white is one of the most easily digested proteins. The fact is that it is one of the most resistant to digestion. It passes quickly and easily through the stomach because it happens to be soluble, and it reaches the intestine largely in its original undigested state. The digestive reserves of the intestine are so great that they normally complete the work of breaking down the egg protein chains. However, the egg protein is one of those which are most likely to be absorbed in the undigested state, and to cause sensitization, particularly in infants. In fact it is said that raw egg white fed to an infant has been observed to be absorbed in such amounts that it reappeared in the urine. The most digestible form in which egg proteins can be fed is that obtained by coagulating them with thorough cooking, and then breaking the material into finely divided particles by passage through a sieve.

In the intestine the gastric products meet the enzymes secreted by the pancreas and the intestinal wall. It used to be thought that the trypsin of the pancreas had the power to break at least part of the peptide chains completely to amino acids, but it now appears that trypsin can carry the digestion no further than to the stage of peptides of the average size of six or seven amino acids per peptide molecule.

Dr. Robert Dillon and I succeeded some years ago in devising a method of analysis which was specific for free amino acids. It depended on the ability of a mild oxidizing agent called ninhydrin, which first attacked the amino group of the amino acid, breaking off NH_3 from the *R*.CH(NH_2).COOH, and leaving in its place the keto acid *R*.CO.COOH. Boiling decomposes the keto acid into aldehyde and carbon dioxide. The actual analysis consists merely in boiling the amino acid and ninhydrin together and measuring the carbon dioxide evolved.

For the series of reactions that end in the evolution of carbon dioxide it is apparent that one must have *both* an NH_2 group and a COOH group in adjacent positions, and this is the definition of an alpha-amino acid. If either the NH_2 or the COOH group is tied up in a peptide linking, the reaction cannot go through to a finish and no carbon dioxide is evolved.

With this method Dr. MacFadyen, who followed Dillon in our laboratory, was able to show that purified crystalline trypsin splits protein to peptides, but not to free amino acids, but that 'crude trypsin', comprising a mixture of the pancreatic enzymes, goes much further and splits many of the peptides into free amino acids. It is evident that the pancreas produces peptidases as well as trypsin, but that pure trypsin is not a peptidase with the power to accomplish the last step of protein hydrolysis, namely, to set the amino acids free.

Although the trypsin alone does not carry digestion to the stage of free amino acids, experiments both

* Substance of a paper read at the Fifteenth Anniversary Celebrations of the University of Chicago on September 23, 1941.

in vitro and *in vivo* have shown that the mixture of pancreatic and intestinal enzymes does produce free amino acids. Whether all the protein products in the intestine are digested to free amino acids before they are absorbed is not certain, but it does appear that the greater part of these products are absorbed as free amino acids. The evidence of this is that during protein digestion there is an increase in the free amino acid content of the mesenteric blood, and also of the blood of the general circulation, but reliable methods have failed to demonstrate an increase in peptide nitrogen, of which very little is present.

The speed with which digestion begins was evidenced by experiments of Cullen and McLean in which dogs were fed meat, and the blood was analysed for urea at short intervals. Within fifteen minutes the blood urea content had risen 10 per cent, indicating that a measurable part of the protein had already passed through all the stages, not only of digestion, but also of absorption and degradation. The process once started goes on steadily until absorption of the ingested protein is completed. The length of time required for completion varies in proportion to the amount ingested, but is usually 2–4 hours.

To find where the absorbed amino acids were taken from the blood, and what happened to them, Cullen and McLean anæsthetized dogs during digestion and quickly drew blood from the portal vein between intestine and liver, from the mesenteric vein leaving the liver, and from the vena cava, where blood from all the tissues is mixed. It was found that the amino acid content of the blood rose about 20 per cent as the blood perfused the intestines, and that the greater part of the absorbed amino acids were removed by the liver. In return, the liver poured into the blood of the hepatic vein an amount of urea nitrogen which almost balanced the amino acid nitrogen that had been taken up. One could watch the work of the liver in taking up the amino acids and destroying them, turning their nitrogenous parts into urea for excretion by the kidneys.

Other experiments, performed with Dr. Gustav Meyer, showed that the liver did not get quite all the absorbed amino acids, but that some escaped, and could be absorbed by other tissues. In order to magnify the effects of such absorption blood amino acid concentrations were raised to high levels by intravenous injection of amino acid solutions. Portions of muscle, kidney, and liver tissue were analysed for amino nitrogen before and after the injections. It was found that even in the fasting animal the amino acid concentration in the tissues was about eight times as great as in the blood plasma, namely, about 40 mgm. of amino acid nitrogen per 100 gm. of tissue, compared with 5 mgm. per 100 gm. of plasma. When amino acids were injected the amounts taken up by the glandular organs were much greater than by the muscles. The content of the muscles in amino acid nitrogen rose to about 60 mgm., of the kidneys to about 80 mgm., and of the liver to about 120 mgm. per 100 gm. of tissue. During the next three hours the amino acids in the muscles and kidneys remained practically unchanged, but the amino acids in the liver almost fell back to their original level, and an equivalent of urea nitrogen appeared in the circulation.

The evidence in these experiments, that the liver is the organ where urea formation takes place, supported an ancient but much contested hypothesis that the liver is the only organ that forms urea. Its unique distinction in this power was clinched by Bollman, Mann, and Magath, of the Mayo Clinic, who showed that removal of the livers from dogs led to an accumulation of amino acids in the blood, and entirely stopped the formation of urea.

The chemical steps by which the nitrogen of the amino acids is converted by the liver into urea have been demonstrated by Krebs. The nitrogen is first oxidized off as ammonia. Two molecules of ammonia then combine with one of the diamino acid, ornithine, to form the 4-nitrogen amino acid arginine. The arginine is then hydrolysed by the enzyme arginase in the liver, with formation of one molecule each of urea and ornithine. The net result is to change the highly toxic ammonia into the non-toxic and highly diffusible urea, an end-product ideally suited for transportation to the kidneys and excretion. The ornithine can go through the cycle an indefinite number of times, taking up two molecules of ammonia and giving them off as one molecule of urea. The ornithine thus acts as a true catalyst. Liver had been demonstrated years before by Dakin to be rich in the enzyme arginase, which hydrolyses arginine to urea and ornithine, but the physiological purpose of the arginase in the liver had been a mystery until Krebs' work showed its role in the final step of urea formation.

Another vicissitude of the amino acids which the work of Mann and his colleagues located in the liver is the transformation into glucose. Graham Lusk, in the early part of the century, showed that when protein is catabolized by dogs made totally diabetic by phloridzin poisoning, about 60 gm. of glucose was formed and excreted from each 100 gm. of protein catabolized. Lusk and his collaborators also showed that certain of the amino acids had their carbon partly or entirely turned into glucose when their nitrogen was turned into urea. Mann and his colleagues showed that no glucose formation from proteins or amino acids occurred when the liver was excluded.

Furthermore, the acceleration of the body's heat production that occurs during assimilation of protein digestion products was shown by Mann and his colleagues not to occur when the liver was excluded. This accelerated heat production, called by Lusk the "specific dynamic action", apparently either represents energy produced by the reactions which the amino acids undergo in the liver, or is caused by other reactions in the cells which are stimulated by the presence of products formed in the liver. Such substances must be other than the urea and glucose, for neither of these shows the observed amount of stimulating effect. The specific dynamic effect may be due either to heat evolved from reactions that occur in the liver, or to the effect of products, other than urea or glucose, in stimulating other heat-producing reactions in the body. The decision between these two possibilities awaits future exploration.

Not all the treatment met by the amino acids in the liver is destructive. During periods of heavy protein feeding the body stores considerable amounts of protein in the liver and to a less degree in the other tissues. The protein seems to be different from the structural proteins of the tissues. In the liver Berg has shown that it can, in fact, be differentiated with the microscope by its droplet structure in the cells. Functionally it is characterized by the readiness with which it is metabolized when the protein intake is decreased, or with which it is used to replace blood proteins depleted by hæmorrhage, as found by Whipple and his colleagues. It appears probable that this protein is constructed in the liver part of the amino acids brought to it from the intestine.

Besides the liver, all the living tissues of the body take their shares in the metabolism of the amino acids, for all of them are of substance chiefly protein, and it is a living protein that is continually being broken down and rebuilt from its constituent amino acids. A most interesting part of this process has recently been discovered by two Russian biochemists named Braunstein and Kritzman. It is called 'transamination', and it enables the cells to change keto acids to amino acids by replacing the oxygen atom of the ketone with ammonia, transferred to the CO group of the ketone acid from the $CH(NH_2)$ of either of the dicarboxylic amino acids, aspartic and glutamic. Since at least some of the keto acids can be produced by partial oxidation of carbohydrates, transamination appears to be one of the processes by which the body can construct a portion of its own amino acids ; and it has been well established that the body can in fact synthesize about half the amino acids that are found in its protein structures. The reaction of transamination is caused by an enzyme that occurs in all the tissues, but is particularly rich in the muscles.

It is a peculiar thing that only the acidic amino acids, glutamic and aspartic, with two carboxyl groups each, can give their nitrogen to keto acids. Monocarboxylic amino acids, such as glycine and alanine, cannot transfer their nitrogen to keto acids to and from each other. However, they can transfer their nitrogen to keto-succinic and keto-glutamic acids to form aspartic and glutamic acids ; this is a reversible process. With aspartic or glutamic acids as an intermediary step, therefore, it seems to be possible for leucine, for example, to transfer its amino group to pyruvic acid and make alanine, or in reverse, for alanine to donate its nitrogen to make leucine from its keto acid. In either case the shifting nitrogen first is transferred to glutamic as aspartic acid, and then from that to the keto acid. The transfer is affected by an enzyme, which one of its investigators, Cohen, suitably calls transaminase ; it has been separated in the form of a protein from tissue extracts and exerts its activity in the absence of living cells.

From the fact that by the transaminase action the body can build up at least some of its own amino acids it would follow that not all the amino acids in the body proteins need be provided ready-made in the food proteins, but that some can be made in the body provided the necessary products to form the keto acids are available. In fact, thirty-four years ago Magnus-Levy demonstrated that the rabbit can make the simplest amino acid, glycine. When benzoic acid is fed to an animal it is detoxified by conjugating it with glycine to form hippuric acid, which is excreted in the urine. Magnus-Levy, by feeding hippuric acid to rabbits on nitrogen-free diets, was able to make them excrete as hippuric acid more glycine than they had contained in their entire bodies. They had used other nitrogenous materials to build glycine in order to detoxify the hippuric acid. The task of finding which of the other twenty amino acids are indispensable parts of the diet and which one the animal body can build for itself has occupied some of the leading biochemists since the time of Magnus-Levy's demonstration. The names of F. Gowland Hopkins in Great Britain and of Lafayette Mendel, T. B. Osborne, and W. C. Rose in the United States have been especially brilliant in the list of those who have unravelled this problem step by step. It has required clever and painstaking work to devise diets that contained all the necessary constituents for growth except one amino acid, and to handle the animal experiments in such a manner that the results were unequivocal. In the course of these studies W. C. Rose found evidence from his rat responses that there was some previously unknown constituent of hydrolysed casein which was necessary for maintenance, and in searching for it discovered and identified the amino acid threonine. As the result of twenty years of work by all the investigators in the field, Rose finally was able to divide them all into two groups, one comprising the amino acids which must be supplied as such in the food, while the other group can be made by the body and need not be supplied in the protein food.

Essential amino acids (Must be supplied ready-made in the diet)	Non-essential amino acids (Need not be supplied in the diet)
Lysine	Glycine
Tryptophane	Alanine
Histidine	Serine
Phenylalanine	Norleucine
Leucine	Aspartic acid
Isoleucine	Glutamic acid
Threonine	Hydroxyglutamic acid
Methionine	Proline
Valine	Hydroxyproline
Arginine	Tyrosine
	Cystine

The extent to which nitrogen fed in the form of amino acids is synthesized into tissue proteins, both in the form of the fed amino acids and of other amino acids to which the nitrogen is transformed by transamination, has been studied brilliantly by Schoenheimer and his colleagues in the Departments of Chemistry and Physics at Columbia University. They have synthesized amino acids with heavy nitrogen, ^{15}N, have fed the amino acids to rats and mice, and finally have hydrolysed the proteins in their bodies and isolated various amino acids from the hydrolysates. Finally, they have analysed the isolated amino acids for ^{15}N to determine the amounts of the ingested amino acid that were built into the body proteins, both in the form of the administered amino acid and in the form of other amino acids, formed from the administered one by transamination or other reactions. They have found that incorporation begins almost immediately, and that, while more of the marked ^{15}N is found still in the amino acid with which it was administered than in any other amino acid, nevertheless a considerable proportion of the marked nitrogen was found distributed among the other amino acids.

The results of Schoenheimer and his colleagues have entirely dispelled the view that the tissue proteins when once laid down remain as unchanging structural blocks until eventually destroyed by the wear and tear of metabolism. It appears that every protein molecule in the living body is itself alive in the sense that it is continually changing and renewing its structure.

Transmethylation. The discovery of du Vigneaud that methyl groups can be transferred from methionine to other substances in the body has opened a new field rivalling in interest that of transamination. Du Vigneaud found that some substance in the vitamin B complex could be replaced by methionine. This substance he identified as choline, which is thus identified as one of the necessary vitamins. Du Vigneaud proved that the choline could be formed with the aid of methyl groups from methionine, by administering methionine in which the methyl group was marked by having one of its hydrogens in the form of deuterium. When this labelled methionine was fed to rats on a choline-free diet, choline could be isolated from their tissues with part of its methyl groups containing the deuterium. It was found that this marked methyl group could be further transferred from the choline to creatine. The methyl group of the amino acid methionine could therefore be used by the body in synthesizing two of its essential non-amino acid constituents.

Detoxifying effects of amino acids. We have already noted the manner in which the body uses glycine to combine with and detoxify benzoic acid by forming hippuric acid. In some much less obvious way cystine and methionine protect the liver from intoxication by chloroform. This peculiar effect of the two sulphur-containing amino acids was discovered in 1940 by Miller, Ross, and Whipple. They had observed that a heavy feeding of meat would protect a dog from the effects of a dose of chloroform that would have led to fatal liver degeneration if administered in the fasting state. Investigation of the different types of amino acids yielded by protein digestion proved that only the two containing sulphur had the protective effect.

