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MAN-POWER AND WAR PRODUCTION

THE dominant lesson of the War is that the quantity and scale of the equipment which the combatants can throw into the scales at the right place will go as far to determine the issue of the struggle as the military virtues of the rank and file or the skill of the commanders. The industrial effort of Great Britain and its Allies must be raised to a level from which the flow of equipment will swamp that of Germany. Not until it can be said of the Allied forces that, like the German fighting man, they are equipped with every offensive weapon and every device for their protection that forethought and ingenuity can provide, may our war production be regarded as adequate.

Ultimately war production resolves itself into the question of the disposition and control of man-power and woman-power, and in considering whether our industrial effort is adequate to our needs there are three main factors to be examined. The first concerns labour, the second management and the third staff work at the centre. The proposals outlined by the Prime Minister in the House of Commons on December 2, with the call for a further inroad upon the amenities of life, appear to lay the main stress upon labour, but the response in the subsequent debate to the Prime Minister's appeal for proposals for the development of the war effort indicates that Parliament is well aware of the importance of the second and third factors, as indeed the reports of the Select Committee on National Expenditure have already shown.

When Mr. Bevin called for a 40 per cent increase in production this winter, he justified by implication much of the criticism to which the Government has been exposed in this matter. That criticism has been essentially constructive, as is recognized in the whole procedure adopted by the Government in dealing with what Mr. Churchill termed the crisis of man-power and woman-power which will dominate the year 1942. The attention focused on the amount of man-power and woman-power by the White Paper which has now been issued, and discussions as to the means of directing our diminishing reserves to the points at which they can contribute most to the national effort, should not be allowed to deflect attention from the equally vital matter of the use to be made of the reserves thus deployed or of the forces already in action on the Home Front or in the Services. The full national effort will only be exerted when all possible reserves of man- and woman-power have not merely been brought into service but when their potentialities are being utilized to the best possible advantage.

It is on this question that there is the most serious reason for anxiety. A disquieting volume

of evidence, some of which was provided in the recent debate, some in reports of the Select Committee on National Expenditure, and some in the preliminary report of the Beveridge Committee on the use of skilled labour in the Services, indicates that management in the Forces and in industry has not been so efficient as it might be in eliminating waste. There is other evidence, notably in the handling of the concentration of industry, and of the distributive trades, the limitation of supplies and the registration of retail shops, of defective staff work at the centre leading to the dissipation or disappearance of labour which should have been released for war purposes by the closing of businesses or retail shops. The persistent reluctance of the Government to use boldly and imaginatively the wide powers, given to it by the Enabling Act, on the formation of Mr. Churchill's Government, is probably the most potent single factor in any uneasiness with which the Government's handling of this extremely complicated and difficult question of man-power and woman-power is still regarded.

If the Government has never taken full advantage of the psychological value of the Enabling Act, it is the more important that nothing should be done to impair whatever fresh opportunities the new National Service Act may afford. There should be no possibility of fresh charges of discrimination between class and class or of causing friction that may endanger single-minded devotion to winning the war. The exclusion of married women under thirty from conscription, whether or not they have home ties or duties, may easily engender a sense of unfair discrimination against the unmarried woman, particularly if already employed, or lead to untoward or undesirable social consequences unless the situation is carefully handled on some such lines as those now to be applied in the new system of reservation for men. Sufficient substance has already been forthcoming for criticisms of wasted man-power for the country to be entitled to an assurance that when the Government and industry receive these immense supplies of new labour they will be more efficiently used than those already available. The immense demands made on leadership and management by the system of individual rather than group reservation are scarcely realized. Sir John Wardlaw-Milne's comments regarding the Special and Central Registers voice an anxiety widely existent among scientific workers and one which will not be dispelled while there is any evidence of undue tenderness to management or workers who put selfish or sectional ends before the national interest.

The system of individual reservation will be welcomed by scientific workers, who have already from time to time expressed serious concern as to the use which is being made of Great Britain's scientific man-power. The closer scrutiny of the essential character of every man's work, however, makes demands on management as well as on the new man-power boards which will involve no small measure of public spirit and sound judgment, if their purpose is to be served and if no bottlenecks are to be created in any transfer of workers. There should be opportunities for much fuller co-operation by the professional associations of scientific men, and the new system is likely to call forth their utmost sense of public responsibility.

To remedy the lack of co-ordination and utilization of scientific and technical man-power, a conference of the Association of Scientific Workers in Birmingham has already suggested a programme for the full employment of technical staff, the pooling of technical information between the Government and industry and adequate training facilities for inexperienced personnel (see p. 759). Peace-time methods of organization were alleged to be preventing the fullest use being made of the reserves of existing laboratories, and it was also stated that production has been impeded by the absence of systematic pooling of scientific information. Certain of these criticisms and proposals will doubtless be further explored at the open Conference on Science and the War Effort convened by the Association in January, particularly at the session on January 11, when the material collected by the Association's Industrial Committee on the utilization of scientific personnel will be considered.

In the meantime, Mr. Bevin's decision to establish in the Ministry of Labour machinery a proper appointments department including the Central Register (see p. 747) will be carefully watched. "The time has come", he said, "when proper provision in the technical branches of industry, right up to managements, should be conducted by the State, and the right people within the department should be appointed to handle it as a specialist's job." That is an important step, and when implemented should do much to secure the more effective use of scientific and technical man-power and the appointment of managers capable of the staff work upon which so much depends if the new supply of labour is to be fully utilized. The present position of the employment of physicists is dealt with by the honorary secretary of the Institute of Physics on p. 756.

It has been widely appreciated that a more comprehensive survey of man-power cannot be made public without enlightening the enemy. Mr. Bevin's inability to place the Beveridge Report before the House is understandable. So, too, is the recognition that Britain lacks the man-power to maintain a great Navy, Army and Air Force and at the same time a sufficiently vast

industrial output. That main conclusion of Mr. J. D. Biggers's survey on President Roosevelt's behalf of British war production had already formed the basis here of an argument for a comprehensive strategy. What stands out above all else at the present time is the emphatic demand for careful and efficient administration. The need for perfecting the organization and use of man-power becomes greater, and the chief concern of most of the critics has been to strengthen the organization so that it may be equal to the burden placed upon it.

It cannot be fairly suggested that over the whole field output has fallen, as a result of slackness or indifference or absenteeism by the workers, much below what it would have been right to expect. The great body of workers, men and women, have worked well and consistently in conditions to which the War of 1914–18 could show no parallel, and Mr. Bevin's spirited defence of them is fully justified. Moreover, to some extent, what loss of output has been due to the workers, has frequently been the result of inefficient management as, for example, the absenteeism due to the attempt to work excessive hours, or sickness due to failure to provide adequate transport arrangements, canteens, efficient heating or ventilation and precautions against accidents. These are all day-to-day staff matters in industry, and the very fact that there have been such failures in Government factories, as well as in private industry, is bound to lead to some anxiety, in view of the increasing importance of such staff work with the growing influx of women in the war factories.

The utilization of married women, whether with or without children, and particularly on part-time work, involves even more complicated questions of administration and closer attention to welfare work. Apart from the questions of training, transport and hours, the provision of canteens and the like, there is the difficult question of shopping. Not all shopkeepers are as helpful as they might be to the industrial worker, and there is already a certain amount of discontent at the way in which a sheltered position is being used against the general interest. Government action in regard to shopping hours and facilities may become as imperative as in regard to the provision of crèches or day nurseries where local authorities or factories are slow to act. The chemical industry has already set an example in methods of co-operation which other industries might study with profit.

What is required, in fact, is not merely organizing ability and energy, but also sympathetic and imaginative insight into the needs and problems of potential and existing war-workers. It is this that gives special significance to a letter of Prof. Norman Bentwich in *The Times* regarding the use of neglected older men and women experienced in administration work, who are on the Central Register. Many such men and women would be content to do modest administrative work in the Services and would willingly be directed by their juniors in age. They might well supply that reservoir for the staffing of the welfare and administrative work of Government factories, which the Civil Service is untrained to provide and of which the Government, as the largest employer of labour, is in great need in the ordnance factories which have come or are coming into production. Prof. Bentwich suggests the formation of panels in the large towns and civil defence regions to interview those resident in the area and registered on the Central Register, with a view of recommending what use could be made of their services locally.

An admirable example of how the area boards themselves can contribute in such matters as the staggering of hours was described by Sir Edward Crowe in a lecture "Co-operation for Production" given before the Royal Society of Arts on November 28. The delegation of increased powers upon the regional boards of the production executive has been strongly urged as a means of revolutionizing output, coupled with effective staffing and the establishment of much closer relations with the industrial units. The work they have already done in removing bottlenecks, as described by Sir Edward Crowe, does indeed warrant the belief that there are wider spheres in which such boards could act promptly and with decision, and remove from the ministerial plane details of executive work which are properly handled by officials, as the Select Committee has already suggested.

The idea of a War Cabinet free from departmental responsibilities, the members of which could devote themselves to the major tasks of planning and of policy, like the establishment of a Ministry of Production to which Sir George Schuster inclines, is still resisted by the Prime Minister. None the less, Sir George's call for a new spirit as the greatest thing of all will meet with a wide response. It was apparent in the debate that on all sides of the House there are those who share his regret that the Government has not taken the step of enrolling every one for national service with payment on a subsistence basis during the War, and Sir George's suggestion of an expert committee to report on the effects of the present taxation system on industry has been warmly welcomed. In pressing for more unified direction of programmes at the top, for some organization for providing an independent check on the working of the Government machine with the view of learning from our errors, and for a thorough overhaul of departmental personnel and office methods, among other matters, Sir George was voicing beliefs widely held among scientific workers.

RELICS OF RICHARD JEFFERIES

The Nature Diaries and Note-Books of Richard Jefferies

With an Essay, "A Tangle of Autumn", now printed for the first time. Edited with an Introduction and Notes by Samuel J. Looker. Pp. 82. (Billericay : The Grey Walls Press, 1941.) 8*s*. 6*d*. net.

JEFFERIES has been dead for half a century, while three of his posthumous works were published in 1889, 1892, and 1909. Mr. Looker's scrap-book (it is scarcely more than that) of Jefferies' jottings will, therefore, come as a surprise to most people who, since Jefferies died at the age of thirty-eight after publishing twenty books in his lifetime, must have believed that only private letters remained to be read. Mr. Looker's remains, except for the short essay, "A Tangle of Autumn", are unhappily like the dead leaves brushed together by the gardener after the tree has shed them. They consist, apart from the essay, of a "Nature Diary" written between August and October, 1879, a notebook of stray gleanings between August, 1883, and July, 1884, and a couple of poems published in periodicals. The rest of the book is filled in by a longish introduction, a short bibliography, explanatory notes by the editor, and quotations from the published books where Jefferies had worked up an entry in the diary or notebook. It is not much of a harvest (the poems were certainly not worth reprinting), but the editor has at any rate performed a labour of love.

The mistake that nearly all commentators have made about Jefferies is indiscriminate praise, and Mr. Looker is no exception. It does his fame no good at all to speak of him as a great philosopher and profound metaphysician, which he emphatically was not. Many of the jottings in the notebook are obviously first drafts of "The Story of My Heart", a book which is now forgotten and, as the product of an almost pathological neurosis, not unjustly so. In that book Jefferies was stretching out towards "an existence infinitely higher than deity", which is rather like saying "I desire a life infinitely more deathless than immortality", and much of this fragile introspective stuff appears in the notebook in a briefer but not more intelligible form. The following is typical : "Aristotle : that God and design and all is a failure and immortality and soul : we must find something else : and reject the chart but sail the voyage and find a new thing, unforeseen". It is hard that poor Jefferies, who suffered so much from illness, disappointment, poverty and loneliness, should have his memory plastered with such babblings as these.

The essay is full of Jefferies' descriptive charm and eloquence (his strength was always in the objective, and it is sheer cruelty to his memory to resuscitate the subjective brooding of a frustrated life). But it is Jefferies at a good level average, not Jefferies at his best. The diary is very pleasant, and in its terse, brief, truncated observations not unlike Gilbert White's diaries, though not so good.