Concentration of amino acids in the blood plasma and the effect of the endocrines upon it. In the normal fasting adult the concentration of amino acid nitrogen in the plasma is constant at 5 mgm. per 100 c.c. If amino acids are absorbed from a protein digest or are injected intravenously there is a transitory rise, and a return soon to the original fasting concentration. The changes in blood amino acid concentration are similar to the changes of blood sugar after administration, orally or by vein, of glucose. There is an equilibrium between the amino acids of the tissues and those of the blood plasma, with the concentration in the tissues ordinarily eight or more times greater than in the plasma. What the forces are that maintain such an unequal balance is not known, but, as in the case of blood glucose, the endocrines have been found to be factors in the control of the plasma concentration. Luck and his collaborators have shown that administration of either insulin or adrenalin lowered the plasma amino acid content of animals. Mirsky has shown that insulin greatly retarded the passage of amino acids from muscles to blood in eviscerated dogs. The effect of insulin on the blood amino acids is much like that on the blood sugar. The opposite effect, to increase the plasma amino acid content, is shown by some of the other hormones. Thus Farr and Alpert in our laboratory have recently found that intravenous administration of the growth- or metabolism-stimulating factors of anterior pituitary extract, of antuitrin, pitressin, or adrenal cortical hormone was followed in dogs by increase of the plasma amino acid content.

Blood amino acid concentrations in disease. From the manner in which hormones can influence the concentration of amino acids in the plasma it is evident that the interpretation of changes found in disease may be difficult. If the plasma amino nitrogen content were merely the mechanical resultant of inflow from the intestines balanced against absorption and metabolism by the tissues, one would anticipate that liver damage would result in a retarded removal of amino acids from the blood, in abnormally large increase in plasma amino acid content during digestion of protein foods, and in abnormally slow return of the plasma amino acids concentration to normal after injections of amino acids. In fact all these results have been reported by various authors, but they seem to be definite only when the hepatic damage has reached a severe grade. This might be expected from the experiments of Frank Mann with partially hepatectomized dogs. He found that it was necessary to remove 80 per cent of the liver before the blood amino acid content began to rise. It does not appear therefore that one can expect blood amino nitrogen determinations to afford a delicate means for detecting moderate degrees of liver injury.

In Bright's disease two extraordinary changes of plasma amino acid content in opposite directions have been observed in our laboratory. One of them was discovered by Kirk in patients in or near uræmic coma. The plasma amino acid nitrogen in some of these patients rose in a day or two from but little above the normal level to six- or eight-fold as much. If, by treatment with saline and glucose injections and other therapeutic measures, recovery from the severely uræmic state could be induced, the plasma amino acid content fell as quickly back to normal. The sudden rise might be explained as due to an accelerated tissue breakdown accompanied by a simultaneous failure of deaminizing function of the liver, but there was no independent evidence that either of these conditions occurred. The mechanism of the amino acid rise in uræmic coma remains a puzzle.

In the opposite direction, Far and MacFayden, using the ninhydrin method first worked out with Dr. Robert Dillon, showed that children with nephrosis are likely to have chronically subnormal plasma amino acid values. But, of particular interest, is the fact that when the patients have the sudden illnesses known as 'nephrotic crises', when sudden collapse occurs without infection or any other obvious cause, the plasma amino acid nitrogen shows precipitate falls to as low as 2 mgm. or even 1 mgm. per 100 c.c. Whether the cause is an endocrine-influenced shift in the equilibrium between blood and tissues, or some factor that is as yet totally unidentified, remains uncertain. However, regardless of the mechanism of the plasma amino acid fall, the injection of generous amounts of amino acids in the form of predigested milk proteins has regularly produced a marked alleviation of the collapse, and a great reduction in the mortality from these attacks.

Nutrition by intravenously injected amino acids. Shortly after early work cited in this article showed that amino acids were absorbed from the intestine during protein digestion in amounts sufficient to account for all the nitrogen digested, Henriques in Copenhagen demonstrated that nitrogen equilibrium could be maintained with intravenously injected amino acids as the sole intake. He placed a cannula in the neck vein of a goat kept in a stall, and maintained the animal in nitrogen equilibrium for several weeks by giving the great part of the necessary nitrogen in the form of a protein digest hydrolysed completely to amino acids and injected intravenously. The therapeutic application did not follow until twenty years later, when Ellman began the regular use of intravenous injections of predigested casein. He was followed by Farr and MacFadyen, who showed that the injected amino acids were assimilated fully as well as the nitrogen from ingested proteins digested in the alimentary tract. A large part of the nitrogen required can be given in this form over a period of weeks. It appears that this form of nutrition can well supplement intravenous calories in the form of glucose in conditions that prevent adequate feeding by mouth.

SIR WILLIAM BRAGG, O.M., K.B.E., F.R.S.

BRAGG's first research paper was published in 1904, when he was forty-two years old. This fact is not without significance for an understanding of his work and character. He had gone out to Australia as a young man of twenty-four, without any experimental experience and without, indeed, any real training in physics—he was fond of telling how he learnt the elements of the subject on the boat as he travelled to take up his appointment as professor of mathematics and physics at Adelaide. He soon showed a liking for experiment and set up the first X-ray tube to operate in Adelaide, possibly the first in Australia. He made a name as a teacher and as a man of great social gifts, and might have spent a pleasant and useful life without ever carrying out any original investigations, for in those days 'research' was not a professional necessity. It was not until he had had long experience in expounding the fundamentals of his subject, and in so doing had developed a keen critical sense for what was important and what was trivial, that he set out to discover something about radioactivity, a subject that had stirred his active curiosity when he was preparing an account of what had been done in this field. So well, however, had he taught himself in those years of preparation that his first paper, on the range and ionization of alpha particles, is a classic. Within three years he had been elected a fellow of the Royal Society.

Many characteristics of Bragg's scientific work were shown in his Australian days. He never attacked a problem until he had a clear and simple picture before him of what he wanted to do, and he was never satisfied until he had a clear and simple answer to his question. The task he set himself was always one of deep significance, his exposition was always lucid and persuasive and he was always generous in his acknowledgment of the work of others. His gift of stimulating those about him to fruitful endeavour was also shown throughout his life. In Adelaide he made an enthusiastic collaborator of Kleeman, while his school of research at the Royal Institution is world-famous and has attracted students of varying degrees of maturity from all parts of the world. Nothing hasty, nothing immature, nothing of that pretentious work the triviality of which is disguised by its difficulty and obscurity ever came forth from his laboratory. His work, like his personality, was simple yet profound, sincere and compelling.

Bragg was born on July 2, 1862, the son, as he liked to recall, of a yeoman farmer of Cumberland. After a brilliant school career he went to Trinity College, Cambridge, with a major scholarship and studied in particular mathematics. He was third wrangler in 1884, gaining a first class in Part III of the Tripos in 1885. It was in 1886 that J. J. Thomson casually suggested to him that he should apply for the post at Adelaide, which he obtained, and he was professor there until 1908. He quickly endeared himself to his colleagues and fellow-citizens, showing the talent for making friends and winning affection which was so marked all his life. He never wooed popularity deliberately, being, at bottom, somewhat diffident about his own powers and qualities, but he had a charm of manner and a pretty patience with what Karl Pearson used to call "our weaker brethren" that won all with whom he came in contact. In Adelaide he married Gwendoline, daughter of Sir Charles Todd, and there all his three children were born—the present Sir Lawrence Bragg; Gwendy, now Mrs. Alban Caroe; and Robert, who was killed at the Dardanelles. Australia left a deep mark on Bragg's life and he always spoke with affection of the years which he spent there. Scientifically, this period of his life is characterized by the fundamental work on alpha rays to which reference has already been made.

In 1908 he returned to England as Cavendish professor of physics at Leeds. He speedily established his name as a teacher and wrote a monograph on alpha rays published in 1912 under the title "Studies in Radioactivity". It was in the Leeds days that he began to be deeply concerned as to the nature of X-rays, a problem which was exercising the scientific world. It had been contended in some quarters that they were of a wave nature, but the doubtful results of certain attempts to produce diffraction had militated against the general acceptance of this view. Bragg himself inclined to the opinion that they were of the nature of a particle, an electrically neutral doublet, when in 1912 von Laue's fundamental discovery revealed that they possessed the properties of light of an exceedingly short wavelength. It is characteristic of the balance of Bragg's mind that while he at once grasped the significance of von Laue's work, at the same time he still contended that a wave nature left some things unexplained. With rare prevision he wrote in NATURE at the end of 1912: "the problem then becomes, it seems to me, not to decide between two theories of X-rays, but to find, as I have said elsewhere, one theory which possesses the capacities of both."

Following a paper by his son in which the reflexion law was established he began, in collaboration with him, the classic work in which was demonstrated the existence of monochromatic X-radiation and the possibilities of applying X-rays to the investigation of crystal structure. The first joint paper, "The Reflexion of X-Rays by Crystals", appeared in 1913 and the joint book, "X-Rays and Crystal Structure", in 1915. A reprint of the early researches of the two Braggs appeared in German in 1928.

This work on X-rays and crystal structure, which Bragg often expounded in terms so simple as to make it all seem inevitable, laid the foundations of one of the most beautiful structures of modern science. It was used for fundamental advances in both inorganic and organic chemistry. Metallurgy is deeply indebted to it. The names of those who were initiated into research in this field by Bragg—if we mention Astbury, Bernal, Mrs. Lonsdale, Müller, Patterson, Monteath Robertson and Shearer we recognize that there are others with equal title to be cited—recall some of the developments for which he was directly responsible. Bragg retained his active interest in the subject and showed all his freshness of approach up to the end. His last paper dealt with the extra reflexions in X-ray photographs, which aroused all his old enthusiasm and flair for a simple explanation.

To return to his career, the War of 1914–18 found him at Leeds. He was appointed Quain professor of physics at University College, London, in 1915, but his time until the end of the War was devoted wholeheartedly to war service. He was a member of the panel of the Board of Inventions and Research from its inception, and in 1916 undertook the task of directing the acoustic work on submarine detection, which was carried through with such success. After the War he took up his professorial work at University College, but post-war conditions made the establishment of an active laboratory difficult. Good work was done, with which the names of Müller and Shearer must be associated, but in 1923, before Bragg had had time to become identified with University College, he was appointed to the directorship of the Royal Institution and of the Davy Faraday Research Laboratory.

This was in every respect a happy appointment. At the Royal Institution Bragg had full scope both for his wonderful gifts as a popular exponent of science and for his leadership in original investigation. The first Christmas Lectures which he delivered, "The World of Sound", at once made it clear that the Faraday of "The History of a Candle" had found a worthy successor. His Friday Evening Discourses gave delight to an ever-growing circle. At the same time his very broad interests—Bragg was a keen lover of music, as Mr. Mark Hambourg was reminding me recently; he was widely read; and as a young man he painted and drew with considerable skill—and his personal charm enabled him to attract to the Institution a wide variety of distinguished lecturers. His family, too, identified itself with the Institution. Until her death in 1929 Lady Bragg took a very active part in all its social life, and since then Bragg's daughter, Mrs. Alban Caroe, has played the hostess with great tact and charm; while Sir Lawrence not only delivered a set of Christmas Lectures and various discourses but has, since 1938, been professor of natural philosophy there. Bragg loved the Royal Institution and took the keenest interest in its traditions and history. He played, for example, a prominent part in the publication of Faraday's Diary.

Many honours came to Bragg from all parts of the world. In 1915, he, with his son, was awarded the Nobel Prize for physics for the work on X-rays and crystal structure. In 1931 he was admitted to the Order of Merit. From 1935 until 1940 he was president of the Royal Society, an office which he filled with conspicuous charm and unaffected dignity. He was awarded the Rumford and the Copley Medals. Through all these distinctions he retained a modest and chivalrous outlook, in which seriousness of purpose was balanced by a deep sense of humour, deep religious feeling by a complete lack of bigotry. His family life and his public life were serene, cheerful and complete. The end was sudden. His heart had troubled him for some time. On Tuesday he had to take to his bed and he died on Thursday, March 12.

E. N. DA C. ANDRADE.

THERE are men of science one cannot help admiring without liking them overmuch, and there are others one likes while secretly thinking them misguided: to few is it given to be both loved and admired. Sir William Bragg was one of those few—more than that, he was said to be the best-loved man of science in the world. One just wanted to do things for him, and do them well. He was that kind of a man.

The story of the latter part of Bragg's scientific life is, of course, the story of structure analysis: he was not an active participant in everything, naturally, or the originator of every new idea, but he was the soul of everything. We who were his disciples and are his apostles had always the impulse to "tell Bragg about it" wherever we were working, for we knew that we could talk to him, that he would listen, and that he would be just as thrilled as we were. In the laboratory he would run to us just the same to tell us of any new idea that had occurred to him. He had a very human desire to share his joy, his boyish glee, and to be told that it *was* a good idea. His face would sometimes fall quite like a boy's if (very rarely!) you happened to think it was not a good idea after all—but you could always argue peaceably with him; he was your pupil just as much as you were his. That, added to his great kindliness and modesty, was, I think, the secret of Bragg's influence. There was no question of his making regular tours to discuss progress; but he might pop into your room any time to tell you something or ask you something, and it was your pride to be able to talk intelligently about the one or to answer the other.

When in 1921 I had the good fortune to become one of Bragg's assistants at University College, the first exciting days were over in which he and his son founded crystal analysis and X-ray spectroscopy, and he was turning his mind more to space-groups and organic crystals. At that time he was not really conversant with space-group theory—none of us were—for he was a physicist first and a crystallographer by implication, but he and his son had already demonstrated the laws experimentally. If I am asked to convey in a word all that the Braggs in those earlier years did for crystallography, quite apart from their stupendous contribution to spectroscopy and diffraction theory, I like to tell this story, based on the fact that nowadays straight crystal analysis runs so smoothly that it has become difficult to believe that there were once birth pangs and growing pains. There was put to me some such question as this: "Tell me, what was all this business about sodium chloride? From the theory of space-groups and a little common sense the thing could scarcely be anything else but O_h^5. You can work the whole thing out simply from atomic weights, the density and Avogadro's number. What *did* the Braggs do with sodium chloride?" To which I could not help replying, "Oh, they just proved the theory of space-groups, that's all."

Soon after the War of 1914–18, as I say, Sir William's mind became engrossed with the shapes, sizes and distribution in crystallographic space of the larger non-ionized molecules of organic chemistry, and in this field he broke first ground with that splendid investigation of the structures of naphthalene and anthracene. Not that he ever abandoned inorganic crystals or loved them any the less—witness, also about that time, what to my mind is one of the most beautiful things he ever did, the structure of ice; or his later return to quartz to explain so elegantly its modes of twinning. But he tended more and more towards organic structures, not merely as a convenient division of labour with his son's school at Manchester, where giant strides were being continued in the inorganic field, technique and diffraction problems, but also because at heart, besides being by implication a crystallographer, he was by induction a biologist, a molecular biologist. When we went to the Royal Institution in 1923 and set about helping him to re-found the Davy Faraday

Laboratory, he not long after gave a series of lectures on the "Imperfect Crystallisation of Common Things" (reported in one daily paper as the "Imperfect Civilisation of Common Things"!), and it was my privilege to provide X-ray photographs of hair, cotton, bone, sea-hedgehog spines and such-like —pretty dreadful photographs they were too, as we know now, but none the less precious, because of their associations. I would say that dating from that time Bragg saw, and saw more clearly with the passing years, that the crowning glory of structure analysis would one day be in the realms of biology. It was granted to him to live to see this dream beginning to come true in the work of his own pupils.