My own view is that Mr. Locker would have done better to have given us an anthology of Jefferies's published writings, with occasional passages from the unpublished work, each section of the florilegium illustrating some particular phase of the writer's genius. For example, Jefferies as a regional writer, as Clare, Bloomfield, Thomas Hardy, William Barnes and Gilbert White were. Jefferies was emphatically the poet-naturalist of a particular region, the Wiltshire-Berkshire borderland, though likewise of the South Downs and the once green belt of London. He was not a traveller like Hudson, and indeed he hated change :—"Let change be far from me ; that irresistible change must come is bitter indeed. Give me the old road, the same flowers, the old succession of days and garland, ever weaving into it fresh wildflowers from far and near." He and Alfred Williams were the tutelary spirits of White Horse and Liddington Hills and it is good that a memorial stone has recently been raised here to their joint memory. In these days of standardization and diffused uniformity, to dwell on the regionalism of our choicest English writers would be a service not only to literature but also humanity.

Yet Jefferies' regionalism was incomplete, and there is a passage from "Field and Hedgerow" in Mr. Looker's pious collection which sharply illustrates in what sense it is so : "I wish the trees, the elms, would grow tall enough and thick enough to hide the steeples and towers which stand up so stiff and stark, and bare and cold, some of them blunted and squab, some of them sharp enough to impale, with no more shape than a walking stick, ferrule upwards, every one of them out of proportion and jarring to the eye. If by good fortune you can find a spot where you cannot see a steeple or a church-tower, where you can see only fields and woods, you will find it so much more beautiful, for Nature has made it of its kind perfect." What an extraordinary passage ! Even Hudson, who was decidedly crotchety in his dislike of gardens and his indifference to the cultivated field, would never have committed himself to so outrageous a

myopia as this. It is not merely outrageous but silly, because the "fields and woods" are not pure Nature any more than the steeples and towers are man-made only. The latter are Nature working upon the works of man and the former man working upon the works of Nature with the result of a perfect synthesis between them, not to be matched anywhere else in the world. Yet Jefferies missed this unique beauty!

We shall do good rather than harm to the memory of a great Englishman if we recognize frankly that there is a fair amount of nonsense in Jefferies, that he was a more limited writer than either Hudson or Gilbert White and that his metaphysics will not bear looking into. They lack the stuff of thought. But as an observer of the familiarities of his own countryside no writer was greater than Jefferies, and to that power of seeing was often wedded an exquisite sensibility to the sheer beauty of the natural scene. His style can be monotonous, but at its finest it is that of a true poet. He could draw character too: Is there anything of its kind to touch his picture of a yeoman in "Amaryllis at the Fair"? "After London", too, is a very fine story, while his delight in colour and bird and beast and flower and fish and the great sun over all is true elementalism. So, if he lacked certain qualities as a writer, he possessed grace abounding in others.

H. J. MASSINGHAM.

PHYSICS OF THE SOIL

Soil Physics

By L. D. Baver. Pp. xi+370. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1940.) 24*s*. net.

SOIL physics, although a science having but few devotees, has grown up in two separate divisions, one dealing with soil as a habitat for plants and the other for large public buildings and roads, etc. Unfortunately these two divisions are still in almost water-tight compartments with respect to each other, there being neither any appreciable co-ordination between the two sets of workers nor, for so far as the agricultural workers are concerned, any ready access to the journals in which the civil engineering workers publish their results. The consequence is that text-books form the only easy means of finding out what the other workers are doing. The civil engineers are much better provided for than their agricultural confreres in this respect, as several good text-books have been published for them in recent years, while the last standard text-book on soil physics from the agricultural side was Keen's monograph published in 1931 and long since almost unobtainable. Now comes Baver's book to fill this important gap.

The author himself is well known for his researches in soil physics. But he has been a teacher as well as a research worker, and this book is the result of many courses of lectures he has given. Further, as he himself says in his preface, he has been fortunate in having ready access not only to the American but also to the extensive and very scattered European literature on soil physics. The result is a book containing references to the work of a great number of workers, and therein lies its chief limitation for the student but great utility for the research worker: for the incorporation of so much of the literature has been done at the expense of clarity in outline in some places where a clear outline could, in fact, have been given. Further, the author has not always quoted quite enough of some published work to make it self-explanatory, nor has he always indicated which points of technique in quoted work are fundamental to the interpretation of the results or to the use of the method and which are more or less arbitrary.

The book discusses all the subjects that usually come under the heading of soil physics from the agricultural point of view. It begins with a historical summary of the early work, and the reviewer himself was particularly interested in the many references made both here and in the body of the text to the work and results of the early pioneers. Then come two chapters on the mechanical composition of the soil, the definition, structure and properties of clay, and the various methods of mechanical analysis that have been devised and used. Mechanical analysis is discussed in great detail and on the whole very well, but it is marred by slurring over the concept of equivalent particle diameter. The author discusses all the main assumptions involved in obtaining Stokes's Law for the velocity of a freely falling sphere and discusses the complications occurring when one tries to apply it to soil particles, but the whole discussion is really trivial since he does not mention in this context that most clay particles are nowhere near spherical, and this introduces a far greater uncertainty into the interpretation of the results than all the other factors he has discussed. What he has not stressed is that the mean settling velocity of a non-spherical particle in water at a given

temperature has nothing whatever to do with Stokes's equation. The value of the equation is to transform this velocity into an equivalent particle diameter using a somewhat arbitrary value for the density of the soil particle.

The chapters on soil structure, soil air and soil temperature maintain a high standard, but that of soil water is less satisfactory. There is still a surprising confusion in the minds of most soil workers on the fundamental conceptions of soil water, which is reflected in this chapter by an unfortunate vagueness in some of the fundamental concepts and in particular in some of the consequences of these concepts. As an example, there is quite a good account of the concept of capillary potential or pF of the water in the soil, but the author does not seem to have realized explicitly the necessary connexion between the distribution of pore sizes in a sand or soil and its pF curve, with the consequence that a number of results on soil permeability are given as perhaps unexpected experimental results instead of obvious deductions from the underlying theory.

The last two chapters deal with the application of soil physics to soil cultivation and to erosion control. The former gives an excellent account of Nichol's work on the plough, and of the conditions one would expect in an ideal seed-bed, without, however, showing how far plants respond to these conditions. It also discusses briefly but adequately the effect of keeping the soil surface mulched. The last chapter discusses briefly such topics as the effect of slope and vegetable on soil and water run-off and on the rate of infiltration of water.

The text is well supplied with the relevant figures and tables needed to illustrate the main points discussed, and the book itself is, needless to say, very well produced. It forms a valuable addition to the very small library of books devoted to soil physics and it will amply repay most research workers and lecturers in soil science the time taken to study it. E. W. RUSSELL.

A PHYSICAL TREATMENT OF THE RAMAN EFFECT

Scattering of Light and the Raman Effect

By Prof. S. Bhagavantam. Pp. x+333+2 plates. (Waltair : Andhra University, 1940.) 15 rupees ; 22*s*. net.

A BOOK on the Raman effect, written from a physical point of view, has been badly needed for some time. Since the discovery of the effect in 1928, there have been several attempts to review and collate the enormous literature which has grown up in the succeeding years. Although there are now several good bibliographies, and Hibben's excellent book on the chemical applications, Professor Bhagavantam is the first to give a general account of this phenomenon in English, with proper emphasis on the physical aspects. Almost half the book is quite properly devoted (as the title indicates) to the general subject of light scattering. In addition to providing a good up-to-date account of the basic phenomenon, this method of treatment helps to make clear the relation of the quantum theory to the classical theory of light scattering, and the extent to which classical ideas (for example, anisotropy and polarizibility) may usefully be employed in the interpretation of Raman spectra.

Any treatment of the Raman effect is naturally based on the theory of Raman spectra of diatomic and polyatomic molecules, and this is given with considerable skill, the essentially mathematical parts being relegated to appendixes. Applications of Raman spectra to problems of molecular structure, of crystal structure and to a variety of problems in physical, inorganic and organic chemistry are presented in five separate chapters. A particularly valuable chapter is included on experimental technique, since Professor Bhagavantam is an outstanding contributor here, and to obtain really satisfactory Raman spectra is not so easy as is generally supposed. In this connexion the description of the gradual discovery of the phenomenon is of considerable interest.

The only serious defect which the reviewer has noticed is the virtual omission of the interpretation of the magnitudes of Raman frequencies in terms of a molecular model with definite restoring forces between the atoms. The knowledge of inter- and intra-molecular forces which has been obtained from the Raman effect by this means is now very considerable. In this connexion the explanation of the breadth of the Raman bands of water given on p. 156 as "due to the existence of polarity and close packing" is not at all adequate. The exposition, while generally very clear, is occasionally marred by careless phrasing. For example, on p. 175 it is stated "that for a Raman line to occur with appreciable intensity either $\left(\frac{\partial \alpha}{\partial q}\right)_0$, or $\left(\frac{\partial \gamma}{\partial q}\right)_0$, or both should not vanish".

On the whole the book can be warmly recommended to anyone wanting an elementary treatment of this rapidly expanding branch of molecular physics.

G. B. B. M. SUTHERLAND.

GENETICS IN THE U.S.S.R.

By PAUL G. 'ESPINASSE
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AN opportunity to see old problems in new circumstances and discussed by new-comers is rare enough to be usually worth taking. Interest is added when the problem is the central one of biology and the speakers are Russians engaged in trying to build a society about which there may be as many opinions as observers, but which at any rate can be said to contain some novelties of a far-reaching character. Such an opportunity is provided by the report of a Conference on Genetics and Selection held in the U.S.S.R. in 1939. The proceedings[1] have been translated for the Society for Cultural Relations with the U.S.S.R. by Mrs. Beatrice King. The material thus made available was discussed at a meeting at the Caxton Hall on October 5, 1940. While the original Conference and the Caxton Hall meeting were noticed to some extent at the time, and rumours of genetic controversy occasionally reached Great Britain[2], it seems proper now to make some attempt to evaluate any contributions to genetic thought which may have been made in connexion with them.

First, the genesis of the Conference should be noticed. It was held under the auspices of a philosophical review, *Pod Znamenem Marxisma*, and its purpose was to determine whether any, and if any then what sort of, genetics should be taught in schools and the lower reaches of university courses, and to examine the philosophical credentials of the subject.

The reasons for the importance which the Russians gave to genetic theory are worth looking at. Ever since the Revolution the Russian Government has been engaged in trying to build up an economy strong enough to confer upon that country a degree of independence. In this endeavour time was considered to be a most important factor. It was believed likely that about twenty years was all that could be counted on before the onset of what was considered as the almost inevitable attack on the new regime by some Power or combination of Powers bent upon its destruction. As well as the building up of armaments and engineering works, it was felt necessary to increase the productivity of Soviet agriculture and horticulture so as to provide an increased food supply no longer based so largely upon the more vulnerable districts of the country. It was seen that genetics had an essential part to play in this programme. That is why, at a time when most of the world was burning coffee, destroying crops, and paying men not to produce, the Russian men of science were being asked urgently to increase yields. That is why the impact of genetics on a Russian was likely to be different from its impact on a citizen of another country.

It was because of the importance of the time factor that any offer of an increased speed in the production of desirable varieties of crop plants and of stock was so attractive to the people and Government of the U.S.S.R. The demand for speed led inevitably to the supply of offers, some honest and useful, some honest, ignorant and useless, and some, as in other countries, possibly to a considerable extent consciously fraudulent.

At the Conference the Russian geneticists who have made important contributions to genetic theory, among whom one of the well-known names is that of N. I. Vavilov, came into conflict with other workers, led by T. D. Lyssenko, who attacked certain of their conceptions. Some of these critics made it quite clear that they did not understand what it was that was being discussed. Others made real criticisms; often expressed in terms which make them most difficult to follow, but still real. The important criticisms were directed almost exclusively to three points, though they started from widely different fields and wandered about sometimes in a fatiguing manner.

The first real point of attack was the meaning, the reality and the interpretation of the Mendelian ratio of 3 : 1. Now, qualities resident in parents may appear in their descendants either never, sometimes, or always. If they never appear they are said not to be hereditary. If they appear always they are regarded as hereditary, but the mode of their inheritance would appear to defy analysis by familiar means. If, however, they appear sometimes, then the proportions in which they appear can be used as evidence about the mode of their inheritance. The conventional structure of genetic theory claims that the proportions in which heritable qualities appear are nearly always *sensible*. That is to say that they are regular in essence and that any apparent irregularity can be accounted for satisfactorily—can, in fact, be made sense of. This claim is coherent, and is based upon an immense body of observation and calculation. One of the simplest of these calculations leads to the expectation that a certain procedure in breeding will give descendants with certain qualities in the ratio of 3 : 1. Since this simple calculation is fundamental to the Mendelian concept its history is perhaps important.