Those were great days when he re-made the Davy Faraday, and we all had our chosen tasks building with him—X-ray tubes and spectrometers, long-chain compounds, space-groups, basic beryllium acetate and other fascinating co-ordination compounds and organic crystals, X-ray photometry, the theory of rotation photographs, and all sorts of lovely things. Bragg himself was too busy with other duties to stick to any continuous line of research, but he lectured about all that was going on (and about much, besides, that was outside X-ray analysis), thereby revealing ever-new points of view, and from time to time he would dash back into the fray to thrash out something that had excited his eternally boyish interest. He had the most amazing faculty of taking up a subject on which he had only the foggiest ideas to begin with, and quickly improving it out of all recognition; as, for example, at the Faraday Society's discussion on "Liquid Crystals" held at the Royal Institution in 1933, when he explained the optics of smectic substances in terms of the cyclides of Dupin; and often, if you met him a few weeks afterwards, he would have reverted, not indeed to his initial fogginess, but to a state of comparative forgetfulness, just because he was pre-occupied doing the same sort of thing in some other line.

As a lecturer and writer he was pre-eminent, as everyone knows. I should say that he was the most charming and lucid scientific writer of our time. Is there anything in all scientific literature to equal the opening sentence of his "Universe of Light": "Light brings us news of the Universe"? And who among our men of science could have matched his article in *The Times* on the nation's food that he wrote at the age of seventy-eight? But one cannot even begin in this brief homage to show all the man that Bragg was. To many, like myself, he was a scientific father. Simply and affectionately we called him "The Old Man". W. T. ASTBURY.

IT is seldom that the death of a leader in science brings so deep a sense of intimate and personal loss to people of all ages and conditions, as does that of Sir William Bragg. From his own contemporaries and colleagues down to the children, for whom he loved to exploit his wonderful faculty of simple presentation, everyone feels that, with this departure of another of the great ones of a great period in science, a dear and familiar friend has gone from us.

Nowhere will the loss of him be more constantly or more keenly felt than in the circles of the Royal Society. Living at the Royal Institution, a short walk from Burlington House, he was within easier access to the Royal Society and a more frequent visitor there than other presidents of recent years. It would have been impossible to miss the signs of his influence on the Society, and of his activity on its behalf during his presidential term. Bragg's period of office had seen the gathering and breaking of the storm, and he had early foreseen that Great Britain and its Government would need science as never before. He had steadily and patiently brought to bear the whole weight of his reputation and the strong influence of his personality, so impressive in its wisdom and so charming in its gentle modesty, to ensure that the voice of science should be heard, and that the Royal Society should take its place as the most widely representative of the spokesmen. The appointment of the Scientific Advisory Committee to the War Cabinet, with three officers of the Royal Society as members *ex officio*, was announced during his last year of office, and greeted by him in his last anniversary address to the Society.

The War brought him other duties also, as chairman of the Advisory Committee to the Cabinet on Food Policy, and in many other directions. Some of these duties he laid down with the presidential office, but we were eager to keep him in consultation and still to have the benefit of his wisdom and experience, wherever possible. I hope that we did not keep him at work too long; for, though he had found it necessary to limit his physical effort, he remained so alert, so quick in understanding and so clear in his memory, that it was difficult to think of old age in connexion with him. For two months from Christmas, when I had to go away on other duty, he came back to the presidential chair; and so he remained, quietly at work and ready to give a helping hand anywhere, right up to the few days of illness which brought the end—the close of a long life of whole-hearted devotion to science and to the interests of his fellow-men. H. H. DALE.

BY the death of Sir William Bragg, British science loses its most distinguished physicist, while a much wider section of the nation loses also a friendly guide who interpreted the results of science to them with great lucidity and charm. Sir William Bragg's work in furthering the application of science in both Government and industry may not, however, be so widely known and appreciated.

Throughout his life, and particularly in his later years, he saw ever more clearly how the practical applications of scientific work were becoming first the luxuries and then the necessities of human life, and realized that, in consequence, only by organized and appropriately directed scientific research could any industry serving the community continue to thrive. He always advocated, too, the need for the greater incorporation of the results of science in national affairs, but warned us that "it is science itself, not scientists, that we are trying to lift to the high places. . . . We do not claim that scientists shall be entrusted with authority because they are scientists: we do claim that authority shall be exercised in the light of a knowledge which grows continuously and with continual effect on politics, on industry, and on thought itself."

Sagely he added: "If we, in the continually increasing contacts of scientists with current affairs, can show that we have something of great value to contribute and that we give it freely, placing our individual interests below those of a greater purpose; if we try to understand the motives and principles of those whom we meet who may not share our vision, just as we may fail to appreciate theirs, then by so doing we have the best chance of bringing about the changes that we desire."

The contacts of this kind which he personally established were wide and numerous. During the War of 1914–18 he acted as a scientific adviser to the Admiralty, devoting his attention to the problem of submarine detection. During the present War he has been frequently consulted on a variety of scientific matters and has been chairman, since its formation, of the Committee advising the War Cabinet Food Policy Committee on scientific aspects of war-time food problems. He has also been a member since its formation of the Scientific Advisory Committee established under the chairmanship of Lord Hankey. As he himself pointed out, the significant feature of these committees was their close and direct association with the Cabinet, so that scientific advice was brought into Government at the highest possible level.

It was the same appreciation of the place of science in everyday life and in industry that led him to accept appointment to the Advisory Council of the Department of Scientific and Industrial Research, of which he was still a member at the time of his death. But he counted his duties as a member of this body insufficiently discharged in the formal business of meetings, and the young men of science in both the Department's own stations and in the laboratories of the research associations will long remember his heartening and inspiring visits, when the distance between senior and junior magically vanished and both hopes and difficulties were shared.

EDWARD APPLETON.

EVERY journal devoted to scientific learning has been deprived of an unfailing source of light and leading by the death of Sir William Bragg ; but none can have benefited more than NATURE from his wisdom and judgment. It is with a full and grateful heart that I remember many occasions when he readily gave guidance upon subjects in which his special knowledge as well as his wide interests were of particular value, and when his contributions to its pages enlightened the readers of this journal. With a diffidence which was natural to him, he often suggested, when asked for copies of addresses or lectures delivered by him, that he doubted whether NATURE would find much in them suitable for publication, though his printed words were always as highly appreciated as his spoken utterances and the light of them penetrated to a much greater distance than the sound.

Sir William Bragg's first communication to NATURE was in 1908, and its subject was the nature of γ- and X-rays. He was then at the University of Adelaide and had entered the new and wonderful field of physics opened by the discovery of radioactivity and the isolation of the electron. In the following year he became Cavendish professor of physics in the University of Leeds, and a year or two later I induced him to prepare a monograph bringing together, under the title of "Studies in Radioactivity", methods and results of investigations of the phenomena attending the passage of the new types of radiation through matter. This monograph was the first of his published books. As editor of the series to which the volume belonged, I was able to make a few suggestions upon its scope and structure, but with the characteristic generosity shown to all associated with him in work of any kind, Sir William referred to me at the end of the preface in the words : "He has been most kind in allowing me to benefit by his experience. He set me my task, but he has done his best to make it an easy one."

Our friendship began with the production of this volume thirty years ago, and throughout this period I have followed with fraternal affection the leading part played by Sir William in the renaissance of modern physical science through the development of his pioneer studies. It would be presumptuous for me to praise the insight and the ingenuity which he used to reveal regularities of arrangements of atoms and molecules by the method of X-ray analysis ; but with all his friends I share personal pride in his great achievements, and thankfulness that his son, Sir Lawrence Bragg, remains with us to continue to explore this fertile field.

By their individual and joint researches, what began as an academic study soon extended into the fields of applied science and has now become a subject of prime importance in the understanding of many industrial processes. They have enabled us to see and trace patterns in the structure of matter previously beyond the sight of man though not beyond his imagination. In one of his sonnets, Michael Angelo beautifully expressed the similar function of a sculptor to unfold a form hidden in a block of marble, in the words :

> The very sculptor can no thought conceive,
> That does not lie deep buried in the stone.
> And this, the eye discovereth alone,
> That doth commandment from the mind receive.

Just as light becomes visible only when it impinges upon matter, so natural knowledge has to be perceived before it can produce enlightenment. Sir William Bragg was not only a rich source of such knowledge, but also the creator of waves of thought with which every intelligent mind could make appreciative contact. His style of exposition was effective because it was simple and unpedantic in scientific substance or literary embroidery ; and his messages appealed, therefore, to all classes of the community. He was an acknowledged master of scientific craftsmanship in a field of work to which he devoted the greater part of his life, and also a creator of designs and a convincing exponent of their beauty. With the desire for truth always in his heart, and the pursuit of it in the domain of verifiable knowledge as the purpose of scientific inquiry, he combined wise counsel and the might of understanding, and has bequeathed to the world a splendid heritage to be treasured with affectionate memory.

R. A. GREGORY.

THE loss of Sir William Bragg will be felt by physicists all over the world. His rare combination of experimental skill with lucidity of thought and pre-eminent clarity of exposition would have marked him as an outstanding figure in any generation. But he will be remembered among his many friends almost more for his kindliness and charm, especially to the younger generation. He was always ready, as I know from my own experience, to discuss any problem, even with a young undergraduate, on equal terms. Argument and contradiction never ruffled him. Even when he appeared to be caught out by some contradiction, such as were only too easy to construct in the days when we were all fumbling for the explanation of the quantum paradoxes, his serene imperturbability was never disturbed. All the scientific honours heaped upon him made not the slightest difference to his modest and unassuming manner and address. He was a man who can never have had an enemy and who has left an abiding mark in the memory of his innumerable friends.

CHERWELL.

THE late Sir William Bragg's wide influence upon contemporary science is universally acknowledged. It was always his desire that men of science should throw aside the cloak of mysticism and seclusion and appear as other men striving after truth in no matter what field of action. This view has recently acquired especial significance because of the great service to the State which science, when properly applied, is now generally seen to be capable of giving ; and it was this attitude of mind that largely prompted his delight in simplifying, so far as possible, for the benefit of others many of the highly complex problems of physics with which his name is so closely connected. Thus his lectures were remarkable for their clarity and experimental illustration. The underlying motive was always to let others see and understand what his own clear vision could discover.

The Royal Institution afforded ideal facilities for research and exposition, which exactly suited Bragg's temperament. He showed in many ways how deeply he felt the honour and responsibility of following in the footsteps of Faraday. Sir William's versatility was particularly noticeable in the courses of Christmas Lectures to Children, which he delivered in 1919–20 upon "Sound", since it was then that his interest in music suggested many ingenious illustrations. For the series he gave in 1931–32 he chose "Light" as the subject and dealt fully with the nature of colour and colour mixtures. In this connexion it may be pointed out that during the last meeting of the British Association at Cambridge, an exhibition of pictures by members was arranged, and there Sir William showed several charming water-colour landscapes which he had painted when abroad. His Christmas Lectures were memorable occasions for many reasons, because the presence of children always stimulated in him those fascinating qualities of friendliness and enthusiasm which were a dominating characteristic of his nature. His quick mind often enabled him to make a witty reply to a question, but it never wounded.

After each of the Christmas lectures there were delightful tea parties in Sir William's private rooms.

We, at the Royal Institution, deplore the loss of one whose guidance in all affairs was so invaluable and fair-minded. We cherish the memory of his invariable courtesy, kindliness, enthusiasm and loyalty to the great traditions of his calling. He was beloved by all.

CHARLES E. S. PHILLIPS.
(Hon. Sec. Royal Institution.)

IN the death of Sir William Bragg we lose a great man and well-tried friend ; and, distinguished as have been his services to science and to the State, it is the sense of personal loss, the tribute to his rich human qualities, which now dominates. The loss was so completely unexpected ; age had not withered him ; his wide and generous knowledge was ready to hand and at the service of all real inquirers ; his interests were as fresh as ever, and his unique power of lucid exposition seemed to grow greater as time passed this tract on electromagnetism, which saw the light but a month or two since, is a model of its kind).

His pioneer contributions to physical science have provided a probe for the scrutiny of the submicroscopic world and, equally with these investigations, his faculty for seizing on essentials, for reducing a complex problem to its simplest elements, for describing physical phenomena with incomparable clarity and charm, made him a most fitting head of an institution the traditions of which are so intimately associated with the names of Davy and of Faraday.

A little incident comes to mind which may serve to illustrate these qualities. A paper was read before one of our societies by a young investigator who, with the blundering particularity of youth, insisted on describing methods and results with such indiscriminating zeal and detail, that his audience was left completely befogged. Perfunctory applause had died down, when Sir William rose, and in a five-minute speech gave a masterly sketch of the paper, which showed it for the sound piece of work that it was, cleared the mists from the minds of his hearers, and left the author heartened and encouraged.

Friendliness and helpfulness were of the essence of his being ; and though institutions may remain, while those who direct their activities come and go, it is difficult to think of the Royal Institution without Sir William's friendly presence, guiding and leading the researches of the laboratory and informing the work of the Institution with the spirit of Faraday.

May his memory long be kept green !

ALLAN FERGUSON.

THOUGH it was a great pleasure to meet Sir William Bragg anywhere and on any occasion, it is on his own ground at the Royal Institution that most of us best remember him. The setting so became him ; and he so graced the setting. Whether receiving the guests on a Friday evening, or expounding some of the mysteries of science in the great lecture theatre, or merely entertaining some stray scientific visitor to tea, Bragg had the art, which was no art because it was rooted in real interest and a genuine affection for humanity, of making the visitor feel at home. Any scientific society which might have been fortunate enough to obtain the privilege of holding a meeting in the Institution would usually find on arrival that the Director, by some happy chance, had business which took him into the entrance hall, and the visitors would receive from him friendly informal greetings which made them feel that they were not intruders, but welcome guests. In the work and welfare of the younger generation of men of science Bragg's interest was almost paternal.

In his early work Bragg made some fundamental contributions to the science of radioactivity. He was, I believe, the first to point out that gamma rays and X-rays behaved, in many respects, like uncharged particles : an idea with which modern quantum theory has now familiarized us. His remarkable work on the elucidation of crystalline structures by X-rays, carried out in collaboration with his son W. L. (now Sir Lawrence) Bragg, has founded a new branch of science, and has forged a new and valuable weapon in the armoury of industrial research. X-ray analysis is now being applied to the study and improvement of an amazing variety of commercial products.

As an interpreter of physics to the public Bragg was unrivalled in the present age. His discourses at the

Royal Institution, illustrated with all the resources at its command, were a sheer delight. Simple yet profound, the non-scientific hearer could gather a clear mental picture of the subject discussed, while the professional man of science enjoying the apparently effortless artistry of the presentation usually found that, in addition, he had gained some quite new side-lights on a subject with which he had thought himself completely familiar.