Mendel noticed the proportions in which certain qualities in certain plants appeared in subsequent generations. He pointed out that in fact these proportions were those in which the qualities would be expected to appear if their appearance depended upon the distribution to the offspring of real physical entities present in the parents. To mediate the appearance of the qualities as observed, the entities would have to be present twice in the parents, to separate at the formation of the reproductive cells, and so to be present again twice, once from each parent, in the offspring. It was seen at the beginning of the century that chromosomes did behave and were distributed in a way analogous to this. Further work has shown that certain qualities in certain forms do depend upon the presence of certain parts of certain chromosomes. Mendel happened, it may be said by chance, to choose for investigation qualities which were mediated by factors present (in our terminology) on different chromosomes, or distributed as if they were, that is, practically at random with respect to each other by the crossing-over of chromatic material. If he had not done so he would presumably not have been able to make the generalizations which he did make.

If two parents are unlike in respect of one character in such a sense that in one both factors mediating it are similar, and in the other both are again similar to each other but different in state from those in the first parent, it can readily be seen that the mechanism described will give a first generation all alike and a second generation, derived by random mating in the first, in the proportions of one of each original type to two mixed. If one state of the factor permits the expression of the character if that factor is present only once, while in the other state the factor needs to be present twice, all the individuals will show the character except those which have the second state of the factor twice, once from each parent. This results in the second generation being in appearance three of one kind to one of the other. By an extension of the same argument, if two qualities are considered together the second generation will have four different appearances in the ratio 9 : 3 : 3 : 1.

Precisely these ratios are scarcely ever found in fact. Many things, such as differential death-rates, upset them. It was soon realized that the chromosomes were insufficient in number to account for the phenomena observed, and the factors were postulated as existing along the length of the chromosomes. They were called genes. The difficulty of expressing in terms of genes the heredity of such qualities as height, which can clearly vary continuously, soon made it necessary to consider the interaction of genes with each other, and such workers as Bridges and Timoféeff-Ressovsky were soon interpreting heredity in terms of the interaction of all, or at least many, of the genes with the environment. This enables genetic situations far less simple than those examined by Mendel to be analysed and expressed in Mendelian terms.

The critics at the Conference took the term "the 3 : 1 ratio" as standing for any of the ratios which would be given by such a mechanism as has been described, and in attacking it they were attacking this conception as a whole. They pointed out, what is well known, that these ratios are scarcely ever realized. They expressed this, in their very difficult terminology, by saying that the 3 : 1 ratio was a mathematical law, and not a biological law. Stated in ordinary terms this is simply the commonplace observation that many qualities which are hereditary have an inheritance mediated by many genes and not simply related to any one of them, and that many factors have to be considered as influencing the situation. If nothing is considered for the moment beyond the genes, it is clear that this means that the qualities will appear not in a simple 3 : 1 ratio but in a more or less complicated combination of such ratios, granting the whole Mendelian mechanism.

From this point the discussion really turns upon the question—a perfectly proper one—of whether the analysis of the inheritance of important qualities into terms which are likely to give so complicated a set of possibilities—almost as complicated as the animal one starts with—is really worth while. This question is not asked by Russians only. In Great Britain Hammond[3], among others, has recently suggested that the points which make a sheep good for killing are beyond useful analysis of this kind.

The fact is that animal- and plant-breeding are not the only customers that genetics has. Genetic theory has proved of immense value to the botanist and the zoologist engaged in constructing theories of evolutionary mechanics, where there is no hurry. Many papers on genetics are about its evolutionary aspects and the mathematics of inheritance in populations. Formal genetics, while it is used in much important work on many forms by many workers, has developed a side which is of little immediate use to the breeder. The reasons for this are fairly simple. The culture of Drosophila and the observation of populations are often based upon numbers which it would be inconvenient for the animal breeder to maintain if he were using cows. Some Russians believe that there "ought" to be a certain relationship between theory and practice, rather as some philosophers think there "ought" to be a certain relationship between, for example, what is said and the truth.

One cause of the distrust with which the Mendelians are sometimes regarded by some

breeders may perhaps have its roots in a misunderstanding of the claim by such workers as Muller that, in Drosophila, all heritable differences behave as Mendelian entities, or at least behave as they should do if they were dependent upon a number of these. Muller[4] mentions only one apparent exception, provisionally ascribed to the action of a virus. The breeder may sometimes feel the danger that this statement may be used to prejudge the nature of any instance of heredity in any form which may come up for discussion, and, worse, to belittle the successes of the breeder working with un-analysed material. It does not, for example, invalidate the truth of such well-authenticated observations as those of plastid inheritance in plants. The Mendelian behaviour of an inherited variation is a fact which has to be established for each variation. The formal geneticists feel strongly that, since about 1915, the onus is on the doubters to show that any case of inheritance is *not* Mendelian. Their opponents hold that until the mode of inheritance of any variation is known, it is formally inadmissible to presuppose one mode rather than another.

This questioning of the usefulness of the Mendelian analysis becomes involved with an attack on the logistic situation of formal genetics. Particulate genes, it is suggested, of a rather Lucretian atomicity, are invoked when convenient and, when inconvenient, are rendered almost unapproachable mathematically by an appeal to an ever more complicated system of interactions, only to reappear at the right moment. Perhaps partly because wheat is of great importance economically, it is in the discussion of the genetics of wheat that this second line was developed most clearly.

Wheat is normally a self-fertilizing plant. The widely used wheats to which names have been given have been produced by artificially crossing different strains. This is done by preventing self-fertilization and substituting pollen from a chosen source for that of the plant itself. The grains resulting are sown and the plants thus obtained are allowed to fertilize themselves in the ordinary way. If, now, the individual plants with the qualities desired in the new strain to be set up are alone allowed to survive, then as generation succeeds generation the variation in respect of these qualities grows less, because, in respect of the genes responsible for the mediation of these qualities the strain becomes more nearly homozygous—that is to say, the genes in question are present twice in an ever-increasing proportion of the population. The strain thus set up is called a pure line. It was pointed out long ago by Johannsen that the only variants to be found in a really pure line would be those due to environmental differences and so would not be inherited, apart from occasional mutants. Many of the strains of wheat set up by de Vilmorin in the middle of the last century are said to show no progressive changes since then[5].

Now, some of the Russian workers under Lyssenko claim to have produced strains of wheat by crossing within a previously recognized strain. If the strain in question is really a pure line this procedure of 'intra-varietal crossing' should be meaningless, and the wheats produced should be like their predecessors. The Russian workers claim that they are not. They claim that they differ, and that some of them are better than the wheats originally used.

They refuse to concern themselves with a full Mendelian analysis of the situation, holding it to be not worth while. The way in which the allegedly different qualities behave in heredity is therefore impossible at present to make out. Apart from accidental cross-pollination, the only thing that seems likely to change a really pure line, that is one that is really homozygous for the genes in question, is mutation. Wheats do mutate. If they did not it does not appear that they could evolve. It is conceivable that the Russians have obtained their alleged results by crossing plants which were not really homozygous for the genes concerned. But it must be borne in mind that through the breakage of the material of the chromosomes and other disturbing factors it is extremely difficult to get any individual pure, or homozygous, for *all genes*. It is, indeed, uncertain that such a thing has ever been done. It is here that a logical weakness in the structure of formal genetics is alleged. If all, or many, genes are relevant to any character, as they are assumed to be to account for other phenomena which are not easily accounted for otherwise, then, as more genes are reckoned in, the more improbable it is that any strain of wheat is homozygous for all the genes relevant to any quality, and the more meaning there is in 'intra-varietal crossing'. It should be remembered that the evidence for the persistence of qualities in de Vilmorin's wheats can in the nature of things only refer to qualities that can either be preserved dead for comparison year after year or else be precisely recorded. It is not evident that every single character of wheat, or even every useful one, falls into either of these categories. If the concept of the interaction of the genes is retained, as logically it seems that it must be, then any gene difference is relevant, and some would be possible between any two plants in a strain. In denying such a possibility the formal geneticist would be in a difficult position.

The third front of attack on the Mendelians at the Conference was much wider and much looser. There are certain technical procedures which can be carried out upon animals, and perhaps more upon

plants, which are useful inasmuch as they improve the plant or animal so treated. These procedures range from the commonplaces of agricultural and horticultural technique, such as seeing that the subjects are well nourished, to such bizarre performances as the grafting of a tomato on to a potato. Hammond, as well as discarding as useless the Mendelian analysis of the inheritance of some qualities in cattle, pigs and sheep, has emphasized the necessity of selecting stock for breeding in the best possible conditions of environment, including in particular those of diet. It may be doubted whether, in reality, these conditions contribute much more to the situation than that they enable the breeder to select those animals the genetic outfit of which permits them to take most advantage of good food. Selection in different conditions would produce different animals. Which is 'best' depends upon the available food and the humour of the market. If the environment of the selected animals is to be East Africa, a different procedure of selection will be proper from that which would be suitable if they are to be kept in Sussex.

If the effects of some of these technical procedures spread from the treated animals to their descendants either for a few generations or for ever, their value is evidently enhanced. The claim that they do is therefore tempting. It happens that the nature of the procedures and the nature of the material used in agricultural and horticultural practice make it far less easy to dispose of the claim that these effects do so spread than it is to dispose, for example, of the claim that the descendants of a mouse whose tail was cut off will have short tails. The two procedures which are of immediate importance in this connexion are vernalization and vegetative hybridization.

There does not appear to be anything particularly occult about vernalization. It has been found in Germany, and probably independently in the U.S.S.R., and confirmed in other countries, that if seed is moistened and warmed and then kept cold for some time and later sown, the seedlings grow faster than do those from seed not so treated. Some points about the process are beginning to be more or less understood. It has to do with the mobilization of food reserves in the seed, which mobilization is less checked by the cold than is the growth of the seed. When, then, the seed begins to grow after it has been sown, it has a more readily available supply of food material than if it had not received this treatment. The facts here seem fairly well established. They were greeted with considerable scepticism when they were first advanced.

It is claimed by Lyssenko and his associates that the effects of this treatment spread to generations subsequent to that treated. These workers, once more, refuse to engage in an analysis of the persistence they allege in terms of Mendelian inheritance. Such questions as whether the differences segregate they ignore. They are not interested. It may well be that they have not found anything in the least in conflict with orthodox genetics. While this state of deadlock persists, it is not easy to see how progress can be made. Each side in the argument considers that it has a set of terms in which the living universe makes sense. Each side believes that the other is childishly sensitive to what it mistakenly regards as an attack on an important and vital principle. The historian of science, with the centuries to draw on, will probably not find this situation unique.

The other procedure, that of so-called 'vegetative hybridization', once more raises the question of whether an effect does or does not spread to generations subsequent to that one which receives a particular treatment. Details of the procedures of grafting and the production of chimæras and 'vegetative hybrids', are given by W. Neilson Jones[6]. The chief facts are briefly these : in the ordinary way a scion grafted on to a stock grows under the influence of the stock and is affected by the qualities of the stock in various ways, probably partly, at any rate, through the sap which is shared. This is well known, and is recognized commercially in the selection of stocks suitable for different purposes. The relation between stock and scion may be of a more intimate nature. It occasionally happens that a bud with a mixture of cells derived partly from the scion and partly from the stock will grow from the region of the junction of the two. This bud gives rise to what is called a chimæra. The tissues may be related in different ways. Sometimes one tissue is on one side and the other on the other, and sometimes one is outside and the other inside. Finally, it has been claimed in the past that the relation may be of a still more intimate character, and that two nuclei, one derived from each source, may occasionally fuse as gametes fuse, and, with or without a subsequent reduction division, may give rise to a tissue the nuclei of which themselves contain a mixture of the contents of the nuclei of the two original plants, and are contained in a cytoplasmic environment strange to some of their genes. Such a plant, derived from the fusion of two vegetative nuclei, is called a 'vegetative hybrid' or 'burdo'. Whether such a plant has ever in fact existed is disputed.

The Russians under Lyssenko claim to have vegetative compounds of various kinds, the descendants of which display some of the mixed qualities. Yet again, they refuse to embark upon a Mendelian analysis of their material, holding it to be not worth while. At the Caxton Hall meeting of October 5,

Prof. J. B. S. Haldane suggested that some of the effects, if real, might be due to the transmission of something like a virus, as in the case of the recalcitrant Drosophila. It is a fact that some of the most striking examples claimed by the Russians are in the Solanaceæ, well known as the hosts of viruses sometimes with pseudo-hereditary effects.

While effects of this kind have been claimed in the past as occurring not infrequently, they may perhaps be considered to be rather rare on the whole. The Russians state that they have used large numbers in their experiments, and it may be that they have come upon an occurrence which has been overlooked in smaller numbers of subjects in work done elsewhere. No amount of appeal to other work can settle the Russian claim; only examination of the Russian material can do that. It is difficult at present to get a clear idea even of the simple facts of the chromosome situation of their plants.

It comes, then, to this. The followers of Lyssenko seem to the formal geneticist to be returning to the methods of the eighteenth century. This was suggested in NATURE in 1937[2]. But if the methods of breeders then were rule-of-thumb, they gave results which are, some of them, still to be seen. The followers of Lyssenko can retort that the formal geneticists are returning to the methods of the Middle Ages. It was believed then that stars moved in circles. If a star did not seem to be doing this very obviously it was considered proper to assume that the centre of the circle necessarily described in its path must itself be moving in a circle. This epicyclic method of explanation increases the complication of the situation it seeks to explain. This lack of economy is looked upon with disfavour. It affords a tempting refuge for the hard-pressed theoretician. Ptolemy is quoted[7] as having remarked, perhaps incautiously, that the phenomena could be saved by eccentrics and epicycles.

The phenomena do not need saving; they need investigating. It is suggested that now, in view of the recent tragic happenings in the U.S.S.R., many of the Russian varieties of plants and fruit-trees may be taken to Great Britain and the United States to be preserved from the invader. It is an irony of history that if this is done it will provide an opportunity for the analysis of the material when no one has time to do it.

[1] Report of the Conference on Genetics and Selection organized by the Editorial Board of the journal *Pod Znamenem Marzisma*. Translated for the Society for Cultural Relations, and available for consultation at its offices at 98 Gower Street, London, W.1.
[2] NATURE, 139, 143, 185, 1048 (1937).
[3] Hammond, J., "Farm Animals", London (1940).
[4] Muller, H. J., "The New Systematics". Ed. J. S. Huxley, Oxford (1940).
[5] Haldane, J. B. S., "The Causes of Evolution", London (1932).
[6] Neilson Jones, W., "Plant Chimaeras and Graft Hybrids", London (1934).
[7] Sarton, G., "Introduction to the History of Science", 2, Pt. 1., p. 16.

SURFACE CHEMISTRY

By Prof. W. D. Harkins
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ONE of the most interesting of the Fiftieth Anniversary Symposia, held at the University of Chicago during September 22–27, was that on two-dimensional systems or surface chemistry. Introductory remarks on the origin and development of this subject at the University were made by Dr. Irving Langmuir, Prof. H. I. Schlesinger, and Prof. W. D. Harkins. [It is interesting to note that this symposium was organized in honour of Prof. Harkins and the twenty-fifth anniversary of the publication of his first paper in the field of surface chemistry.—*Editors.*] Experimental work on the theory of molecular orientations in surfaces was begun in 1912 on the arrival of Prof. Harkins at the University. The first course of lectures on orientation was presented in the winter quarter of 1913–14. The gist of the theory is contained in a statement from the notes of George L. Clark taken during a lecture which dealt with the more tightly packed films of long-chain organic acids: "COOH of acid down because both acid and H_2O associated in polar." This is the earliest recorded statement of the direction of orientation of surface molecules.

In the first problem considered, but not the first to be solved, it was found that the adsorption of polar-nonpolar molecules is much higher at the surface of water than at the interface oil-water, as was predicted by the initial electrical field theory of orientation.

Interest in this problem arose in connexion with work in Karlsruhe in 1909 on Haber's theory of muscular motion, which assumed, as one of several steps, that a change from acid to basic causes a very great lowering of surface tension both in (1) the muscles, and in (2) a benzene-water system, with a strong acid and a strong base as solutes. However, experimental work proved that (2), assumed from work done in Berlin, is incorrect, so it was planned to substitute an organic acid. This gave Prof. Harkins the idea that at the benzene-water interface the hydrocarbon ends of

the molecules would dissolve in the oil phase and the polar groups in the water, but there was no opportunity to begin a test of this idea until 1912. Later an extensive search through the literature revealed the fact that in 1912 Sir William Hardy expressed the idea that the asymmetrical stray field at the surface of a liquid or a solid causes an orientation of the molecules.

While Hardy gave no evidence in favour of this idea, Harkins found evidence for orientation in Hardy's values for the work of adhesion (W_A) between water and other liquids. Since this evidence was made somewhat uncertain by the inaccuracy in the drop weight method used by Hardy, a considerable amount of experimentation was carried out by Humphery, Brown and Davies, in order to give a high degree of accuracy to the method. This was the more necessary on account of the fact that the internal (surface) energy (E) is much more intimately related to the molecular orientation than is the free surface energy (F), and the determination of E involves the entropy, that is, the slope $(\partial\gamma/\partial T)_{p,\sigma}$, where σ equals molecular area.

Even at the present time one of the best lines of evidence for the orientation of molecules in interfaces is given by the values of W_A, and especially of E_A, at the liquid-liquid, and at the solid-liquid interface. For example, the energy E_C in erg.cm.$^{-2}$ required to pull *n*-octane apart is 100, while for *n*-octyl alcohol it is only 101, showing that the polar group has almost no effect, since the molecules orient so that only the non-polar hydrocarbon groups are pulled apart. To pull *n*-octane from water requires an energy of 107, but to pull *n*-octyl alcohol from water a much higher energy is needed (165), since the polar group must be separated from the water.

In recent work with Dr. G. E. Boyd the relative energies of immersion (E_I) of TiO_2 (anatase) are found to be: water, 1·00; butyric acid, 0·77; ethyl acetate, 0·69; butyl alcohol, 0·67; nitrobenzene, 0·55; carbon tetrachloride, 0·46; benzene, 0·28; iso-octane, 0·20, and these ratios are practically the same for the solids, which give the following values of the total *energy of adhesion* (E_A) in erg.cm.$^{-2}$: $BaSO_4$, 490; TiO_2, 520; SiO_2, 600; ZrO_2, 600; SnO_2, 680, and $ZrSiO_4$, 850, graphite 265. Graphite, however, exhibits abnormal values of the ratio, namely, 0·73 for CCl_4 and 0·85 for benzene. All the crystalline solids (except graphite) are found to be much more polar than water and the polar groups are turned towards the solid.

Values obtained by the adsorption of four vapours by H. K. Livingston show that all give the same area for any particular solid, provided the areas per molecule in the completed first monolayer are taken as: nitrogen, 15·4; water, 10·6; propyl alcohol, 20·0; and *n*-heptane, 55·0 A^2. The last value shows that in the completed monolayer *n-hydrocarbon molecules lie flat on the surface.*

In his paper on the properties of solid surfaces, Dr. Boyd gave examples of the *free energy of adhesion* between a solid and various liquids. With TiO_2 the values are: water, 380; propyl alcohol, 129; and *n*-heptane, 78. The corresponding values of $\gamma_S - \gamma_{SV_0}$ (energy of immersion in the saturated vapour) are 240, 82 and 38 erg.cm.$^{-2}$ for the clean surface of anatase. The values were calculated from the vapour adsorption isotherms obtained by Livingston and the proper Gibbs's adsorption equation.

Dr. Fritz London, of Duke University, considered the centres of van der Waals' attraction. A special type of long-range attraction is assumed to act between large molecules where the virtual electron oscillators are of appreciable extension.

If a molecule possesses considerable electrical anisotropy in its parts (as in the chemical bonds), it is no longer permissible to use the dispersion force as a central force, but rather specific formulæ must be employed. For example, the interaction energy between two anisotropic force centres (bond ellipsoids) is:

$$E_{\mathrm{I,\,II}} = -\frac{1}{R^6}[A - B - B' + C\ (\sin\delta\sin\delta'\cos\varphi - 2\cos\delta\cos\delta')^2 + 3\,(B - C)\cos^2\delta + 3\,(B' - C)\cos\delta' + B + B' + 4C],$$

where R is the distance between the centres I and II, $\alpha_{\parallel}\alpha_{\perp}$ and $\alpha'_{\parallel}$, $\alpha'_{\perp}$, the components of their polarizabilities, respectively, $\bar{\nu}_{\parallel}$, $\bar{\nu}_{\perp}$ and $\bar{\nu}_{\parallel}$, $\bar{\nu}_{\perp}$ the corresponding frequencies, δ, δ', the slopes of the two bond directions with respect to the line joining the centres, and φ the angle between the projections of the two bond axes into a plane perpendicular to the joining line.

In the special case where the interaction energy between large oscillators is desired for distances shorter than the spacial extension of the interacting virtual charge distributions of the molecules, it was found desirable to represent each oscillator by several distinct poles, 'monopoles', of different sign, suitably located in the molecule. As a consequence of the quantum mechanical treatment of the problem in these terms a new formula for the energy of interaction is reached:

$$E^{(2)} = \frac{\varepsilon^2\varepsilon'^2}{h(\nu+\nu')}\left[\frac{1}{R_{++}} + \frac{1}{R_{--}} - \frac{1}{R_{+-}} - \frac{1}{R_{-+}}\right]^2$$

where R_{++}, R_{--}, R_{+-}, R_{-+} symbolize the distance of separation of the respective monopoles; $\varepsilon, \varepsilon'$ give the magnitude of the high-frequency dipoles.

The theory should be useful for systems containing conjugated double bonds, of which rubber is an example, and for large biological molecules.

Prof. J. G. Kirkwood, of Cornell University, discussed the theory of the transition expanded to the intermediate liquid phase. This transition is considered as an order-disorder transformation in axial orientation of the molecules which constitute the film. By postulating a free energy barrier of appropriate form, which hinders the relative axial rotation of neighbouring molecules, Kirkwood is able to demonstrate a phase change of the second order in a *model* film of cylindrical molecules of elliptical cross-section vertically oriented on the subphase. By means of the statistical mechanical theory of co-operative phenomena the magnitude of the discontinuities in the heat capacity, the coefficients of thermal expansion and compressibility attending the transition, have been calculated. These agree well with the experimental values of Harkins, Young and Boyd.

Surface entropy of pure liquids was dealt with in a paper by Mr. Henry Eyring of Princeton University.

A relation between free surface energy (A_S) and the Eötiös equation is :

$$A_S = E_S - TS_S = N^{1/3} V^{2/3} = 4{\cdot}4\,(T_C - T - 6)$$

The entropy, 4·4 Cal. mole^{-1} deg.$^{-1}$ arises from expansion of the surface region, the free energy of which can be estimated by the partition function of normal liquids (Walter and Eyring). The final equation is $\gamma = (\rho_L - \rho_V)\,(a - bT)$ where $a/b \sim T_C$.

Remarkable electron microscopophotographs of gas carbon, bacteria and the coatings of insects were presented by Prof. E. F. Burton, of the University of Toronto, the pioneer in this field in America.

Dr. George H. A. Clowes, research director of Eli Lilly and Co., described the interactions of biologically significant substances.

From extremely extensive data it is shown that many carcinogenic polycyclic hydrocarbons are highly soluble in sterol monolayers (10-methyl-1-2 benzanthracene in cholesterol), in which case the logarithm of the mol fraction of the hydrocarbon varies linearly with film pressure (π). A complex of one molecule of hydrocarbon to two of sterol forms with a free energy of 2·5 kilocalories or less. Increase of pressure on a two-dimensional solution may force the hydrocarbon into colloidal solution in the subphase. Such material penetrates the film at lower pressures. The relations to biology were discussed.

The intrinsic viscosities and the reciprocals of the frictional ratio of fifteen globular proteins were compared by Prof. Henry B. Bull and Mr. J. A. Cooper, of Northwestern University, and an empirical, linear relation found to exist between them. This empirical relation was used to estimate the average volume hydration, which was found to be 0·283 c.c. per c.c. of dry protein, with a standard deviation of the mean of 0·042 c.c.

A test applied to several theoretical equations in the literature relating viscosity and asymmetry of suspended particles is based upon the empirical linear relation between viscosities and reciprocals of the frictional ratios of the protein molecules. None of the theoretical viscosity equations are valid when applied to protein solutions.

Increase of surface tension (γ) by highly polar organic compounds was the subject of a paper by Prof. Ernst A. Hauser, of the Massachusetts Institute of Technology, and Mr. Adrian J. Grossman.