J. A. Crowther.

Nearly twenty years ago, as a young graduate, I joined the team of research workers at University College, London, who were inspired and led by Sir William Bragg. His was a charming personality and he was an ideal research professor. Keen on his own work, bubbling over with enthusiasm at each new discovery; just as interested in ours, yet never obtrusive, never impatient. We knew that he shared our joy at each idea proved correct, because he himself had such an astonishing intuition. He knew where to look for knowledge; but although intuition showed him the way, he was never satisfied with less than the most complete proof that the knowledge attained was fundamentally sound. An admitted mistake found him sympathetically understanding; like Faraday, he never regarded time as wasted if it increased experience. Yet he could be stern on occasion: a young man who spoke slightingly of one whose lifetime had been spent in determining one physical constant really accurately was most surprised to receive a sharp rebuke. Such painstaking and unspectacular labour Sir William knew to be the very cornerstone of research.

Sir William attracted and welcomed to the laboratories of the Royal Institution workers from all parts of the world, and most of them must remember with gratitude not only the opportunities for scientific research and discussion thus afforded but also, and perhaps not least, the delightful garden parties given at his country cottage at Chiddingfold. Those of us who are still working on the problems that enthralled him to the last, feel that we have lost not only a leader but also a personal friend.

Kathleen Lonsdale.

NEW FELLOWS OF THE ROYAL SOCIETY

The following were elected to the fellowship of the Royal Society on March 19:

Prof. J. H. Burn, professor of pharmacology, Oxford, formerly dean of the College of the Pharmaceutical Society; distinguished for his work in physiology and pharmacology and on the principles and methods of biological standardization.

Dr. F. M. Burnet, assistant director of the Walter and Eliza Hall Institute for Medical Research, Melbourne; distinguished for his researches in bacteriology, especially on avian and mammalian viruses.

Dr. M. Dixon, lecturer in biochemistry, Cambridge; distinguished for his work on tissue respiration and respiratory catalysis.

Prof. E. C. Dodds, M.V.O., professor of biochemistry, Middlesex Hospital Medical School; distinguished for his investigations in biochemistry in relation to physiology and medicine and especially in the synthetic production of œstrogenic agents.

Mr. A. Fage, principal scientific officer, Aerodynamics Department, National Physical Laboratory; distinguished for his contributions to the experimental study of aero- and hydro-dynamics, particularly in relation to turbulent flow.

Colonel N. H. Fairley, A.A.M.C., consulting physician in tropical diseases, director of special research, Hospital for Tropical Diseases, London; distinguished for his researches in tropical medicine.

Mr. P. Hall, university lecturer in mathematics, Cambridge; distinguished for his contributions to pure mathematics, particularly in the theory of groups.

Prof. G. H. Henderson, professor of mathematical physics, Dalhousie University, Halifax, Nova Scotia; distinguished for his work in radioactivity and particularly in the investigation of pleochroic haloes.

Prof. T. P. Hilditch, professor of industrial chemistry, Liverpool; distinguished for his work on the chemistry of natural fats.

Prof. E. Hindle, regius professor of zoology, Glasgow; distinguished for his work in parasitology, and on the cytology of artificial parthenogenesis.

Dr. C. S. Hanes, senior scientific officer, Low Temperature Research Station, Cambridge; distinguished for his researches in botany and biochemistry, especially the first enzymatic synthesis of starch.

Prof. A. Holmes, professor of geology, Durham; distinguished for his work in petrology and the applications of radioactivity to geological problems.

Prof. D. M. Newitt, assistant professor of chemical technology, Imperial College, London; distinguished for his work on high-pressure technology and for his researches on combustion.

Dr. C. C. Paterson, O.B.E., director of the Research Laboratories, General Electric Company, Wembley; distinguished for his work in promoting physical and industrial research.

Dr. J. K. Roberts, assistant director of research, Colloid Science Laboratory, Cambridge; distinguished for his investigations by physical methods on adsorption and other surface phenomena of importance in catalysis.

Dr. H. W. B. Skinner, Wills research fellow and lecturer in spectroscopy, Bristol; distinguished for his work on the X-ray spectroscopy of the solid state, leading to results of importance in the theory of the structure of metals.

Prof. D. Thoday, professor of botany, Bangor; distinguished for his researches in plant physiology, particularly those dealing with photosynthesis, causal anatomy and the water relations of plants.

Prof. A. R. Todd, professor of chemistry, University of Manchester; distinguished for his researches in organic chemistry, notably the synthesis of vitamin B_1 and other natural compounds of physiological importance.

Prof. A. E. Trueman, professor of geology, Glasgow; distinguished for his work in palæontology, particularly on molluscan faunas of the coal measures.

Mr. A. H. Wilson, university lecturer in mathematics, Cambridge; distinguished for his contributions to the electronic theory of solids and for his work on the properties of metals.

NEWS and VIEWS

Tributes to Sir William Bragg

ELSEWHERE in this issue, a few of the innumerable friends of Sir William Bragg, and representatives of bodies concerned with the various phases of his activities, pay their tribute to him. In particular we would endorse Sir Richard Gregory's reference to Sir William's services to NATURE; and we may add that his wisdom and advice, given in characteristically kindly and modest manner, remained at our disposal right up to the end. His abiding interest in crystal analysis was reflected in a communication published in NATURE of December 27, 1941, p. 780, on the problem of the diffuse spots in X-ray photographs.

At the memorial service in Westminster Abbey held on March 19, a great company of those who had been associated with Sir William during the course of a long life of service in the cause of science showed by their presence the honour in which he was held. H.M. the King was represented by Earl Fortescue, the president of the Board of Education attended, and scientific societies and Government Departments were represented by their officers. The Archbishop of Canterbury and the Dean of Westminister took part in the impressive service: the Lesson was taken from I Corinthians, xiii, concluding with the words, "the greatest of these is charity"—surely an apposite phrase to associate with Sir William Bragg's memory. Prof. E. N. da C. Andrade has ably summed up Sir William's many-sided character in verses he wrote as a dedication to his book "Engines"; we quote these lines:

You, by a twofold excellence
Raised to deservèd eminence,
Not only Nature can compel
Her enigmatic oracle
To breathe to you, but can convey 't
Clear to the uninitiate.

. . . .

Three times yourself at Christmastide
Have charmed us as the children's guide,
In ice and snow's fantastic frond
And close-compacted diamond
Have shown the wonders that abound,
And wandered through the World of Sound:
And have most curiously displayed
How science guides the hand of trade.

Dr. J. de Graaff Hunter, C.I.E., F.R.S.

NEWS has been received from Sir Gerald Lenox-Conygham of Dr. J. de Graaff Hunter, formerly director of the Geodetic Branch, Survey of India, who is a prisoner in Germany. Dr. Hunter had gone to California to represent Great Britain at the Pacific Science Congress which was to be held there in September 1939, and it had been his intention to spend the winter there; his wife and daughter were with him and it was thought that the climate of California would be good for his daughter's health. When war was declared, he found himself unable to obtain money from England and was obliged to move to some place in the 'sterling' area. He thought of Jamaica, but eventually decided on Nassau in the Bahamas. He had in the meantime written to the Surveyor-General of India offering to return to India to serve in his old department in any capacity; and after some considerable time, he learned that he would be welcomed back in India. Dr. Hunter then went from Nassau to New York, intending to take ship to Cape Town and after arrival in Cape Town to plan the remainder of the journey. He accordingly sailed from New York in the steamer *Zam Zam* on March 15, 1941. This ship was attacked and sunk by a German raider when she was about three days from Cape Town. The passengers were put on board a supply ship and were at sea in her for a long time. Eventually they were landed at a port near Bordeaux and were conveyed by slow stages to internment camps in Germany. Dr. Hunter's address is: Gefangennummer 102872, British Civilian Internee, Ilag VIII, Deutschland; Mrs. Hunter and her daughter are at Interniertenlager, Liebenau, Würtemburg. Letters are being received both from Dr. Hunter and from Mrs. Hunter, from which it appears that they are tolerably well.

Breeding of Mosquitoes in Static Water Supplies

THE Limmer and Trinidad Lake Asphalt Co. Ltd., has issued a memorandum of notes on mosquitoes breeding in static water supplies. It is written by J. F. Marshall, director, British Mosquito Control Institute, in collaboration with K. W. Attwooll, chief chemist to the above-named company. From among the thirty different species of mosquitoes known to inhabit Great Britain, only *Culex pipiens* is at all likely to breed in ordinary water-storage tanks. It is, furthermore, a species that rarely or never bites man. Two other species, namely, *Theobaldia annulata* and *Culex molestus*, occur in such tanks under special conditions only. The first-named breeds almost exclusively in water fouled through contamination with sewage or other nitrogenous matter. *C. molestus*, on the other hand, appears to select water located in dark underground places such as basement-stored water. It is pointed out that static water supplies in open-air tanks need never be changed or treated from October until March inclusive since *Culex pipiens* is then in hibernation. At other times treatment need only be applied when necessary to allay public apprehension of the presence of breeding mosquitoes. In so far as the other two species are concerned, any larvicide used should be non-injurious where asphalt or bituminous rendering has been employed for water-proofing purposes. This means that oiling of the water is undesirable; also it is deleterious to the rubber of stirrup pumps, etc. Disinfectant fluids of the nature of coal tar derivatives are harmless in the above connexions and at the same time effective larvicides at about one part in 28,000–50,000, according to circumstances. Their use is therefore preferable and to be recommended.

Entomology of Commerce

AT the annual general meeting of the Society of Public Analysts and Other Analytical Chemists held on March 6, a lecture on "The Entomology of Commerce" was delivered by Prof. J. W. Munro, director of the Biological Field Station, Imperial College of Science and Technology, Slough. After a brief description of the main types of insects responsible for damage to foodstuffs and other materials, Prof. Munro mentioned some instances in which the ravages of certain insect pests have been traced to economic causes; for example, troubles from wood-boring insects due to importation of long-stored timber, and appearance of new types of infection in tobacco due to certain importations from Africa. Combating insect pests by cleanliness and rigorous control of storage conditions may suffice with materials initially sound, but is inadequate with materials imported in a highly infected condition. Work on this subject is being carried out at the Biological Field Station at Slough. Destruction by heat has been employed against wood-boring insects. Low temperatures are used in the tobacco trade; the resistance depends on the rate of cooling, and improved results have been obtained by a second cooling after an intermediate warming. Studies of the insecticidal action of some inert powders have given promising results; the action appears to be due to withdrawal of moisture. In discussing chemical insecticides that act in vapour form, Prof. Munro directed attention to the influence of various factors, such as temperature, and inequalities of distribution, and gave some results obtained in studying them. Investigations are in progress to elucidate the mechanism of insecticidal action and so to ascertain what properties are necessary in an insecticide to enable it to penetrate the epicuticle and cell-walls of an insect and upset the normal processes within.

National Astrophysical Observatory of Mexico

A NUMBER of distinguished scientific men from both North and South America took part in the Inter-American Scientific Conference held in Mexico during February 15–26, on the occasion of the dedication of the new National Astrophysical Observatory of Mexico. President Manuel Avila Camacho, of Mexico, in issuing invitations to the conference, said: "The purpose of the Mexican Government is to contribute to the maintenance, in the American continent, of the progress of science and culture, and thus counteract as much as possible, the paralysation of scientific and cultural activities in the countries devastated by war". The new Observatory is situated on land provided by the Government of the State of Puebla, near a small town of Aztec origin called Tonanzintla, about 80 miles east of Mexico City. Under the direction of Prof. L. E. Erro, observations of the southern Milky Way will be made with a 24–30-in. Schmidt camera, the most powerful telescope in the tropics. This instrument will be similar to the Jewett telescope at Harvard Observatory, and its mounting is at present under construction in the Harvard shops. Its location in lat. 19° is of great importance for studies of the southern skies, which are inaccessible to instruments farther north. The climate is excellent for observation, especially during the winter. The programme of the Observatory includes variable-star studies, and observations of meteors and the sun.

Carnegie Trust for the Universities of Scotland

THE fortieth annual report of the Carnegie Trust for the Universities of Scotland covers the academic year 1940–41, and includes details of the interim distribution of grants, the endowment of post-graduate study and research, assistance to students and an abstract of financial accounts for the year ended September 30, 1941 (Edinburgh: Carnegie Trust for the Universities of Scotland). Of the three who were elected to fellowships at the beginning of the year, two are still working in universities, and of the nine awarded senior scholarships, five (of whom four were women) completed the session's work. Of the forty-five scholars elected at the beginning of 1940–41, nineteen resigned immediately upon appointment or requested that their scholarships be suspended on account of war service. Of the thirty-five fellows, senior scholars and scholars elected in July 1941, thirteen have similarly asked that their awards be held in suspense, while three others were unable to accept owing to war work.

Reference is made in the course of the report to Dr. Webster's and Mrs. Hickie's work on the synthesis of compounds of possible value as anti-malarials, and to R. R. Coats's investigation on the interconversion of aromatic sulphonic acids and sulphones and on syntheses of sesquiterpene derivatives. J. Forrest has synthesized certain complex hydrocarbons and thrown much light on the reactions of fluorene, while A. B. Grant's work on the chitin of crab-shell has advanced our knowledge of chitose. Mention is also made of the work of Dr. W. Tebrich and Dr. J. M. Robson on the degree of penetration of sulphonamide compounds into the ocular tissues of rabbits when they are superficially deposited on the eye (see NATURE, Dec. 6, 1941, p. 695) and of Dr. J. D. Loudon's work on the mutual effect of substituent groups in benzene derivatives. The decrease in the assistance to students, amounting to 171 beneficiaries, was mainly among male students in the faculties of arts, law and divinity.

Biological Research in China

THE latest issue of *Sinensia* (2, No. 5–6, September, 1940) that has come to hand will be found an encouraging record of good work from the National Institute of Zoology and Botany, Academia Sinica, Peipah, Szechuan (China). With one exception the twelve contributions that go to make up the issue are the work of Chinese investigators. From the zoological point of view the most important papers are by Sicien H. Chen on leaf-beetles (Family Chrysomelidæ). This author proposes to raise the six sub-families that form this group to the status of separate families. This change implies that each of these families would become of the same taxonomic significance as the well-established families Cerambycidæ and Bruchidæ in the superfamily Phytophaga. In a second contribution the same author contributes extensive "Notes on Chinese Eumolpidæ", which deal with their classification and include descriptions of a number of new species. From the botanical side S. H. Ou's "Phycomycetes of China" (II) is a notable and well-illustrated paper. S.C. Teng's "Studies on Chinese Timber Trees in reference to Forest Management" (I) is a timely investigation now that the forests of China have come to a stage when they require systematic management.

Universities' Federation for Animal Welfare

THE fifteenth annual report of the Universities' Federation for Animal Welfare (UFAW) reports continued activities in its educational and research work; but as few students of the University of London are now in London college activities have been temporarily discontinued. More than six thousand copies of the Federation's new natural history lecturettes have been contributed at cost price to local education authorities. Much work is being done on the humane side of mole- and rabbit-trapping, and authenticated information is being collected from biologists. UFAW is not in entire agreement with the Ministry of Agriculture's war-time rabbit-trapping arrangements in allowing steel traps to be set in the open, and prefers the rabbit to be exterminated as a pest and not preserved for the trapping industry. It disagrees with recent attempts in rural circles to re-stock warrens that have been exterminated in the war-time rabbit campaign. The Federation has recently issued a leaflet directing attention to the condition of the Canadian beaver, noting that more than fifty thousand beavers a year have recently been trapped in Canada. It plans to promote Parliamentary bills to prohibit the sale of rabbits mutilated by gin trap or snare, and to prohibit the sale and manufacture of gin traps. Its Bill to prohibit the setting of gin traps in the open and making rabbit extermination compulsory became law in 1939.

Lice

UNDER the title "Lice" the British Museum (Natural History) has added another pamphlet to its Economic Series (1942). The author, Dr. John Smart, gives a very clearly written account of these creatures affecting man, including their life-history and how infection takes place. A short statement regarding louse-borne diseases is also included and there is a useful section dealing with the prevention and treatment of lousiness. The pamphlet is well up to date and includes some of the most recently acquired information. In its thirty-two pages are comprised all the essential facts likely to be required by non-technical readers. It can be obtained from the Museum or through a bookseller, price 6*d*.

Geophysical Institute of the Andes

THE Geophysical Institute of the Andes, just inaugurated in Bogota, Colombia, at the new Colegio de San Bartolome, is the most important one in South America, the only one in Colombia, and one of eight under the Southern Cross. It is directed by two Jesuits, the Rev. Simon Sarasola and Jose Ramirez, the latter a graduate in seismology at St. Louis. The seismological station is about 8,745 ft. above sea-level, and half-way up the Andes del Norte.

The Hebrew University, Jerusalem

Two hundred and ninety-five students have graduated at the Hebrew University, Jerusalem, during the last eleven years. 90 per cent of them have found employment of a nature permitting them to continue their studies in Palestine. Thirteen graduates found occupations abroad, mostly in the United States, and fifty-six continue with scientific and research work in the University itself, in the Hadassah Hospital, the Palestine Government, or other public institutions.

Hermann C. Vogel, 1842-1907.

HERMANN CARL VOGEL, the German astronomer, was born at Leipzig on April 3,1842. He was the youngest son of Dr. Vogel, a well-known schoolmaster and a brother of Edouard Vogel (1829–56), the African explorer. From the University of Leipzig young Vogel entered Leipzig Observatory and assisted Zöllner in researches on solar prominences. From 1870 until 1874 he was in charge of von Bülow's observatory at Bothkamp in Holstein, where he did spectroscopic work on the sun, the planets, stars and nebulæ. When the German Government in 1874 founded the Astrophysical Observatory at Potsdam, Vogel became one of the assistants, with Spörer and Lohse as colleagues. With Müller he prepared a spectroscopic star catalogue containing particulars of 4,051 stars, and in 1887 with Schreiner began the measurement of the radial motion of stars. He took an active part in the work of the International Chart of the Heavens and in many ways furthered astronomical science. His honours included the Valz Prize of the Paris Academy of Sciences, the Gold Medal of the Royal Astronomical Society, the Draper Medal of the U.S. National Academy of Sciences and the Prussian Order of Merit. He died at Potsdam on August 14, 1907, leaving by his will 17,000 marks to the Berlin Academy of Sciences for the encouragement of research in astrophysics. He had been director of the Potsdam Observatory since 1882, and at his death he was succeeded by Schwarzschild.

Night Sky in April

THE moon is full on April 1d. 12h. 32m. U.T. and new on April 15d. 14h. 32m. Lunar conjunctions with the planets occur as follows: Venus on April 11d. 16h., Venus 0·1° N.; Saturn on April 18d. 05h., Saturn 3° N.; Jupiter on April 20d. 01h., Jupiter 5° N.; Mars on April 20d. 17h., Mars 6° N. On April 4d. 04h. Mars will be in conjunction with Jupiter, Mars 1·7° N., and on April 28d. 09h. Saturn will be in conjunction with Uranus, Saturn 1·6° S. Mars, Jupiter and Saturn are still well placed for observation in the evening. Venus is a morning star and rises about 4h. in the middle of the month. On April 27d. 20h. 15·3m. the star β Virginis, mag. 3·8, will be occulted by the moon. An interesting binary, γ Virginis, has components of nearly equal magnitude, 3·6 and 3·7 respectively; the separation is 5·75″. The Lyrid meteor shower will be active during April 18–22; the radiant is at R.A. 18h., N. Dec. 33°.

Announcements

THE second lecture on the Science and Citizenship Foundation will be given by Prof. Lancelot Hogben at the annual general meeting of the Science Masters' Association, at 8 p.m. on April 9, in the Temple Speech Room, Rugby School, Rugby. The subject will be "Biological Instruction and Training for Citizenship". The lecture is open to the public without fee; tickets may be obtained from Mr. W. Ashhurst, Grammar School, Stretford, Lancs, or from Mr. H. J. Harris, 5, Barby Road, Rugby.

THE Town and Country Planning Association has organized a Conference on Industry and Rural Life which is being held at Newnham College, Cambridge, during March 27–30. Separate sessions will be devoted to agricultural planning and policy, decentralized industry, social life in villages, architecture, rural land-ownership, and design of new towns. Among those taking part are Sir Daniel Hall, Sir Montague Barlow, Prof. Patrick Abercrombie, Mr. L. F. Easterbrook and Prof. Sargent Florence.

ERRATUM.—In the article "The Sun and the Ionosphere" (NATURE, March 7, p. 277), line 9 from foot of Column 1, the word "ultra-violet" should have appeared before "radiation".

LETTERS TO THE EDITORS

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

A New Method in X-Ray Crystallography

The classical methods of X-ray crystallography give either the spacings but not the positions of the reflecting planes (if monochromatic radiation is used, as in the rotating crystal and powder methods), or the positions but not the spacings (if white radiation

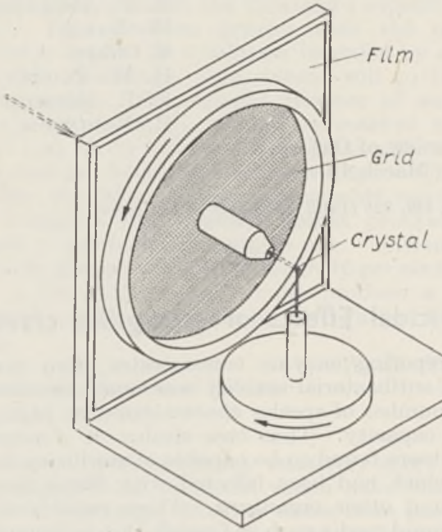

Fig. 1.

is used, as in the Laue method). X-ray 'goniometers' (Weissenberg, Schiebold-Sauter) give both positions and spacings, but only for one layer line at a time. In what follows a method will be described which gives directly both spacings and positions of the reflecting planes for all diffraction spots in a rotation or oscillation photograph on flat film.

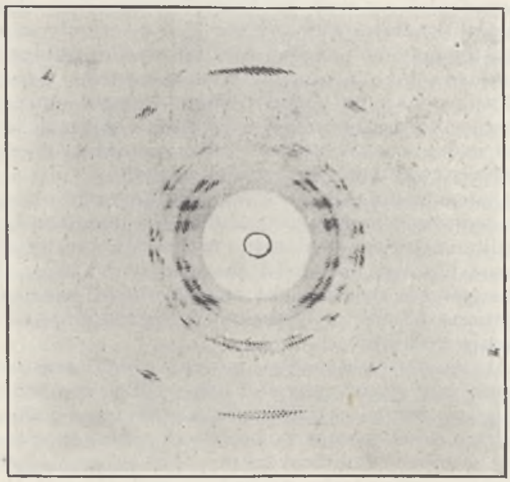

Fig. 2.

Central part of back reflexion rotation photograph; NaCl crystal, copper $K\alpha_1 + K\alpha_2$ radiation. Natural size; distance crystal–film 28·5 mm.; pinhole 1/3 mm.

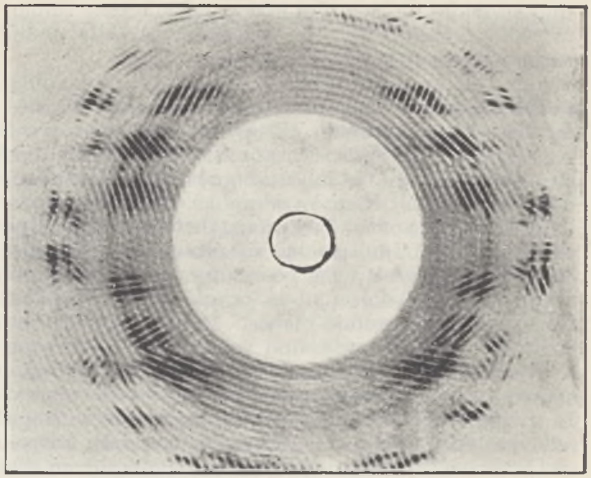

Fig. 3.

Centre of Fig. 2 enlarged by 2·4 diameters.

The apparatus differs from the usual rotating crystal arrangement only by the addition of a fine grid of thin parallel wires, placed close in front of the film, and rotated in its own plane during the exposure (Fig. 1). The rotation of the grid is mechanically linked with that of the crystal; provided that the total rotation of the grid does not exceed 180°, one position of the grid will correspond to one position of the crystal. The shadows of several wires appear as fine lines upon every diffraction spot (Figs. 2 and 3); they reveal the position of the grid wires and so the position of the crystal at the moment of reflexion. Thus the position of the reflecting planes in the crystal is given by the inclination of the shadow lines, while their spacing is obtained from the position of the diffraction spots by means of Bragg's law.

The photograph shown in Figs. 2 and 3 was taken with a back-reflexion arrangement, shown schematically in Fig. 1; in this case the tube of the pinhole can be used as the axle around which the grid rotates. Crystal and grid were rotated by a synchronous motor with slipless wire drive. The grid was made of copper wires (0·19 mm. thick, 23 wires per cm.) stuck to a strong 'Cellophane' sheet by 'Durofix'. Technical details will be given elsewhere. Fig. 3 is a part of Fig. 2, enlarged by 2·4 diameters; it does not show fully the sharpness of the shadow lines because the enlargement has been much over-exposed in order to make the structure of the background visible (see below). The angles between the shadow lines and a reference line are easily determined by a microscope with turn-table, mechanical stage, and cross-wires in the eyepiece. In the photograph Fig. 2 they could be read off with an accuracy of about ± 0·1°. The method offers a simple and quick way of determining crystal orientations; a detailed communication will appear elsewhere.

Originally, the method was developed for the investigation of internal strains, lattice curvatures, submicroscopic inclusions, and other irregularities which cause the diffraction spots to be drawn out to streaks. In such cases usually neither the classical nor the goniometer methods can reveal without ambiguity the character and orientation of the reflecting elements. The rotating grid method shows directly the positions of the crystal at which the different points of the streak were reflected, and thus provides information about irregularities similar to that provided by the classical methods about regular structures.

Fig. 3 shows that the shadow lines are not confined to the Bragg reflexion spots but often can be followed far into the background. (These straight lines in the background must not be confused with the concentric circles which are a trivial consequence of the rotation of the grid about the central spot.) Consequently, a large proportion of the background in the surroundings of a spot had been reflected simultaneously with the spot. This opens up the possibility of analysing the origin of the background in terms of contributions from individual atomic planes. Part at least of the structure of the background would seem to be due to the 'diffuse' ('dynamic') reflexion of X-rays, caused by the thermal vibration of atomic planes. In a system of shadow lines extending from a Bragg reflexion spot into the background, the dark stripes are produced by the total radiation coming from the crystal, while in the light stripes the radiation contributed by the lattice plane of the Bragg reflexion is screened off. Thus the difference of the intensities represented by the dark and the light stripes at two neighbouring points is the intensity diffracted by the lattice plane of the adjacent Bragg reflexion. This provides a means of quantitative measurements of the diffuse reflexion from individual lattice planes. The photograph Fig. 3, taken at room temperature, shows that the method can be used even at low temperatures, if, by a suitable choice of the radiation, the glancing angle of the lattice plane is brought sufficiently near to 90°.

Another possible use of the new method is for obtaining information about the mosaic imperfections of crystals. If the speed of rotation of the grid, but not that of the crystal, is increased, the contours of the shadow lines must become blurred as the transverse movement of the wires during the time of reflexion begins to be noticeable. If the primary beam is collimated by a perfect-crystal monochromator, this effect should give a direct measure for the X-ray imperfection of the crystal.

I am indebted to Sir Lawrence Bragg and to Dr. H. Lipson for valuable suggestions.

E. OROWAN.

Cavendish Laboratory,
Cambridge.
Jan 31.

Nitrogenous Character of Penicillin

PENICILLIN purified as described by Abraham and Chain[1] contains nitrogen. The interpretation of low positive results in the Dumas analysis of less pure material was made uncertain by the failure to respond to the usual qualitative test and by low results in Kjeldahl estimations. However, traces of pyridine have been recognized, by the characteristic absorption spectrum, as a product of the action of boiling concentrated sulphuric acid on the purest material. With this material the Kjeldahl method, under vigorous conditions, gave the same result as the Dumas. The barium salt, dried at 100° *in vacuo* over phosphoric anhydride (no further loss at 120°), contains (Weiler and Strauss): C, 44·3; H, 4·85; N, 4·13 (Dumas), 4·2 (independent micro-Kjeldahl); C-Me, 11·6; Ba, 22·0 per cent (independent estimation 21·3). There was no phosphorus or sulphur, and no O-Me or N-Me groups. These results are in fair agreement with the formula $C_{24}H_{32}O_{10}N_2Ba$. This is provisional, and C_{23} and C_{25} formulæ are not excluded. The barium salt is strongly lævorotatory in aqueous solution. The absorption spectrum does not suggest that aromatic rings are present in the molecule. Hydrolysis affords one carbon dioxide molecule and other products, including a water-soluble volatile acid, and a substance giving a sparingly soluble picrolonate, flavianate and aurichloride.

While it is possible that the above observations hold for pure penicillin, we cannot definitely claim homogeneity of the material in the absence of the usual criteria of purity.

E. P. ABRAHAM.
W. BAKER.
E. CHAIN.
H. W. FLOREY.
E. R. HOLIDAY.
R. ROBINSON.

University of Oxford,
March 18.

[1] NATURE, 149, 328 (1942) and paper in the press.