The increments of surface tension produced in benzene by a 0·5 mole fraction at 40° of dinitrobenzenes are : *ortho* 1·75 (6·05), *meta* 1·3 (3·81), *para* 1·2 (0·32), in dyne cm.$^{-1}$, where the values in parentheses are the dipole moments. Thus the increments in γ are related more intimately to the high bond moment (3·9) of the nitro group than to the molecular moment. Frequent changes in the slope $(\delta\gamma/\delta C)_{T,p}$ were found, and a deep depression of 1·2 dyne cm.$^{-2}$ was obtained with 1-nitronaphthalene.

Mr. Eugene Guth, of the University of Notre Dame, considered stress and elasticity in rubber. The theory presented on the basis of an ideal model of incompressible rubber considers an irregular network of flexible long-chain molecules, and predicts the characteristic S-shaped stress-strain curves found in experiments on an unaccelerated pure gum compound. In the analytical expression for the theoretical curves, the Langevin function of the theory of paramagnetism, or the Debye theory of dipole molecules, enters and describes the orientation of the long molecules due to the applied stress.

It is found :

(1) That the stress is due largely to the kinetic energy (entropy) of the molecules and not to the intermolecular forces, since the latter are found to contribute only about 20 per cent of the stress.

(2) As predicted by the theory the stress at constant length is proportional to the absolute temperature.

(3) The slope of the stress-temperature curves is negative up to 10 per cent extension and is positive above this, due to thermal expansion.

(4) Since the heat developed in adiabatic stretching is proportional to the temperature coefficient of the stress (Kelvin-Joule), heat is absorbed for 0 – 10 per cent extension, and is given off for greater extensions.

A new superliquid phase was described by Prof. W. D. Harkins, Copeland and G. E. Boyd.

At certain temperatures it is found that the condensed liquid (L_2) phase of a long-chain alcohol

on increase of pressure transforms by a *first order* change into a new *LS* phase, which has the compressibility of the solid phase, but exhibits a greatly lowered viscosity compared with that of the liquid from which it is formed by compression and the addition of heat. The internal energy increase and the increase of entropy when this phase expands are excessively large. In the transformation of the L_2 to the solid S phase there is no latent heat, so the change is second order.

Mr. Eyring considered the viscosity of monolayers from the theory of absolute reaction rates.

A decrease in viscosity with increase in pressure indicates that the activated state occupies a smaller area than the initial state, and vice versa. Similarly a decrease in viscosity with temperature indicates that the activated state has a greater energy than the initial state; and increase in viscosity with temperature that the activated has less energy than the normal state.

A thermodynamical theory of the spreading of liquids on surfaces was presented by Prof. Harkins.

(1) A duplex (D) or thick film may spread if its spreading involves a decrease of free energy. On water a D film is always unstable, since there is a decrease of free energy when it transforms into a monolayer (M) and a lens.

(2) Water and all oils spread on mercury, and all liquid oils on water to give monolayers, but if a duplex film cannot spread the pressure (π) of the monolayer may be small.

(3) $\pi_e = S_{b'/a} - S_{b'/a'}$ or the semi-initial minus the final spreading coefficient. Since $S_{b'/a}$ is always negative, π_e, the equilibrium pressure, is always greater than the semi-initial spreading coefficient, and almost always greater than $S_{b/a}$, the initial coefficient for the spreading of the dry oil (b) on clean water (a) as a duplex film.

(4) Water does not spread as a duplex film on any oil.

(5) It always takes *less* work to pull any oil from its first complete monolayer on water than to pull the oil apart.

(6) While lower hydrocarbons give duplex film spreading on water, higher hydrocarbons and some polar oils (as methylene iodide) do not, but form monolayers only.

Dr. Irving Langmuir, of the General Electric Co., discussed the permeability of monolayers.

Copper gauze supporting a layer of $CaCl_2 \cdot aH_2O$, mounted at a distance b above the surface of water in a film trough is used to measure the rate of evaporation. At equilibrium, the rate at which water escapes is determined by the resistance of the moisture-saturated air in the space between the liquid surface and the adsorbent. This resistance to diffusion, ω, is given by $\omega = Awt/M = b/D$, where A is the surface area evaporating, w the grams of water per unit volume of saturated air, t the time in seconds, and M the mass evaporated; D is the diffusion coefficient. A monomolecular film of an acid, alcohol, cholesterol or ergosterol placed on a clean water surface gives an increase in ω, but proteins do not. A logarithmic relation is found between ω and the film pressure. The permeability exhibits extreme sensitivity to impurities. Langmuir considers an impermeable film to be tightly packed at some *definite height in the film*.

NEWS AND VIEWS

In Defence of Liberty

LAST week, on the outbreak of war between the United States and the Totalitarian Powers, the King sent a message to President Roosevelt, which concluded with the words: "We share your inflexible determination and your confidence that, with God's help, the powers of darkness will be overcome and the four freedoms established throughout a world purged of tyranny." President Roosevelt, in his reply, paid a tribute to the courage of the British people during the past two years, and said: "The forces which have plunged the world in war, however strong, cannot prevail against the indomitable strength of free peoples fighting in a just cause."

This was also the text of President Roosevelt's stirring radio address to the American peoples on December 15, the one hundred and fiftieth anniversary of the adoption by Congress of the Bill of Rights The basic principles of the freedom of man embodied in the Bill have been accepted by all the republics of the Western hemisphere, and indeed by some four fifths of the peoples of the world. The present struggle is nothing less than an attempt on the part of the Totalitarian Powers to overthrow all the results that have flowed from the gradual growth of the liberty of the individual. It is an attempt to impose once more on mankind the tyranny and despotic rule of the Middle Ages, from which we have been set free by the courage and sacrifice of our ancestors. The present generation of Americans, President Roosevelt said, are as determined to preserve liberty as their ancestors were to win it, and he pledged Americans not to lay down the arms they have now taken up until liberty is once more secure in the world.

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The Central Register

In reply to a question asked by Sir Herbert Williams, the Minister of Labour and National Service stated in the House of Commons on December 11 that as soon as the necessary arrangements can be made, the present Central and Supplementary Registers are to be merged in a new Appointments Department of the Ministry of Labour and National Service. This new department will deal with persons possessing specified administrative, managerial, professional, or technical qualifications and with others who, though not possessing specific qualifications, have a normal salary in excess of £420 per annum. It will operate through its staff at headquarters or through staff under the control of the Regional Controllers, according to the nature of the vacancies for candidates. It will maintain a separate register of persons within its scope who are known to be seeking an engagement and will endeavour to find suitable employment for such persons in some form of national service. The provincial organization of the department will be closely associated with the new district man-power boards.

Gas-producer Poisoning in Sweden

According to the October issue of the *Anglo-Swedish Review*, medicine and technology in Sweden are collaborating in the problem of poisoning from gas-producers, with the result of the establishment of the first clinic in the north at the Sabbatsberg Hospital in Stockholm. The work is being conducted on the following lines: (1) Examination in the laboratory of specimens of blood for carbon monoxide content. Up to the present 4,300 analyses have been made. (2) A clinic of ten beds has been set up and an out-patient department where over 700 cases have been examined. (3) Physiological examinations are being made to discover the most suitable form of treatment and the proportion of chronic cases. (4) Examination of the cerebrospinal fluid in patients who have died from asphyxia is being carried out. The experiments are being made on human volunteers and on porpoises and rats.

Use of Pitch as Fuel

It is well known that modern life in peace and especially in war depends on fuel in liquid form. While consumption of the lighter and more volatile fuels in internal combustion engines is more apparent to the layman, there is a large consumption of heavier fuel oils consumed for industrial furnaces and on board ships. In peace-time practically all the supply of such heavy oils used in Great Britain were imported and a relatively low price was efficiently maintained. Indeed, industry was furnished with a fuel often superior in quality to what was essential to the purpose in question. The reduction in available supplies of imported oil has compelled the use of heavier and lower grade petroleum oils and indigenous materials such as cresote and pitch-creosote blends.

An interesting development is the use of coal tar pitch itself, both solid—as pulverized pitch—and liquid—as molten pitch. Such materials find their application particularly where consumption is large and continuous—for example, in steam boilers and large furnaces. The fuel has certain attractive properties—low sulphur content, freedom from ash and water, uniformity in quality and calorific value. For use it must be heated to 200°C. and conveyed in pipes to the furnaces at this temperature. This has produced unusual engineering problems, the solution of which has required great skill, because the consequences of failure are serious, if ever the pitch solidifies in the mains. The plant used for this purpose was described at a meeting of the Institute of Fuel in London on October 30. This is a valuable technical achievement, because production of pitch has for years exceeded demand and there is in stock a very large quantity which can replace much petroleum oil formerly employed.

Standardization in the Electrical Industry

A thoughtful address was delivered on October 27 by Mr. H. G. Taylor, chairman of the Liverpool Centre of the Institution of Electrical Engineers, on "Co-ordination and Standardization". He regards co-ordination as the best means of arriving at standardization. He said it would be disastrous if the end of the War found engineers unprepared to face the problems of peace in a changed world. Immediately after the War of 1914–18, a major happening in the history of the electrical supply industry in Great Britain was the appointment by the Board of Trade of the Electricity Commissioners as a technical body under the chairmanship of Sir John Snell. As a result of their investigations and in conjunction with the Weir Committee, the Central Electricity Board was established in 1926, its function being to supply electricity in bulk to various distributors and concurrently to increase the availability of supply. This entailed co-ordinating the existing supply authorities, their personnel and plant, while the question of interconnexion of plant involved standardization of frequency, the necessity of which Sir John Snell foresaw, and powers to enforce a national standard of 50 cycles were consequently included in the Act of 1926. As a theory, standardization in electrical engineering is almost as old as the science itself, but its application in Great Britain has lagged too far behind technical progress to maintain a healthy condition in the industry, the development of the heavier engineering commodities having continued, for the most part, on individual lines.

The recognized centre now for dealing with standardization is the British Standards Institution, which now has more than a thousand committees, with about six thousand professional men who have given their time freely to this national work. It is an independent body in close touch with industrial requirements and modern technical knowledge, with the fullest Government support but free from Government control. It co-operates with the central standardization bodies in various parts of the British Commonwealth of Nations, and participates, directly or indirectly, in the work of international standardization.

After the War, we must produce for export not the apparatus which other countries rightly wished to manufacture themselves, but commodities in which we have the technical ability to make ourselves supreme. By complete co-ordination of industrial organizations and research establishments electrical engineers can assist very materially, and the adoption of international standards must be considered. Mr. Taylor suggested uniformity of design for utility electrical products in common use both in the industrial and domestic fields. Such a standard, to be effective, would need to have behind it the authority of the British Standards Institution, and its adoption might even need legislative action. Manufacturers would be encouraged to adopt these standard commodities as their first line of production, and in consequence they would ultimately replace the many specialized products now on the market.

Arterial Road Lighting

THE arterial road connecting Toronto and Niagara Falls, known as Queen Elizabeth Way, is lighted by incandescent lamps in parallel over its whole length of 70 miles. Already the lighting installation enjoys the distinction of being the longest in the world, and no doubt it will be continued on the proposed 20-mile extension of the highway to Fort Erie, making a total of 90 miles. In planning the installation provision was made for maximum silhouetting of obstacles. The Way consists of dual concrete tracks 20–23 ft. in width with an intervening strip of grass 28–30 ft. wide; the standard equipment comprises wooden poles, along the centre line of the grass, with welded cross-arms overhanging each traffic lane to the extent of 3 ft. The availability of cheap electric power from existing rural circuits operated by the Hydro-Electric Power Commission of Ontario seems to have been a determining factor in the adoption of incandescent lighting and parallel distribution. Sodium lamps are used to mark intersections. Distribution transformers of 15-kva. capacity feed the 115-v. lighting cables from the 2,300-v. rural distribution network. The lamps are of 6,000 lumens, 400 watts, spaced 200 ft. apart, and maintenance is by group replacement twice a year. Operating experience and costs from this installation should be of material assistance in planning the general lighting of arterial roads.

Discovery of Smithfield Industries in Kenya

THE September–October number of *Man* contains a letter which is of distinct importance to those who concern themselves with the problems of Stone Age Africa. It would seem certain that Archdeacon Owen has discovered in a rock-shelter in Kenya an early Smithfield industry, and that Prof. van Riet Lowe has agreed with his interpretation. Smithfield industries occur over large parts of South Africa, especially in the Free State, the material used for their manufacture being usually the local indurated shale which chips well. Scrapers, awls, beads, and occasionally a little pottery have been found. The range in time of the culture extends backwards from modern days to an unknown, but probably fairly remote, period. as the later Smithfield industries show differences when compared with the earlier ones. Thus the plano-convex knife is an early tool type and does not recur in the more recent finds, while pottery seems to be absent from the earlier ones. In South Africa, too, there are regional differences in the industries which add to their complexity. But the main great problem has always been as to whether the Smithfield culture as a whole was an autochthonous growth in South Africa itself, engendered perhaps by culture-contacts; or whether it was not rather introduced into the subcontinent by migrations from the north. Archdeacon Owen's new discovery of Early Smithfield material—considered in fact to be even somewhat older than the Early Smithfield of South Africa—in Kenya would suggest that the latter hypothesis is the correct one.