Bactericidal Effects of *Aspergillus clavatus*

IN preparing enzyme concentrates from certain moulds, antibacterial activity was noted in material from a number of species characterized by high proteolytic capacity. Thus two strains of *Aspergillus clavatus* were found to be capable of sterilizing liquid media which had been infected with *Staphylococcus aureus* and other organisms. These moulds invest simple liquid media such as Csapek Dox solution with distinct antibacterial properties. Small portions of the medium on which the mould has been grown inhibit the growth of *Staphylococcus aureus* in glucose broth and other media. Larger quantities of medium are bactericidal, no viable organisms being demonstrable after the mixture of broth and medium has been incubated for several hours. In intermediate dilutions an initial phase of bacteriostasis may be followed by bactericidal action. The active substance differs from penicillin not only by being bactericidal as well as bacteriostatic, but also in several other respects. First it is relatively stable; filtrates may be handled without sterile precautions, and even high acidity is well tolerated. Aqueous solutions may be boiled without being inactivated. Furthermore, the substance inhibits the growth of, and in higher concentrates kills, a number of organisms that are not attacked by penicillin.

Concentrates of the active substance are obtained by absorbing it on charcoal directly from the liquid medium after removal of the mycelium, and by afterwards eluting the dried charcoal with ether. The ether-soluble fraction shows bactericidal potency in dilutions of 10^{-5}. Occasionally more potent fractions were obtained.

Antibacterial activity is also demonstrable in presence of serum, pus and urine. The medium and active concentrates thereof were administered without adverse effect to mice, to healthy human subjects and to a number of clinical cases. The protective effect *in vivo* remains to be studied in greater detail, but it appears that the active fraction inhibits strains of organisms which proved resistant to such agents as sulphonamides or mandelic acid.

My thanks are due to Prof. H. Raistrick, Mr. George Smith and Dr. Harry Coke for much help and advice.

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London.
March 17.

Potable Water from Sea-Water

I WAS surprised that in his article on "Potable Water from Sea-Water" Dr. A. Parker[1] makes no reference to what seems to a biologist an obvious method—that found in the Bowman's capsule of the kidney. If a pressure greater than the osmotic pressure is applied to a solution bounded by a semi-permeable membrane, pure solvent will go through the membrane. The osmotic pressure of sea-water is about 450 lb./sq. in., a pressure reached over an area of 1 sq. in. by quite small car jacks with no more effort than can be applied with one finger. The only difficulty should be the semi-permeable membrane, and I suggest that research might profitably be devoted to producing a suitable one. It would not need to be perfect; if it let through 15 per cent of the salts, a two-stage pump would produce a liquid within the limit suggested by Dr. Parker for potability.

W. B. YAPP.

Manchester Grammar School.

[1] NATURE, 149, 184 (1942).

IT was not possible in my relatively short article to mention all the methods, which have been suggested, for obtaining drinking water from sea-water. The intention was only to indicate the main principles of the methods.

Suggestions of the kind mentioned by Mr. Yapp have been considered. If a method involving the use of a semi-permeable membrane as a filter under pressure is to be suitable for use under conditions similar to those in open boats, it must meet the following requirements: It must be simple to operate. The membrane must be so robust or so supported that there is little or no risk of the membrane being broken or perforated during transport and use. The rate of passage of the drinking water through the membrane must be reasonably high, say about one pint an hour. It is also desirable in the particular circumstances that the treated water should not contain more than about 100 parts of salt in 100,000 parts; this means the removal of at least 97 per cent of the salt in sea-water.

Ultra-fine membranes of the collodion type under pressures of the order of 250 lb. per square inch have been used in experiments for the Water Pollution Research Board for the removal of bacteria from liquids and for the separation of finely dispersed colloids from saline solution. Experience has shown that although the rate of filtration is very slow, salts such as sodium chloride readily pass through these membranes. It may be that intensive investigation would lead to the discovery of a membrane satisfying the requirements, but the problem presents so many difficulties that the prospects of solving it within a short time are not great.

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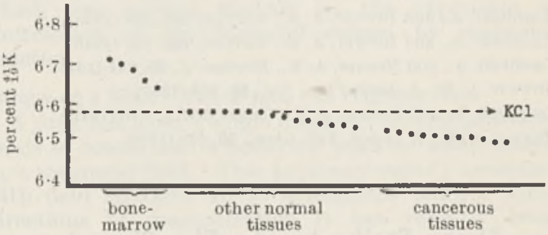
Watford, Herts.

An Isotopic Shift of Potassium in Human Bone-marrow and Cancer

IN previous investigations it has been found that the isotopic constitution of potassium contained in bone-marrow and tumour tissue from the rat was appreciably different from that of potassium in various other normal rat tissues, the shift observed with 'bone-marrow potassium' being opposite to that observed with 'tumour potassium'. As regards potassium in normal tissues other than bone-marrow, the content of the heavy isotope, $^{41}_{19}$K, usually proved to be very close to that of mineral potassium as contained in ordinary potassium chloride (A.R.); only in a few exceptional cases was the $^{41}_{19}$K content slightly decreased[1,3]. However, with potassium in bone-marrow (that is, bone including marrow), a marked and regular increase in the content of $^{41}_{19}$K was obtained; on an average, the increase was 1·9 per cent[1,3]. This result agreed with earlier findings on potassium in bone-marrow from horse and beef[4]. A similar shift was further obtained with potassium present in rat blood plasma[2,3]. On the other hand, potassium in Jensen rat sarcoma showed a distinct decrease of its $^{41}_{19}$K content, and a similar result was found with potassium in mouse sarcoma 37*S*. The average decrease for both tumours was 1·1 per cent[1,5].

It was of interest to carry out similar investigations on potassium contained in human tissues. This has been done, so far, with postmortem material, taken as a rule twenty-four hours after death. A number of normal tissues ('non-cancerous' tissues in a stricter sense) were tested; they included five samples of bone-marrow, taken from lumbar vertebræ, and fifteen samples from liver, kidney, lung, spleen, brain, heart and skeletal muscle. All the samples were derived from organs which showed, on macroscopical examination, little or no pathological changes. Further tests were made with various kinds of cancerous tissue, consisting of eight samples of primary carcinomas which originated from liver, kidney, lung, stomach, colon and rectum, and of three samples of secondary carcinomas (metastases) of the liver. The preparation of ashes and the technique of mass-spectrographic analysis were similar to those previously described[3,6].



CONTENT OF $^{41}_{19}$K IN POTASSIUM PRESENT IN CERTAIN TISSUES FROM HUMANS.

Dotted line indicates content of $^{41}_{19}$K in mineral potassium as contained in potassium chloride, A.R.

The results are illustrated in the accompanying figure. Each recorded point indicates the percentage of $^{41}_{19}$K in potassium contained in one ash sample; the whole of the values is arranged in a descending order of magnitude, independently of the tissues concerned. It will be seen that there are five values which are above the level represented by the $^{41}_{19}$K content of mineral potassium; the increase is, on an average, 1·5 per cent. These values were obtained with bone-marrow. Another group of fifteen values corresponds to the other normal tissues mentioned, seven values being identical with the $^{41}_{19}$K content of mineral potassium and two fairly close to it. The six remaining values are slightly below this level. A more marked decrease, however, was obtained with cancerous tissues: all the eleven values were lower than any of those found with normal tissues. (The two highest values correspond to samples from secondary liver carcinoma.) On an average, the content of $^{41}_{19}$K was by about 1·0 per cent smaller than that of mineral potassium.

It can be said that the results are in general agreement to those obtained with corresponding tissues of animal origin. As in that case, the $^{41}_{19}$K content of potassium in bone-marrow is higher than that of mineral potassium and potassium in other normal tissues, while potassium in cancerous tissues shows regularly a lower content of $^{41}_{19}$K than that of potassium in every tested normal tissue. In particular, there appears to be some lack of agreement, especially if one considers that six of the values found with normal tissues have shown a certain approach to those obtained with cancerous tissues. In accounting for these values one has to remember that potassium in normal rat tissues showed occasionally a similar deviation, and it is further necessary to consider the possible influence of post-mortem changes and of pathological conditions in the tissue other than cancer formation. It is of interest to note, in this connexion, that three of the six tissue samples concerned originated from cancer cases, while the nine other tissue samples belonging to this group were obtained from non-cancer cases only. This might indicate that potassium in non-cancerous tissues of cancer-bearers approaches in its isotopic constitution that in the cancerous tissue: a conclusion which is consistent with previous findings on potassium in muscle tissue from tumour-bearing rats and mice[5].

A. LASNITZKI.

Department of Physiology,
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University of Birmingham.

A. K. BREWER.

U.S. Department of Agriculture,
Washington, D.C.
March 9.

[1] Lasnitzki, A., and Brewer, A. K., NATURE, 142, 538 (1938).
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[6] Brewer, A. K., *J. Indust. Eng. Chem.*, 30, 893 (1938).

Sheep Strike by the Fly, *Phormia terrae-novae* R.-D., in North-east Scotland

DURING May–July, 1941, my colleague, Mr. W. Moore, who is studying pesticides in the North of Scotland College of Agriculture, Aberdeen, accidentally found the fly, *Phormia terræ-novæ* R.-D., attacking sheep in north-east Scotland. In the last week of May, when fly-strike had become fairly general, Mr. Moore decided to clean out and disinfect the breeding-chamber for flies and to restock it with a fresh supply of the sheep maggot fly, *Lucilia sericata* Meigen, bred from maggots found on sheep. The first eleven batches of maggots were obtained from sheep on widely scattered farms. Each batch of maggots was reared under fly-proof conditions. The flies that emerged from the eleven batches of maggots were *Phormia terræ-novæ* R.-D. The species seemed the cause of primary strike in many cases. This is the first record of it striking sheep in north-east Scotland. Not until the second week of July did Mr. Moore obtain maggots of *Lucilia sericata* from sheep, and then he found it mixed with *P. terræ-novæ* in two cases. Later strike by *L. sericata* seemed to become general.

Since strike was very common during 1941 in the north-east of Scotland and since the species responsible for it was not investigated in most cases, it seems probable that *P. terræ-novæ* occurred commonly in strike, at least early in the year. Macleod[1], Haddow and Thomson[2], and Macleod[3] have recorded this fly striking sheep on the mainland of Argyll and in Mull, and in some instances the strike was apparently primary.

Very little is known about the habits and life-history of the insect in Great Britain; for example, the food of the majority of its larvæ is unknown. The insect is abundant in north-east Scotland. Some adults apparently hibernate, for I caught a female in April 1929, a male on March 30, 1930, and a female on April 9, 1930, in the loft of a house in Aberdeen. The flies seem to reach their maximum numbers towards the end of July and to disappear from the open during September–October. Between July 18 and October 10, 1933, I caught in a single trap in my garden in the suburbs of Aberdeen 799 females and 559 males (compared with 863 females, 96 males *Lucilia sericata*), and between June 13 and July 27, 1934, in five traps on a farm of the Rowett Research Institute, Aberdeen, 1,915 females, 1,078 males (compared with 2,249 females, 265 males *L. sericata*).

The traps were baited with carrion, which is highly attractive to the flies, though they rarely breed upon it according to my observations of insects bred from carrion. The only time I bred the insects on carrion—and this is somewhat doubtful, for the flies may have struck the sheep when it was still alive—was at Dornie, Ross-shire, where I found a number of puparia among the wool of a sheep that had died some weeks previously. The puparia were found on May 22, 1940, and flies emerged from them during June 2–10, 1940. Smirnov[4] found *P. terræ-novæ* the chief species of fly visiting baits of meat exposed in the open air in the U.S.S.R.; it seldom oviposited on them; its larvæ occurred chiefly in kitchen refuse.

Evans[5] found it the most resistant of four species of blowflies to high temperature and various humidities. In my trapping experiments I found the fly the most resistant of about thirty species of flies to the effects of chloroform.

G. D. MORISON.

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North of Scotland College of Agriculture,
Aberdeen.
March 11.

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RESEARCH ITEMS

Floral Morphology and Angiosperm Phylogeny

THE *Transactions and Proceedings of the Botanical Society of Edinburgh* (33, Pt. 2; 1941) contains the presidential address by J. R. Matthews upon floral morphology and its bearing upon the classification of Angiosperms. His review makes it abundantly clear how every concept associated with the classical view that floral organs are necessarily modified leaves has been challenged at one time or another. The recognition of stamen and carpel as sporophyll forms, which led to the attempt of Arber and Parkin to reconstruct a hypothetical pro-angiospermic type allied to the Bennettitales, called forth Chamberlain's emphatic statement that any such origin of the Angiosperm must be regarded not merely as improbable but as impossible. Hooker is quoted from a letter to Newell Arber, dated 1907, as holding to Robert Brown's view of the Angiosperm orders "being reticulately, not lineally, related" and there is an interesting discussion of the phylogenetic value of the polyadelphous character of the stamen. Thus the typical stamen may be regarded as the result of a progressive shortening of a dichotomizing branch system while Hunt (1937), as a result particularly of a study of stigma and style, has similarly concluded that the carpel may be traced ultimately to a dichotomous branch system. There is no discussion of Grégoire's rejection of homologies between reproductive and foliar organs, but McLean Thompson's decision that the inferior ovary is 'acarpous' is presented. Grounds are given for the conclusion that "there is clear evidence also of a re-awakening of interest in the problems of taxonomy and phylogeny".

Chemistry of Pterins

AT a meeting of the Royal Society on March 19 Sir Frederick Gowland Hopkins described some experiments chiefly concerned with a derivative from pterins. These pigments have become prominent of recent years, partly on account of the prolonged efforts (1925–1941) of Continental workers to determine their nature. The progress of these constitutional studies has quite recently become dramatic. Moreover, one pterin at least has been shown to occur in mammalian tissues, with probable physiological functions there. The derivative examined involves an oxidation by molecular oxygen in solution of low *p*H. On the acid side of neutrality its formation proceeds throughout a wide range of *p*H values, but not at all on the alkaline side. From one pterin (erythropterin) the yield is large. From another (xanthopterin) it arises only in special circumstances, which are of considerable interest. The properties and behaviour of this derivative (which in some respects are exceptional) are described. No evidence bearing on the actual constitution of the product has yet been obtained. It seems justifiable to claim, however, that until the structure of this derivative is determined and the mechanism of its formation made clear, the chemistry of the pterins will remain incomplete. Another section of this paper deals briefly with the yellow products which occur when aqueous suspensions of uric acid are heated in sealed tubes at high temperature. These show properties strikingly akin to those of the pterins, and in particular yield purple derivatives in precisely those circumstances which lead to the formation from the natural pigments of the products dealt with in this paper which they closely resemble.