Folk-lore of Alcoholism

IN a paper on this subject (*Brit. J. Inebriety*, July–October), Dr. J. D. Rolleston remarks that with the exception of Hovorka and Kronfeld's great work on comparative folk medicine no writers have dwelt at length on folk-lore in relation to alcoholism. He has therefore collected the folk-lore of this condition, as he has recently done in the case of general medicine, dermatology and pulmonary tuberculosis. His paper deals with the nomenclature, popular phraseology, superstitions and leechcraft connected with alcoholism and alcohol, the term 'leechcraft' being that commonly employed in the language of folk-lore to indicate popular methods of prevention and treatment. In a previous paper on "Alcoholism in Classical Antiquity" (*Brit. J. Inebriety*, 24, 101; 1927) he directed attention to the numerous synonyms for inebriated or bibulous persons, both in Greek and Latin, as well as in English, which contained about seventy such terms, only a minority of which could be called slang, whereas there are more than 280 slang synonyms for the word 'drink', 160 for the verb 'to drink', and 150 for various forms of intoxication. Popular interest in the consumption of alcohol, especially in excess, was further demonstrated by the great variety of similes connected with the subject. After dealing with the superstitions and popular errors connected with alcohol and alcoholism, which are legion, Dr. Rolleston discusses the popular methods of prevention and cure for inebriety, which he classifies under the headings of animal remedies, including coprotherapy, plant remedies, of which a large proportion are mentioned by Pliny, mineral remedies, invocation of patron saints and water.

Tuberculosis and War

ACCORDING to an editorial in the August issue of the *Statistical Bulletin* of New York, tuberculosis is already on the increase in other countries than the United States, although the evidence is based only on provisional or fragmentary data. In England and Wales the death-rate among male civilians rose slightly in 1939 and in 1940 in both sexes. For males the death-rate from tuberculosis rose 13 per cent

between 1939 and 1940 from 77·1 per 100,000 to 87·4; for females the increase was 7 per cent from 50·9 to 54·7. In Scotland the deaths from tuberculosis in 1940 increased 14 per cent over 1939, and the death-rate in 1940 was the highest since 1932. In Canada the mortality from tuberculosis did not rise in 1940, but there was a significant increase for the first half of 1941. In Germany and the occupied countries statistics on tuberculosis are not available. As regards France, a sharp increase in the disease has been reported from Vichy. The longer the War lasts and the farther it extends the greater will be the increase in tuberculosis, as is shown by the War of 1914–18, particularly among the women and children in Germany, Belgium, and eastern and south-eastern Europe, and to a less degree among the neutral countries.

Prevention of Typhus Fever

At a meeting of the Section of Epidemiology and State Medicine of the Royal Society of Medicine on November 28, Dr. Melville D. Mackenzie read a paper on the control of louse-borne typhus fever in Great Britain in the light of experience in Russia, Poland, Rumania and China. After discussing the epidemiological relationship of the disease to movements of population, under-nourishment and climatic conditions, he dealt with the rapidity of the spread of typhus fever, the frequency with which it is associated with other diseases and other factors which might complicate diagnosis, the method of infection, the importance of improved nutrition in the control of an epidemic, the value of reducing the number of lice in the population generally in addition to the tracing and delousing of contacts, the possible importance of dried fæces in the spread of the disease and the danger of the first cases being overlooked. Stress was laid on the necessity of utilizing young personnel in anti-typhus work. The greatest importance was attributed to the necessity for the thorough disinfestation of patients and contacts, the premises and their contents, as well as of the ambulance and the staff after duty.

The National Institute for Research in Dairying

The report of the National Institute for Research in Dairying (University of Reading) for the year ended September 30, 1940, has just been published. Many members of the staff are now acting in an advisory capacity on various war-time committees appointed by the Government, especially the Ministry of Agriculture. The realization of the essential need for milk to balance the deficiencies of a war-time dietary and the multifarious problems that this involves is, of course, making demands on the work of the staff and thus a number of long-range research projects have been shelved in order that the staff may devote more time to advisory work and short-range investigations of war-time problems of the dairy industry. Details of the work of the various departments of the Institute, namely, dairy husbandry, chemistry, bacteriology, dairy bacteriology advisory, physiology and biochemistry, and of the experimental dairy are included in the report. Sixty-six research papers were published by various members of the staff during the year, and as usual a separate list of papers which can be supplied by the Librarian is appended. This latter list contains twenty-nine titles. The address of the Institute is Shinfield, near Reading, Berks.

Country-Side

The first number of the war-time issue of *Country-Side*, the quarterly journal of the British Empire Naturalists' Association, has appeared to start the twelfth volume of this well-known journal. It is edited by Mr. Leslie Beckett, the honorary organizing secretary, and comprises a twenty-page octavo issue containing five original papers, a number of smaller notes and lists of regional field records on birds, insects and fungi. There is a list of twenty-one local branches of the British Empire Naturalists' Association (including a new one at Bath) which are remaining active during war-time. Mr. J. W. Bradley has a short article on the birds of Burma, Mr. E. L. Swann describes the formation of a Norfolk salt marsh and its subsequent flora, and Mr. M. B. B. Heath some recent observations of Mars. Among smaller notes there is an account of *sotto voce* song in the hen blackbird, the timing of the reeling song of the grasshopper-warbler to vary from 20 to 65 seconds with stops of 4–20 seconds between; Captain T. Dannreuther describes the immigration of clouded yellow butterflies to Great Britain in 1941. Mr. A. H. Wolley-Dod correlates the rarity of autumn bird song with the dry season, and there is a note on the abundance of privet hawk moth larvæ, even in London, this autumn. Field records include the wood-sandpiper, ruff, shelduck and gadwall at Cambridge sewage farm, the autumn passage of white wagtails in Lancashire, and October song of the blackbird in Wiltshire, where the speckled wood and comma butterflies were very numerous all the season.

Horticultural History

Three papers in recent numbers of the *Journal of the Royal Horticultural Society* describe the history of gardens and gardeners of the past. The gardens at Wormley Bury, Broxbourne, Herts, have been the means of introducing many new plants to the horticulture of Britain. Sir Abraham and Lady Amelia Hume introduced many species between 1785 and 1825, including several notable Amaryllids, two species of Pæonia, *Rudbeckia pinnata* and *Humea elegans*, named after the introducers. Major Albert Pam writes the article (66, Pt. 9, Sept., 1941), and is himself the present owner of Wormley Bury. The other two papers (66, Pts. 9 and 10, Sept. and Oct., 1941) are by the assistant secretary of the Society, and deal with the activities of William Forsyth in founding the Royal Horticultural Society. Forsyth's memory is maintained in the genus Forsythia which Vahl named in his honour, but he also experimented upon the treatment of wounded trees by covering the cut portions to exclude harmful fungi. He made useful contributions in this connexion, but clouded them so with extravagant claims that the benefit came to be largely discountenanced.

Portland Cement Industry of the United States

STATISTICS relating to the Portland cement industry of the United States, compiled by the U.S. Bureau of Mines, show that the quantity of this substance produced in 1940 was 130,216,511 barrels (the unit of measure employed throughout the statistics is the barrel of 376 lb.). The output for 1940 is not only 7 per cent higher than the output for 1939 but also was the largest quantity manufactured since 1930. Nevertheless, the output for 1940 was less by 20 per cent than that for 1928, which still constitutes the peak year of production. Basing their figures on the quantities of cement dispatched from works into the various States of the Union, aggregating nearly 127,800,600 barrels, it is estimated that the annual *per capita* consumption of cement averaged 0·96 barrel (about 3 cwt.) in the whole of the United States in 1940, as compared with 0·94 barrel in 1939. These figures represent only the records of the consignments inside the country. During 1940, 80·9 per cent of the Portland cement dispatched from works in the United States was moved by railway, 15·6 per cent by motor lorry and 2·2 per cent by boat. Furthermore, 25·6 per cent of the cement was dispatched loose, in bulk, 42·4 per cent was packed in paper bags, 31·9 per cent in cloth bags, and 0·1 per cent in other containers, including steel drums and iron or wooden barrels.

Imports of hydraulic cements into the U.S. in 1940 totalled 91,000 tons, compared with 321,000 tons in 1939. In both years the chief supplying country was Belgium and the second was Denmark. In spite of its large annual cement production, the export trade of the United States is small, totalling in 1940 a little more than 1 per cent of the production. The exports for 1940, however, which totalled nearly 284,000 tons, were higher than in any other recent year. Of the 1940 exports, 206,000 tons were dispatched to various countries on the North American Continent, the Central American Republics, the West Indies and Canada. The largest quantity was consigned to the Panama Canal Zone, namely, 82,000 tons. According to *Engineering* of September 26, South American countries imported in 1940, 73,400 tons of cement from the United States, Europe merely 76 tons, Asia 1,320 tons, Africa 2,390 tons and Oceania 70 tons ; 248,500 tons of cement were shipped to Alaska, Hawaii, Puerto Rico and other outlying territories of the United States.

Animal Production and Veterinary Science Abstracts

To meet the requirements of those engaged in the animal industries, a new section of *Biological Abstracts*, to be known as "Section F, Abstracts of Animal Production and Veterinary Science", will begin in January next. It will contain all the abstracts published in *Biological Abstracts* that have to do with the breeding, nutrition and metabolism, husbandry, reproductive and other physiology, anatomy, pathology and parasitology, and arthropod pests of livestock, poultry and semi-domesticated animals and birds, including pet stock. The new section will consist of ten abstract issues a year. The annual subscription rate will be 5 dollars, and subscribers will receive the index to the complete edition of *Biological Abstracts*. *Biological Abstracts* now covers some 1,450 periodicals, so the new section will, from the beginning, afford a very complete survey of the biological literature pertaining to the animal industries. Inquiries should be addressed to *Biological Abstracts*, University of Pennsylvania, Philadelphia.

Announcements

PROF. EMILE PICARD, For. Mem. R.S., permanent secretary of the Paris Academy of Sciences and a distinguished mathematician, died on December 12, aged eighty-five.

The Symons Gold Medal for 1942 of the Royal Meteorological Society has been awarded to the late Dr. J. S. Owens, whose death occurred on December 6. This Medal is awarded biennially for distinguished work in connexion with meteorological science. The presentation will be made at the annual general meeting of the Society on January 21 next.

DR. R. B. McCONNELL, assistant field geologist, has been appointed geologist of the Lands and Mines Department, Tanganyika.

DR. ORLANDO PARK, Northwestern University, will in future edit the "General Animal Ecology" Section in *Biological Abstracts*, thus succeeding Dr. W. C. Allee. The "Speciation" Section will be edited by Dr. Alfred Emerson, of the University of Chicago.

THE title of professor emeritus of logic and scientific method in the University of London has been conferred on Dr. A. Wolf, on his retirement from the professorship of logic and scientific method at University College and the London School of Economics.

PROF. HERMANN STEUDEL, emeritus professor and director of the Institute of Chemical Physiology at Berlin, has been awarded the Goethe Medal for Art and Science on the occasion of his seventieth birthday.

THE Financial Secretary to the Treasury stated on December 11 in reply to a question in the House of Commons that the number of students at universities and university colleges in Great Britain during the past autumn was approximately 25,000, of whom 5,900 were grouped as taking arts subjects and 19,100 scientific, technical and medical subjects.

MR. R. J. FLINTOFF, of Goathland, Yorks, founder of the Northern Ecological Society (see NATURE, December 13, p. 722) bequeathed his notebooks on plants to the British Museum ; £1,000 to the Linnean Society of London for a medal ; £1,000 to the Chemical Society for a medal ; and £1,000 to the University of Manchester for a prize ; he also made provision for the publication of his researches.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of NATURE. *No notice is taken of anonymous communications.*

Names of Electrical Units

WHILE the use of the metre-kilogram-second-coulomb system of units is rapidly becoming more widespread, that of the E.M.U. system is almost non-existent, except in elementary courses and old-fashioned text-books. In purely electrostatic problems, on the other hand, the general use of the E.S.U. system is likely to continue. The lack of distinctive names for the units in this system is a drawback in several respects, of which I will only mention the difficulty of checking dimensions. To remedy this defect a practice has arisen of using names such as 'statcoulombs', 'statvolts' and other equally cacophonous terms. This nomenclature has already been criticized in a recent review of a text-book (*Proc. Phys. Soc.*, **53**, 624; 1941), but no alternative has been proposed. I therefore wish to propose a terminology which should be acceptable to all English-speaking people.

I suggest that the charge which repels a similar charge at a distance of one centimetre with a force of one dyne be called a *franklin*, in honour of Benjamin Franklin, the pioneer of static electricity.

There is no need for any other new names. The accompanying table gives the units of the most important electrostatic quantities in centimetre-gram-second-franklin (C.G.S.F.) units and in metre-kilogram-second-coulomb (M.K.S.C.) units. It seems unlikely that one should want to use the C.G.S.F. system for magnetic measurements, but it can be so used; the unit of H would be franklin/sec. cm. and that of B would be erg cm. sec./franklin.

At the same time, to avoid ambiguity, I suggest that, whatever units be used, the ratio D/E should always be called the *permittivity*, a nomenclature already widely used in the United States, and that *dielectric constant* should denote the ratio of permittivity of medium to that of empty space and should thus be a number independent of the units used. This suggestion is incorporated in the table.

One further point. An increasing number of physicists, though still a minority in Great Britain, prefer to use the rational system. I want to point out that this need not involve a change of units, but merely a change in the definition of D, so that at the surface of a charged conductor, $D = \sigma$ instead of $D = 4\pi\sigma$, and the electrostatic energy density becomes $\frac{1}{2}ED$ instead of $ED/8\pi$. Rationalization thus leaves E unaltered, but reduces D by a factor $1/4\pi$, and this statement is true whether E, D be both measured in C.G.S.F. units or both in M.K.S.C. units.

E. A. GUGGENHEIM.

Term	C.G.S.F. unit (E.S.U.)	M.K.S.C. unit
Charge	franklin	coulomb
Surface density of charge, σ	franklin/cm.^{2}	coulomb/m.^{2}
Displacement, D	franklin/cm.^{2}	coulomb/m.^{2}
Current	franklin/sec.	coulomb/sec. = amp.
Current density	franklin/sec.cm.^{2}	amp./m.^{2}
Energy	erg	joule
Energy density	erg/cm^3.	joule/m^3.
Potential	erg/franklin	joule/coulomb = volt
Field, E	dyne/franklin	volt/m.
Permittivity, D/E	franklin^2/erg cm.	coulomb/volt m. = sec./ohm m.
Value of permittivity of empty space	$1\ \frac{\text{franklin}^2}{\text{erg cm.}}$	$\frac{1}{9\times10^9}\ \frac{\text{sec.}}{\text{ohm m.}}$

THE international procedure which in normal times can be adopted for agreement or otherwise to suggested changes in the nomenclature of fundamental units cannot function at the present time, but it is hoped that Dr. Guggenheim's suggestion, which can be brought to the notice of those it concerns through the columns of NATURE, will find the favour it seems to deserve, and will prevent the 'statcoulomb' becoming an established term, which has neither the merit of euphony nor symmetry in the systematic naming of the electrical units.

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Refractive Indexes of Gases at High Radio Frequencies

SINCE atmospheric refraction plays an important part in the bending of ultra-short radio waves round the surface of the earth, an adequate study of the propagation of these waves requires a knowledge of the refractive indexes of gases at very high frequencies. It was thought desirable to test the assumption, made in all previous theoretical work, that the values of these indexes were the same as their values at lower frequencies. When this work was begun, no figures were available for the refractive index of any gas at a frequency higher than about 4 Mc./sec. Since then, however, a result for water vapour at 42 Mc./sec. has been published by Tregigda[1].

A standing wave method has been used in this work, the standing waves being produced in a gas-tight concentric tube Lecher circuit, by bringing it into resonance with a highly stable crystal-controlled oscillator to which it was loosely coupled. The apparatus was so constructed that the changes in the length of these standing waves as the pressure or composition of the gas inside was varied could be determined with some precision, the refractive index of a gas for a wave of given frequency being equal to the ratio of the length of the wave in a vacuum to the length in the gas. The concentric tube form of Lecher system is very suitable here, as the gas under investigation can be placed in the space between

the inner and outer tubes, and further, the outer tube itself forms a most effective shield from external disturbances. The temperature of the concentric system was maintained constant by a steam jacket round the apparatus, while the temperatures of the oscillating crystal and the water vapour supply were stabilized by means of radiation thermostats, based on that developed in this Laboratory by Laby and Hopper[2].

Results have been obtained for the refractive indexes of dry air and water vapour as follows: for dry air, at 58 Mc./sec., 100°C., 76 cm. mercury;

$$\mu = 1/00024_0 \pm 0{\cdot}000006 ;$$

and for water vapour, at 58 Mc./sec., 100°C., 76 cm. mercury,

$$\mu = 1{\cdot}0030_1 \pm 0{\cdot}00007.$$

It had been hoped to carry out work at other frequencies, temperatures and pressures, and with other gases, but this has been prevented by the War.

The important part played by the water vapour in the atmosphere in the propagation of ultra-short waves can be seen from these results. The figure for water vapour is found to agree with the value of 1·0060 for the dielectric constant of water vapour at 42 Mc./sec., 99·8°C. and 76 cm. mercury, obtained by Tregigda[1] using a heterodyne method.

The work, which was carried out under the direction of Prof. T. H. Laby, was supported by the Australian Radio Research Board.

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[1] Tregigda, *Phys. Rev.*, **57**, 294–297 (1940).
[2] Laby and Hopper, NATURE, **143**, 240 (1939).

Application of the Gibbs Adsorption Equation to Solutions of Paraffin-Chain Salts

WITHIN recent years considerable doubt has been cast upon the validity of the Gibbs adsorption isotherm as applied to aqueous solutions of the paraffin-chain salts (soaps and soap-like molecules)[1,2]. The chief objection has been the numerous well-established examples of dilute solutions showing a minimum in the surface tension – concentration curve, usually at a surface tension of 30–35 dynes, presenting the paradox of a surface tension very much lower than that of water, and yet a zero or negative surface excess of solute as calculated from the Gibbs equation when applied in the customary manner.

Because of this apparent paradox, McBain and Mills[1], in a recent review, have concluded that the Gibbs equation is only a limiting law, and that terms allowing for the effects of orientation, of submerged double layer, and of free electrical charge (if any), should be included. This argument cannot be supported, however, since the systems under discussion are electrically neutral, and the other terms, assuming as they do a particular molecular interpretation of the surface layer, cannot be used as correcting factors, since they would be already included in the thermodynamically rigorous Gibbs equation.

Long and Nutting[3] have recently put forward an explanation based upon the assumption that there is a surface *layer* of solute (giving positive adsorption at the interface) above a diffuse double layer of considerable depth, the concentrations in this double layer then determining whether the "Gibbsian *surface excess*" of solute is positive, zero or negative. (The hypothetical geometrical surface is chosen so that the surface excess of water is zero.) Unfortunately for this argument the total surface adsorption as measured by the microtome method, and which would include both surface and diffuse layers, is always positive[2]. Other techniques support this invariable positive adsorption[2].

The explanation suggested below, previously tentatively discussed by Powney and Addison[4], would seem to provide a simple explanation of the above anomalies.

It is generally accepted that with the solutions under consideration micelle formation sets in at concentrations close to (probably rather less than) that at the minimum surface tension[5]. Also it seems well established that the micelle, owing to its structure, is precluded from existing in the surface layer, the surface active species being the single ionized molecule[6]. Thus the micelles may influence bulk properties such as freezing-point and conductivity, but can have little effect on the surface tension except in so far as their presence influences the concentration of single molecules in the solution. Hence the activity term in the Gibbs equation should be that for the *molecularly dispersed* solute in bulk solution[7]. The much larger amount of solute present in micelle form acts as a 'buffer', keeping the concentration of the molecularly dispersed solute sensibly constant, as shown by application of the Law of Mass Action[6,8]. Accordingly, it is not surprising that, using the activity of the solution *as a whole*, as McBain and Mills, for example, have done[1], the Gibbs equation should break down.

That the Gibbs equation holds, even with the paraffin-chain salts, when micelles are absent, is shown by the results of McBain and Wood with lauryl sulphonic acid[2]. Thus at a concentration of 0·002 gm.mol./l. (concentration at the minimum 0·006 gm.mol./l.), their measured adsorptions were +2·7 and +3·0 (microtome and interferometer respectively), that calculated by the Gibbs theorem being + 2·4 (gm.mol./cm.^{2} × 10^{10}).

The above explanation is further strengthened by calculation of the adsorption of lauryl sulphonic acid at the minimum surface tension[9] which, assuming the adsorbed film to be monomolecular, gives a value of +5·7, in good agreement with that using the microtome[2] (+5·4) (units as above). Further details will be published shortly.

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Nov. 18.

[1] McBain and Mills, "Reports on Progress in Physics", **5**, 30 (1939).
[2] McBain and Wood, *Proc. Roy. Soc.*, A, **174**, 286 (1940).
[3] Long and Nutting, *J. Amer. Chem. Soc.*, **63**, 625 (1941).
[4] Powney and Addison, *Trans. Faraday Soc.*, **33**, 1252 (1937).
[5] Lawrence, Annual Reports Chem. Soc., **37**, 102 (1941).
[6] Murray, *Trans. Faraday Soc.*, 31, 206 (1935); Alexander, *Trans. Faraday Soc.*, **37**, 15 (1941).
[7] cf. Nickerson, *J. Phys. Chem.*, **40**, 285 (1936).
[8] Bury and others, *Phil. Mag.*, **4**, 841 (1927); *J. Chem. Soc.*, 679 (1929); Hartley, "Aqueous Solutions of Paraffin-Chain Salts" (Hermann, 1936).
[9] Alexander, in the press.

Vanadium Pentoxide as a Catalyst for Sodium Chlorate in Weed Destruction

IT is well known that vanadium pentoxide, used as a catalyst, greatly increases the efficiency of sodium chlorate when employed as an oxidizing agent in the production of certain dyes. Investigations have been carried out to determine whether similar use could be made of vanadium in certain methods of weed destruction, more particularly in connexion with the practice of smearing the cut surfaces of bracken fronds with chlorate solution or introducing it into the tissues of bramble plants by immersing the ends of stems from which the tips have been cut.

The experiments were carried out in September of the present year. Brambles were treated by placing the cut ends of the trailing stems in small bottles each containing 50 c.c. of the various materials in aqueous solution.

Ten bottles of each of the following were employed :

(1) Vanadium pentoxide only ; 0·02 per cent solution.

(2) Sodium chlorate ; 10 per cent solution.

(3) Sodium chlorate ; 10 per cent solution, plus 1 part vanadium pentoxide per 500 parts sodium chlorate.

Observations were made on rate of travel up the stem, as evidenced by the destruction of the parts, and on the intensity of the effects. The findings were as follows :

(1) Vanadium pentoxide only ; no effect noted.

(2) Sodium chlorate only ; the usual toxic effects, a fair degree of killing with dark brown scorching of the leaves, taking ten days to reach completion.

(3) Sodium chlorate plus vanadium ; severe destructive effect noted after five days, the rate of travel having been greater and exceeding the final effect of the sodium chlorate solution without vanadium. Apart from this speeding up and greater intensity of killing, a remarkable bleaching effect appeared after twenty-one days. The stems for about a foot above the points of immersion became quite white, ranging to a light yellow above. The leaves took on a light yellow tint, and in the piece of cleared woodland where the trial was carried out, these vanadium-treated plants could be distinguished at a distance without reference to the labels.

Stems from all three treatments were kept under further observation. In treatment 2, they became blacker, but extremely tough and hard, and the leaves were retained. In treatment 3, the stems became soft and brittle and the leaves all broke off from the base of the petioles.

A further trial gave similar, though not so definite, results with an addition of 1 part vanadium pentoxide to 1,000 parts of sodium chlorate.

The above observations suggest the possibility of enhancing the value of sodium chlorate as a herbicide by the employment of a catalyst. Vanadium pentoxide in the proportion used would not be ruled out on the grounds of cost. It is, however, not readily soluble in water, and further investigation is required on this point.

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Nov. 20.