Submarine Contours of the North Pacific

SONIC sounding has increased our knowledge of the details of bathmetrical relief. F. Betz and H. Hess have produced in the *Geographical Review* of January a map of submarine contours of the North Pacific ocean based on the United States Hydrographic Office chart of that ocean in 1939. The detail now available allows the authors to discuss anew the probable structure of the ocean floor. The most interesting suggestions relate to the large number of trend lines in the relief. An orientation N. 75°–80° is particularly notable, but others cross these trend lines, and in particular the Hawaiian rise or swell, the main axis of which is N. 55°–75° W. The shape and other characters of the Hawaiian swell suggest that it is not, as often supposed, a folded ridge, but a fissure or perhaps tension crack accompanied by the extrusion of large amounts of volcanic material. Probably the extrusion covered a long period of geological time. The down bending of the crust beneath the load would account for the slight longitudinal depressions along the margins of the swell. The authors further suggest that the fissure, as, indeed, other Pacific fissures, opened along the strike, so that the origin of these structures is in transcurrent folds which would also explain the relative straightness of these trend lines. Other transcurrent faults in continental structure are cited, and their configurations shown to agree with the Hawaiian and Pacific rises generally. All are not associated with volcanic outpourings.

Magnetostriction in Permalloy

Messrs. Williams, Bozorth and Christensen, of the Bell Telephone Laboratories staff, have found (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941) that magnetostriction in 68 per cent nickel permalloy varies by a factor of ten when the metal is subjected to heat treatment while being oriented in different directions in a magnetic field. Magnetization was also found to affect the elasticity and rate of damping of mechanical vibrations of this material. The tests were conducted on a hollow rectangular specimen wound with long thin coils to form a closed magnetic circuit, thus avoiding demagnetizing effects. The minute changes in dimensions, corresponding to a few millionths of a centimetre for each centimetre length of the specimen, were measured by reflecting light from a small mirror, which was rotated slightly by the expansion or contraction of the material caused by magnetostriction.

Torque on a Silicon Iron Crystal in a Magnetic Field

A DISK cut from a single magnetic crystal generally tends to rotate into a preferred position when placed in a magnetic field. This tendency usually increases with field strength up to saturation, but for some directions of magnetization it has recently been found to pass through a maximum, decreasing with further increase of field strength. R. M. Bozorth and H. J. Williams (*Bell Lab. Rec.*, 20, No. 2, Oct., 1941) have recently shown that this behaviour can be explained by the domain theory of magnetism, which describes a magnetic material as consisting of groups of atoms acting as units. When placed in a magnetic field, these units tend to turn into the direction of the field, the specimen tending to rotate as a whole. Calculations show that for some directions of magnetization, this tendency passes through a maximum as the domains change their alinement under an increasing field. The calculations are confirmed by the authors' experiments, in which the tendency of the crystal to rotate is determined by supporting it on a wire between the poles of an electromagnet and measuring the twist of the wire necessary to counteract the torque.

Impulse Electric Strength of High-voltage Cables

AN official communication (Ref. L/T126) from the British Electrical and Allied Industries Research Association is presented by R. Davis, of the National Physical Laboratory, in the February issue of the *Journal of the Institution of Electrical Engineers* (89, Pt. II, No. 7), giving the results of tests made mostly on virgin paper-insulated single-conductor cables of the solid or mass-impregnated type, but in addition on varnished-cambric, non-bleeding paper, H-type multicore, and belted-type cables. The conclusions reached refer only to the cables tested. The minimum impulse electric strength of virgin mass-impregnated paper-insulated single-conductor and multicore screened cable is approximately constant at 1,000 kv./cm., being independent of the voltage rating and of the sectional shape of the conductor, whether circular or elliptical. The effect of the wave shape of the applied surge on the puncture voltage and of repeated applications of surge voltage less than that necessary to cause puncture, is small. In general the positive puncture value is a few per cent higher than the negative. With impulse-voltage stressing, the non-bleeding and varnished-cambric types of cable punctured at a lower voltage than the fully impregnated types. While no direct comparison has been made between aged and unaged cables which are otherwise identical, the tests have failed to differentiate between the behaviour of aged and virgin cable with impulse voltages. The research continues.

The Electric Spark

AN important contribution to the study of the electric spark is contained in a paper read recently by J. M. Meek before the Institution of Electrical Engineers in which the author first discusses the inadequacy of the classical theory of spark discharge when applied to long gaps at atmospheric pressure. A brief description of the streamer theory of the spark follows, which latter not only explains the observed sparking phenomena but also incorporates a criterion, based on atom-physical considerations, facilitating the calculation of the breakdown potentials of different gaps in which the field distribution is known. For gaps in which corona is observed to precede sparkover, the corona onset voltage is that determined. The results of such calculations for various types of gaps are described, with particular reference to the sphere-sphere gap. Various features of point-plane breakdown are also mentioned, and an explanation is given for the occurrence of the upward-growing positive streamer from the earthed plane when the high-voltage point is of negative polarity. It is further shown that in the case of lightning discharge from a negative cloud to earth in open country, upward-growing positive streamers from the earth are not likely to be more than a few metres long and thus will rarely be observed. Irradiation and statistical time-lag are dealt with in some detail. Various experiments are described, and it is shown that quite different results can be obtained according to whether the gap is illuminated or not by the light from neighbouring spark-gaps. The effect of such irradiation is found to be important for short gaps and for gaps several cm. long, and in particular for the positive impulse breakdown of a sphere-gap when the spacing is greater than that corresponding to the Toepler discontinuity. The lowering of spark-over voltage for uniform and non-uniform gaps by the intense light radiated from a nearby spark source was also investigated and an explanation of the various results obtained is given in terms of the new theory of the spark.

Concrete at Low Temperatures

THE problem of concreting in freezing weather frequently arises. It is well known that the structural value of concrete if 'frozen' may be utterly destroyed, and consequently present-day methods prescribe that if concrete is placed in freezing weather it will be heated and maintained by insulating material at temperatures well above freezing point. The additional use of calcium chloride has been suggested, as it speeds the attainment of strength and reduces the time during which protection is necessary. As a small quantity of calcium chloride reduces the freezing point of water by only a few degrees, it has been assumed that calcium chloride would not prevent the freezing and destruction of concrete cooled well below freezing point. J. C. Yates, of the Calcium Chloride Association, working at the U.S. National Bureau of Standards, has made specimens of concrete at 70° F. containing 0, 2, 3 and 4 per cent of calcium chloride by weight of cement, immediately placing them in rooms kept at various temperatures maintained between 20° F. and 40° F. (*J. Frank. Inst.*, Jan., 1942). The specimens were removed one day before testing, and it was found that with the exception of the plain concrete all had gained strength. At 28 days, the plain concrete at 25° F. had a strength of 1,130 lb./in.^{2}, at 32° F. a strength of 3,150 lb./in.^{2} and at 40° F. a strength of 3,790 lb./in^2. The addition of calcium chloride increased the strength at all temperatures and ages. The earlier the age and lower the temperature the greater the effect. With 4 per cent calcium chloride, the 28-day strength at 20° F. was 1,370 lb./in.^{2}: at 25° F. the strength increased from 1,130 to 3,030 lb./in.^{2}.

Galactic Absorption and Apparent Distribution of Spectral Types

GEORGE ALTER has shown that the absorption conditions in a uniform and continuous absorbing galactic layer can be determined by the observed relation between colour index and absolute magnitude, and limits are given for the absorption coefficients (*Mon. Not. Roy. Astro. Soc.*, 101, 2, 84). The influence of this absorbing layer was shown to be dependent on a parameter *b*, the qualities of which are discussed in a recent paper on the subject (*Mon. Not. Roy. Astro. Soc.*, 101, 8). The investigation is extended to absorbing layers which are either discontinuous or non-uniform, or both, and thus includes irregular absorbing clouds. Various conditions of interfering absorbing matter are assumed, and an attempt is made to derive the relation between true star distances and those determined by observed colour indexes. Alter shows that this interfering matter is responsible for falsifying the average mixture of spectral types, and in some cases the mixture falsification under certain assumptions becomes very complicated. Deductions of the investigation are confirmed by an instance from a colour index examination in a region of absorbing clouds.

COFFEE GROUNDS IN ANIMAL RATIONS

By W. KING WILSON
Harper Adams Agricultural College

DURING war-time the urgent need for more foodstuffs for human consumption results in oats and other feeding stuffs commonly used for animals being largely diverted from animal rations, for which therefore other materials must be found. Among the substitutes for concentrates in the rations of the domestic group of animals (for example, pigs, poultry and rabbits), household food scraps have to make a large replacement. For this purpose house-waste is collected individually, or in some urban areas by the local authority. The majority of the food-scraps are of approximately known feeding-stuff value, but the values of some ingredients that may be present, such as coffee grounds, are more problematical. Coffee grounds are not generally used as a feeding stuff, but during the War of 1914–18 coffee grounds were collected and fed to livestock in many parts of Germany[1], although the digestibility of their crude protein was very low, namely, 11–20 per cent.

The general chemical character of spent coffee grounds is illustrated by two samples of dried coffee dregs from the second infusion which gave the following composition[2], per cent: water, 9·45 and 11·42; fat, 11·64, 12·45; nitrogen, 11·68, 11·5; caffeine, traces; starch, 17·00, 22·47; sugar, traces; ash, 1·71, 2·03; nitrogen-free extras, 14·81; and fibre, 25·30 (second samples).

Coffee dregs have been fed to cattle (beef and dairy), horses, pigs, rabbits and poultry (chickens and ducks). They were found to be more suitable when powdered and fed very dry, instead of as grains. The following amounts could be consumed daily: steers 3·3 lb., cows 2·2, horses 1·7, but preferably only up to 0·8 lb.[2] From other experiments it transpired that not all animals would eat the finely ground coffee dregs[3]. When horses received 1·1 lb. daily, in place of a similar quantity of oats, it produced nervous excitement. Apart from these scanty reports there is little guidance as to the feeding value, if any, of coffee dregs as an animal foodstuff in war-time rations.

Although Great Britain is primarily a tea-drinking country, during 1935–37 the apparent annual consumption of coffee rose from 294 thousand hundredweights to 302 thousand hundredweights and may have increased further since the introduction of tea rationing. The weight of refuse grounds available must be very considerable, and the frequency with which they will be mixed with the general household food waste makes it desirable that further information as to their value should be obtained. (To cope with the high production of coffee, Brazil destroyed 30 per cent of the pre-war crop. In the period June 1931–August 1938 more than 74,000,000 hundredweight were thus destroyed. Stocks remained high and coffee planting was forbidden. United Kingdom imports were then almost entirely confined to high-grade coffee from East Africa, India and Costa Rica.)

In 1939 observations were made in the Rabbit Section of the National Institute of Poultry Husbandry on feeding small quantities of coffee dregs in the maintenance rations of different types of rabbits. For the first two or three days this material was generally left uneaten, but by reducing the concentrates most of the animals were soon induced to eat the fresh coffee dregs, up to the equivalent of 10 per cent of the concentrates, although a few individual animals remained adamant in their refusal. Afterwards the following small experiment was initiated to continue through the period of winter food scarcity, prior to the growth of appreciable quantities of spring greenfoods.

Twenty adult rabbits were divided into two equal groups, of similar live weight, housed in individual hutches and fed on mixed rations consisting of approximately 8·3 oz. roots, 1·7 oz. hay, and 2·3 oz. mash to the control group, while the other group had 10 per cent (on dry matter basis) of the concentrates replaced by fresh spent coffee grounds. Four times the weight of fresh moist grounds were fed to replace one of dry food. The daily quantities were modified slightly to a level where the coffee group cleared their daily ration, and roots were fed more extensively. The roots and hay were fed in equal quantities to both control and coffee-fed groups. The details of food consumption are set out in Table 1, by periods of lunar months.

TABLE 1.—AVERAGE DAILY FOOD CONSUMPTION (OUNCES).

	Control			Coffee			
Period	Mash dry	Roots, etc	Hay	Mash, dry	Coffee	Roots, etc.	Hay
1	2·32	8·29	1·71	2·09	0·93	8·29	1·71
2	2·14	11·20	1·77	1·93	0·86	11·20	1·77
3	2·05	11·20	1·71	1·85	0·82	11·20	1·71
4	2·05	11·20	1·71	1·85	0·82	11·20	1·71
Average	2·14	10·48	1·73	1·93	0·86	10·48	1·73

There was a noticeable tendency for the coffee grounds to be left until the other foods had been eaten, thus indicating that they were less palatable, although better than nothing, and were consumed in moderation up to 0·8–0·9 oz. On both of these rations the general condition and live weight were maintained, although there was a slight temporary drop, but this was due to seasonal modifications in the feeding of roots during frosty weather, and affected both groups. Apart from this their condition was maintained and later showed the usual small gains in live weight, in both the control and the coffee-fed animals, as seen in Table 2.

TABLE 2.—AVERAGE LIVE WEIGHTS.

	Control	Coffee	Difference
	lb. oz.	lb. oz.	oz.
Initial L. Wt.	8 6·50	8 6·30	−0·20
1 Month	8 2·90	8 4·60	+1·70
2 ,,	8 1·20	8 1·20	—
3 ,,	8 8·70	8 4·50	−4·20
4 ,,	8 11·20	8 9·40	−1·80
Average Gain	4·70	3·10	−1·60

Apart from improvement in live weight and body condition, there were regular observations of the fur development. There was a slight tendency to lose the coat gloss in the first period on coffee, which was followed by heavy shedding of the fur of four of the coffee-fed animals. Otherwise the general condition of the fur of both groups was generally good during the feeding of both rations. The only other note-worthy observation was that three animals appeared to move with a somewhat shaking gait from eight to ten weeks after the commencement of the coffee feeding. When inspected by the veterinary officer he asked for close observations to be kept on them. However, this tendency decreased and was not noticeable after twelve weeks, when they moved about more or less normally.

During the last period the stock in both groups was mated and the coffee-feeding was terminated. The fertility of the two groups showed little difference in the proportion of fertile does from this batch of matings. In the control group eight produced litters and in the coffee ration seven, a difference of only one.

The diet had a direct effect upon thirst, and whereas the controls, receiving dry mash, drank 5·2 oz. of water daily, those receiving a 10 per cent replacement of fresh (moist) coffee dregs only drank 3·1 oz.

[1] Bruttini, A., "Uses of Waste Materials" (1923).
[2] Aruch, E., *L'Italia Agricola*, **55**, 299 (1918).
[3] Bretana, *La Riforma Agraria*, **1**, 264 (1920).

AIR-RAID DAMAGE AND ELECTRICITY SUPPLY

A FURTHER series of articles in the February issues of the *Electrical Review* record instances of the air-raid damage sustained by overhead lines, cables, and substation equipment, and the steps taken to effect repairs and restore supply (see also NATURE of February 7, p. 173). Although many engineers fully expected that overhead lines in the path of bomb blast would be levelled to the ground, actual damage has not reached a quarter of that anticipated. Admittedly, line conductors have suffered, and on pin type insulator lines, conductor binders have been severely strained, but it requires direct hits on towers or poles to interfere seriously with supplies. Bomb splinters, not blast, are generally responsible for the damage, stranded conductors showing definite evidence of having been severed. Wood poles appear to withstand blast better than steel ones, one large rural undertaking reporting that out of many near misses, only one wood pole was rendered unserviceable. Damage to pole transformers is rare and is usually only a slight puncturing of the casing.

As an indication of the amount of damage substation equipment can withstand, a switchboard which was blown right out by blast needed only minor wiring repairs. On another occasion a large outdoor transformer had its cooling tubes pierced at their lowest point by bomb splinters, and although the entire oil contents drained away the plant continued to function. At a certain static substation, a large bomb almost dived under the floor, which was split into four complete sections. Each of these, containing plant, was raised a foot and was at a different angle from its neighbour. The 6·6-kv. switchgear was found at an angle of 15° to the normal horizontal plane, many insulators were cracked and broken, all the trifurcating cable-box supporting lugs were torn away, and feeders were left hanging by their tails. The transformers were moved 2 ft. and lay taut on their cables, while the low-voltage floor-mounted switch-fuse gear was flat on its back with all the cable plumbing cracked. The roof was distributed among the plant, but the supply was maintained. A heavy bomb fell close to the side wall of another substation containing a 500-kw., 6·6-kv. to 460-v. D.C. glass bulb rectifier equipment. The substation was rendered nearly roofless and quite windowless and doorless, but the electricity supply remained intact. When the internal debris was cleared away it was found that the entire substation equipment had been moved at least 6 in. One rectifier bulb was destroyed but it had successfully cleared its A.C. and D.C. protection; the remaining three bulbs were unharmed and complete automatic control remained.

A safeguard employed by one undertaking against incendiary bombs on slate-roofed buildings is the placing of iron sheeting above the 2 in. of sand which is recommended for covering the rafters or flooring immediately below the roof. This sheeting absorbs the impact of the bombs, which otherwise has a tendency to disturb the sand. Substations appear to suffer little damage from fire, and it is not uncommon to find that they are the only part surviving of buildings destroyed by this means.

Ideas are being rapidly revised on the subject of fire danger to transformers. Instances are recorded of their having been charred, their insulation burnt off underneath, their oil having been boiling and actually burning, and their connecting cables being burnt off to stumps at the point of entry, but in each of these cases the apparatus has been salvageable.

Damage to cables has provided the largest source of instructive facts and problems. Although, despite the most severe bending, stretching, twisting and flattening, cables frequently remain in service, it cannot be taken for granted that an apparently sound length is unharmed. In many cases steel armouring has been found to have saved cables from damage, but it is advisable to carry out a pressure-test from at least the draw boxes on either side of the crater. Sometimes damage is caused to cable joints by vibration from nearby bombs, resulting in water entry. Pilot cables are often damaged although the main cables remain unharmed. Remarkable instances are reported of cables remaining alive after almost unbelievable damage. A 6·6-kv. cable cut by a bomb splinter remained in service for a fortnight, lying under debris without breaking down.

An indication of the depth of penetration that may be expected with some types of high-explosive bombs is provided by a chance hit on a 33-kv., 0·18-sq. in. submarine cable passing across a river mouth. This was damaged although the cable was some feet below the river bed and the water was several feet deep.

Restoration of electricity supplies after an air raid is very much simplified by having the area split up into sections, which, in a large area, may be self-contained and each have its own emergency repair gang. In repairing mains ruthless amputation of faulty sections is generally found to be the most successful course to adopt. Normally, cable saving has always been of paramount importance with distribution engineers, but under 'bomb conditions' experience has shown the necessity for quickly 'cutting and sealing' at the most convenient place for, generally, the craters quickly fill with water from damaged mains. Comparatively seldom, however, does the urgency of restoring supplies justify temporary cable repairs. While special emergency joints utilizing cold-filling compound have apparently justified their makers' claims, the general consensus of opinion is that they are not often warranted on the score of saving a few extra hours and should be used only when immediate recommissioning of the cable is essential. It must be emphasized that while some manufacturers claim their cold-filling joints are permanent, these joints are primarily for emergency use, and permanent repairs usually have to be carried out later. Failure to appreciate the necessity for very efficient mixing was, in fact, the cause of the breakdown of an 11-kv. joint after three months' operation. Another undertaking has come to the conclusion that the use of these joints is advantageous for cables of 33-kv. and higher, considering the saving of approximately a day and a half in the repair work worth while. In the bridging of cables across craters, many devices have been widely adopted, such as the use of scaffold poles as supports and the suspension of the cables temporarily on adjacent walls. Another scheme is the utilization of steel structures to support the cables temporarily while other parties requiring access to the crater attend to their work. These steel structures, which are generally covered with boarding to give the cable protection against stray splinters of anti-aircraft shells, etc., are erected rapidly and leave an almost clear space around for other work to be undertaken.

Practically all undertakings have now come to the conclusion that there is nothing to be gained by attempting anything in the way of actual repairs, apart from isolating bad sections of the system and restoring supplies to sound sections by means of alternative switching, while the raid is still in progress, except in very special circumstances. Apart from the unwarranted risk to personnel, little can be done until daylight. Much time and money is spent unnecessarily on having emergency repair gangs on duty throughout the twenty-four hours, and without any question of slackness it has been proved in practice that a much more satisfactory arrangement is to have the men standing by in their own homes and to call them up by telephone, or even by messenger, only when actually needed.

MARINE RESEARCH IN THE UNITED STATES

THE eight papers in the latest number of the *Journal of Marine Research** deal with all aspects of oceanography, physical, chemical, biological and bacteriological.

A. H. Woodcock continues an earlier inquiry into the effect of cold winds on a water surface. In shallow water the cooled surface water finds its way downwards by converging into small-scale streamings about 1 cm. across and several centimetres apart running parallel downwind. In vertical section a shallow surface stratum is broken up into a series of convection cells, and at the surface there are alternate convergent and divergent strips. In the open sea the small-scale streaming is present on the surface of the large waves, but there is also a large-scale convection mechanism with streams 50–100 ft. apart. On the small scale, lycopodium powder dusted over the surface falls at once into the linear pattern, and the gathering of Sargassum weed into parallel strips under the influence of a cooling wind is used as evidence of large convection cells.

* *Journal of Marine Research*, Vol. 4, No. 2, 1941. Sears Foundation for Marine Research, Bingham Oceanographic Laboratory, Yale University

Whitney describes measurements of the scattering of daylight in sea water. Whatever the altitude of the sun the light becomes more and more vertical as it penetrates, until it appears to reach an equilibrium distribution in which the light received from below is about half that received horizontally and roughly a fortieth of that from above. The depth at which such equilibrium is reached seems to vary between 5 and 30 metres according to the turbidity of the water. The measurements were made off the United States Atlantic coast and in a freshwater lake.

The waters off the United States Pacific coast are described by R. B. Tibby, who has measured the proportions of subarctic and equatorial waters in a broad coastal belt.

The first of the chemical papers deals with the $Na^{\cdot}/Cl'$ ratio in sea water. The relative concentration of all important ions in the sea is remarkably constant, but Robinson and Knapman, using a direct analytical method, have found a slightly higher ratio of $Na^{\cdot}$ to Cl' in the coastal waters of Puget Sound than in the open Pacific Ocean. The method will be of great value in studying small variations or continuous trends in the composition of sea water.

Sanderman and Utterback, measuring the radium content of bottom sediments off the west coast of America from Canada to the Arctic Ocean, confirm the earlier conclusion that deep sea sediments are richer in radium than those of the land areas, and that the concentration is largely confined to a very thin surface film. Their richest sample was one that was just skimmed from the sea bed, so fine that it took several days to settle. While admitting that the plankton is 100–1,000 times as rich in radium as the surrounding water they agree with earlier workers that the role of plankton as a carrier of radium to the bottom is likely to be negligible; their sediments from the regions of most abundant plankton were no richer than those from the most barren areas.

The biological papers deal mainly with the phytoplankton. W. E. Allen discusses the mechanism by which diatoms suspend themselves at levels favourable for their growth, or in some way keep contact with them. He considers their production of oils and gases, methods by which they can exert more or less friction on the surrounding water, and the possible effects of turbulent water movements. He believes that there are no reliable data for estimating the rate of sinking, laboratory methods lacking dependability for estimating the rates under complex sea conditions.

Gordon A. Riley summarizes his work on the plankton of the western North Atlantic in a diagram which illustrates the relationships between the phytoplankton and its environment. He makes an attempt to give algebraic expressions for the relative importance of the different factors. The equations need testing, and are likely to apply better to average than particular conditions, but they give some hope that the phytoplankton production will eventually be predictable with some accuracy.

A bacteriological paper is by C. W. Hock, who has isolated bacteria capable of decomposing chitin, the tough leathery substance found in both rigid and flexible parts of most invertebrates. The bacteria which attack this very inactive substance have been found in sea water, marine sands and muds, and in the intestines of several marine animals. Two species are described, both aerobic; ammonia-reducing substances and organic acids were among the products of decomposition.

G. E. R. DEACON.

FORTHCOMING EVENTS

Monday, March 30

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. C. E. N. Bromehead: "The Early History of Water-Supply".

Thursday, April 2

TOWN AND COUNTRY PLANNING ASSOCIATION (in the Dome Lounge, Dickins and Jones, 224 Regent Street, London, W.1), at 1.20 p.m.—"Reconstruction and the Land".

APPOINTMENTS VACANT

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

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Town Hall, St. Helen's, Lancs. (endorsed "Appointment of Electrical Engineer and Manager") (April 6).

DIRECTOR OF THE WELSH PLANT BREEDING STATION AND PROFESSOR OF AGRICULTURAL BOTANY—The Principal, University College of Wales, Aberystwyth (April 11).

LECTURER IN BIOCHEMISTRY—The Secretary, The University, Edmund Street, Birmingham 3 (April 25).

ENGINEER for the Sierra Leone Government Public Works Department—The Central Register (E. 370), Queen Anne's Chambers, Tothill Street, London, S.W.1.

TEACHER OF PHYSICS in the Science Department—The Principal, South-West Essex Technical College and School of Art, Forest Road, Walthamstow, London, E.17.

LECTURER (MAN OR WOMAN) IN MATHEMATICS in the Junior Technical School for Boys—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

PROFESSOR OF ANATOMY—The Secretary, University College, Cork.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Institute of Chemistry of Great Britain and Ireland. The Precious Metals. By H. Gordon Dale. (Twenty-fourth Streatfeild Memorial Lecture, 1941.) Pp. 20. (London: Institute of Chemistry.) [232

Royal Meteorological Society. Bibliography of Meteorological Literature. Prepared by the Royal Meteorological Society with the collaboration of the Meteorological Office. Vol. 5, No. 1 (January–June 1941). Pp. ii+14. (London: Royal Meteorological Society.) 2*s.* 6*d.* [252

Transactions of the Royal Society of Edinburgh. Vol. 60, Part 2, No. 16: The Macrofauna of the Intertidal Sand of Kames Bay, Millport, Buteshire. By Dr. E. Emrys Watkin. Pp. 543–561. (Edinburgh and London: Oliver and Boyd.) 2*s.* 6*d.* [262

Scientific Proceedings of the Royal Dublin Society. Vol. 22 (N.S.), No. 47: Phosphate Separation in Qualitative Analysis. By Prof. J. Reilly and M. O'Brien. Pp. 447–458. 1*s.* Vol. 22 (N.S.), No. 48: Note on the Analysis of an Irish Phosphate Ore. By C. L. Simpson and Prof. J. Reilly. Pp. 459–470. 1*s.* (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [262

British Empire Cancer Campaign. Eighteenth Annual Report of the Grand Council, 1941. Edited by J. P. Lockhart-Mummery. Pp. xii+238. (London: British Empire Cancer Campaign.) [272

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 13, No. 2, September 1941. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Alexander. Pp. iv+79–155. (London: H.M. Stationery Office.) 4*s.* 6*d.* net. [23

Smoke Prevention in relation to Initial Post-War Reconstruction. Pp. 24. (Nottingham: National Smoke Abatement Society.) 2*d.* [23

No Clean City: the Need for Smoke Prevention in Post-War Reconstruction. Pp. 14. (Nottingham: National Smoke Abatement Society.) 2*d.* [23

Éire: Roinn Talmhaidheachta (Department of Agriculture): Brainse Iascaigh (Fisheries Branch). Report on the Sea and Inland Fisheries for the Year 1940. (P. No. 5036.) Pp. 32. (Dublin: Stationery Office.) 6*d.* [93

Other Countries

Bulletins of Indian Industrial Research. No. 23: Dry Cell Manufacture. By G. D. Joglekar, Dr. K. Subba Ramaiah and Dr. Lal C. Verman. Pp. iv+58. (Delhi: Manager of Publications.) [232

Proceedings of the United States National Museum. Vol. 90, No. 3117: Notes on the Birds of North Carolina. By Alexander Wetmore. Pp. 483–530. Vol. 90, No. 3118: Notes on some North and Middle American Danaid Butterflies. By Austin H. Clark. Pp. 531–542+plates 71–74. Vol. 90, No. 3119: A New Genus of Psammocharid Wasp from China. By P. P. Babiy. Pp. 543–546. Vol. 90, No. 3120: Two New Species of Cecidomyiid Flies from Phlox. By Charles T. Greene. Pp. 547–552. Vol. 91, No. 3123: The North American Moths of the Genus Arachnis, with One New Species. By J. F. Gates Clarke. Pp. 59–70+plates 10–12. Vol. 91, No. 3124: Some Little-known Fossil Lizards from the Oligocene of Wyoming. By Charles W. Gilmore. Pp. 71–76. Vol. 91, No. 3125: New Species of Hydroids, mostly from the Atlantic Ocean, in the United States National Museum. By C. McLean Fraser. Pp. 77–90+plates 13–18. Vol. 91, No. 3126: The Nevada Early Ordovician (Pogonip) Sponge Fauna. By R. S. Bassler. Pp. 91–102+plates 19–24. Vol. 91, No. 3127: The Mexican Subspecies of the Snake *Coniophanes fissidens*. By Hobart M. Smith. Pp. 103–112. Vol. 91. No. 3128: Report on the Smithsonian-Firestone Expedition's Collection of Reptiles and Amphibians from Liberia. By Arthur Loveridge. Pp. 113–140. Vol. 91, No. 3129: Notes on some Crayfishes from Alabama Caves, with the Description of a New Species and a New Subspecies. By Rendell Rhoades. Pp. 141–148. Vol. 91, No. 3130: Notes on the Snake Genus Trimorphodon. By Hobart M. Smith. Pp. 149–168. (Washington, D.C.: Government Printing Office.) [242

Report of the Secretary of the Smithsonian Institution and Financial Report of the Executive Committee of the Board of Regents for the Year ended June 30, 1941. (Publication 3643.) Pp. ix+136+5 plates. (Washington, D.C.: Government Printing Office.) [252

Smithsonian Miscellaneous Collections. Vol. 101, No. 7: Archeological Remains in Central Kansas and their Possible Bearing on the Location of Quivira. By Waldo R. Wedel. (Publication 3647.) Pp. ii+24+10 plates. (Washington, D.C.: Smithsonian Institution.) [252

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