Spectrochemical Analysis of Eggs

IN the course of an investigation into the mineral content of foodstuffs, some analyses of hens' eggs were made. The white and yolk were treated separately. The ash was analysed by the ordinary arc spectrum method, and the liquids were also analysed directly by a spark technique similar to that described by Langstroth and Macrae[1]. Calcium, magnesium and sodium were present in relatively large quantities in all specimens. Potassium and lithium were also present in fair quantity. Traces of the following elements were also found in both yolk and white : copper, iron, manganese, strontium. silicon, phosphorus and aluminium. Barium was present in the yolk but could not be detected in the white. A very small trace of lead was indicated in one specimen of white, but its presence could not be detected in other specimens. The following elements were not present in detectable quantity in any specimen : boron ($< 0·2$), chromium ($< 1·0$), molybdenum ($< 1·0$), zinc (< 10), nickel ($< 1·0$), cobalt ($< 1·0$), cadmium ($< 0·2$) and antimony (< 20, < 200) ; the figures given in brackets indicate limits of detection in parts per million.

These results are in general agreement with those of Drea[2] except that he reported barium, molybdenum zinc and chromium as present in both yolk and white. He also reported rather stronger indications of aluminium and strontium. Drea used graphite electrodes, and Webb[3] has shown that spurious indications of a number of elements (including barium, molybdenum, zinc, chromium, aluminium and strontium) may be obtained with these electrodes. In order to avoid this effect, the present work was done with a silver spark technique, and this probably accounts for the fact that a smaller number of elements is reported as present. My analyses indicated that the copper and manganese content was of the order 0·001 of the magnesium content and did not exceed a few parts per million. Chemical analyses[4] indicate magnesium content of order 100 parts per million and copper content of order 0·3 parts per million. From my analyses the order of magnitude of the abundance of the other metals may be roughly estimated (in parts per million) as follows : iron ($> 1·0$), strontium (0·2), aluminium (0·2) and barium (0·2).

A number of fertilized eggs were examined at different stages of development in order to try to trace changes in the passage of mineral elements from the yolk to embryo. The changes found were, however, only of the same order as the differences between different specimens at the same stage of incubation. The only conclusion to be drawn was the purely negative one that there is no rapid and obvious preferential removal of one mineral constituent from the yolk during early stages of incubation.

This work was carried out in the Physical Laboratory, Trinity College, Dublin, under the supervision of Prof. R. W. Ditchburn, with the aid of a grant from the Medical Research Council of Eire. I wish to thank Prof. T. W. T. Dillon of University College, Dublin, for his advice, and the Albert College, Glasnevin, for a supply of eggs.

R. PRESS.
Trinity College,
Dublin. Nov. 19.

[1] Langstroth and Macrae, *Can. J. Res.*, A, **16**, 17 (1938).
[2] Drea, *J. Nutrition*, **10**, 354 (1935).
[3] Webb, *Sci. Proc. Roy. Dublin Soc.*, **21**, No. 46, 501 (1937).
[4] McCance and Widdowson, "Chemical Composition of Foods".

'Klino-kinesis' of Paramecium

THE suggestion made by Gunn and Walshe[1], that the avoiding reaction of Paramecium fits into the scheme of klino-kinesis, receives some support from the behaviour of the animal in a uniform high temperature, as I described it in 1939[2]. If the temperature of a culture is gradually raised, nothing happens at first except an increase in the speed of the animals. Then at a temperature of about 30° C. avoiding reactions begin, and as the temperature is further raised they become more frequent, with the result that forward motion practically ceases and the animals dance backwards and forwards like particles in Brownian movement. If the temperature is kept steady soon after avoiding reactions have begun, they gradually become less frequent and finally cease altogether. Once the rate of occurrence of the reactions has become very high, however, there is no acclimatization and death soon follows.

But while the term 'klino-kinesis' may be useful as a description of the behaviour of ciliates in unusual experimental conditions, there does not seem to be any justification for its use, instead of the simpler term avoiding reaction, for the ordinary behaviour. For when a paramecium retreats from a hot region or from contact with a solid object, there is no question of sensory adaptation. What happens is that a stimulus is received, a reaction follows, and in many cases this directs the animal away from the stimulating region. There need be no teleological assumption that a reaction occurs *in order to* avoid things: the implication is the quite correct one that by the reaction the animal does, in fact, avoid certain situations.

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Dec. 3.

[1] Gunn and Walshe, NATURE, 148, 564 (1941).
[2] Yapp, "Introduction to Animal Physiology" (Oxford, 1939).

Production of Proliferation-promoting Factors by the Ultra-violet Irradiation of Algæ

PREVIOUS papers from these laboratories have shown that the subjection of yeast, other micro-organisms, and several animal tissues to various forms of injury, such as ultra-violet irradiation, X-rays, mechanical injury, chemical irritation and oxygen lack, results in the release into the intercellular fluids of substances which stimulate cellular proliferation. Because of the mode of formation these substances have been spoken of as "intercellular wound hormones"[1].

In order to determine the generality of the phenomenon it has been of interest to extend the experiments to as wide a variety of cells as possible. Accordingly, preliminary experiments were carried out with mixed cultures of algæ in which the algæ were subjected to ultra-violet irradiation and the cell-free filtrates obtained from the irradiated algæ were tested for their power to increase the proliferation of fresh alga cultures. The preliminary indications having been favourable, more quantitative experiments were carried out and are reported in this note.

30–40 c.c. of a heavy suspension of *Hormidium floccidum*[2] in Detmer's 1/3 medium were irradiated with a Sperti Mercolite ultra-violet lamp (42*TC*) for from two to three hours at distances of 15–25 cm. The suspension was stirred mechanically throughout the irradiation period, as was a similar, but non-irradiated, control suspension. At the end of the irradiation period, both suspensions were filtered, first through filter paper and then through sterile Berkefeld "N" filters. 1 c.c. of the filtrate from the irradiated algæ was added to 5 c.c. of a very dilute fresh suspension of the algæ in Detmer's 1/3 medium, and 1 c.c. of the control filtrate was added to another 5 c.c. of the alga suspension. Four or five tubes were used in each run for both filtrates. Sterile technique was employed throughout. The tubes were kept for 2–3 months at a temperature of approximately 25°–30° C. in the light. At the end of the experimental period the number of algæ in the experimental and control runs were counted by means of a hemacytometer.

Eighteen determinations were made in four separate experiments. In every case the algal suspension treated with the filtrate from the irradiated algæ contained more cells than the corresponding suspension to which the filtrate from the non-irradiated suspension was added, the increase in the various experiments running from about 45 to 115 per cent. These results, in conjunction with the more extensive work in our laboratories on other organisms, indicate to us that algæ, when injured with ultra-violet radiations, release into the intercellular fluids substances which stimulate proliferation of the algæ.

These experiments are being extended to other algæ, including *Stichococcus bacillaris* and *Chlorella pyrenoidosa*. The results will be reported in detail later. The possible effect of the irradiated extracts on chlorophyll formation will also be considered.

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[1] See for example: Fardon *et al.*, NATURE, 139, 589 (1937); *Studies Institutum Divi Thomæ*, 2, 39 (1938) and 2, 233 (1939); Loofbourow *et al.*, NATURE, 142, 573 (1938); 143, 725 and 144, 553 (1939); *Studies Inst. Divi Thomæ*, 2, 137 (1938); 2, 155 (1939); *Arch. exptl. Zellforsch.*, 22, 607 (1939); *Biochem. J.*, 34, 432 (1940) and 35, 603 (1941); Cook *et al.*, Atti X° congr. intern. chim., 5, 26 (1939); *Biochem. J.*, 34, 1580 (1940).
[2] We are greatly indebted to Dr. Florence Meier Chase of the Smithsonian Institution, Washington, D.C., for the algal cultures.

Simple Modifications of the Camera Lucida for Making Larger Drawings

WHEN drawing objects under a microscope with a camera lucida the size of the drawing is normally dependent solely on the magnification of the microscope. Usually this magnification can be adjusted to give a drawing of the required size; but when drawing objects which are only a few microns long, such as chromosomes or the spores of fungi, the image produced by even the highest powers of the microscope is too small to give a drawing of a reasonable size. The devices described below are for the purpose of making large drawings with a camera lucida in such circumstances.

In using a camera lucida the image of the object seen down the microscope is made to coincide with the image of the drawing (and hand and pencil) produced by the prism and mirror of the camera lucida. Now if the image of the hand and pencil is, by optical means, made small relative to that of the object, a large drawing will result. What appears to be a very small hand with a minute pencil traces the drawing in the usual way, and appears to draw it the same size; but as the hand and pencil are in fact their usual size the drawing is an enlarged one.

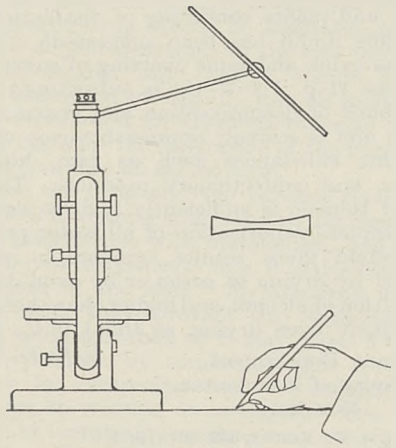

Fig. 1

This result may be achieved in one of three ways: (1) by placing a con*cave* lens between the camera lucida mirror and the drawing (Fig. 1); (2) by replacing the plane mirror of the camera lucida by one which is con*vex*; (3) by using three plane mirrors instead of the usual one, arranging them as shown in Fig. 2.

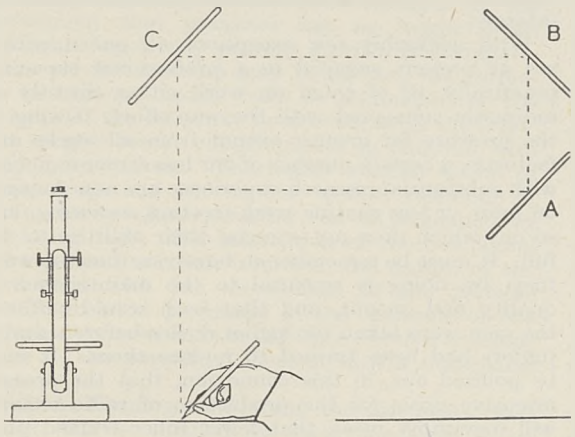

Fig. 2

The simplest of the three ways is the first, using a concave lens. This should be placed about half-way between the mirror and the drawing. If the lens is too high the image of the pencil may come within the least distance of distinct vision so that the eye will not be able to focus it sharply. If the lens is too near the paper the drawing will not be much enlarged. When looking down the microscope the image of the concave lens should come in the centre of the field. The lens should be fairly large so that the work can be confined to near its centre, as there is some distortion near the edges.

The second method, using a convex mirror in place of the plane mirror of the camera lucida, is very similar to the first. A convex driving mirror of a car is suitable for the purpose. The centre of the mirror should be at the height of the prism of the camera lucida and its general direction should be at 45° to the vertical. It may be necessary to fit the convex mirror rather farther from the microscope than the mirror it replaces, to prevent the image of the pencil from coming within the least distance of distinct vision.

In the third method three plane mirrors, *A*, *B*, and *C* are substituted for the usual one as indicated in Fig. 2; retort stands or other means of support are not illustrated. *A* may be almost any distance from the microscope; the farther away the greater the drawing. It is at the same height as the camera lucida prism and is tilted upwards at 45°. *B* is vertically above *A* and is tilted downwards at 45°. *C* is near the microscope, vertically above the drawing and at the same height as *B*; it is tilted downwards at 45°, at right angles to *B*. *C* must be high enough not to obscure the view of *B* from the prism. This arrangement is a little more troublesome to set up than either of the other two; but enables a drawing of any required enlargement to be made, and, provided good quality mirrors are used and they are at 45°, there is no distortion.

The image of the pencil is brought nearer to the eye by the first and usually by the second methods, and is taken farther away by the third method than it is with an ordinary unmodified camera lucida, and some may experience difficulty in controlling the focusing of their eyes so that the pencil is clearly seen through the camera lucida even when the lighting is properly balanced. This is because when looking down a microscope which is in focus the object appears to be sharply focused whether the eye is focused for near or for distant vision; but the pencil seen through the camera lucida is clear only when the eye is focused for the one particular distance. If the eye is focused for almost any other distance the object will be clearly seen, but the pencil will not. Those who find difficulty in focusing their eye on the pencil will find it helpful momentarily to shade the substage mirror of the microscope with the hand.

I wish to thank Miss F. L. Stephens for directing my attention to the problem and for helping me try the methods.

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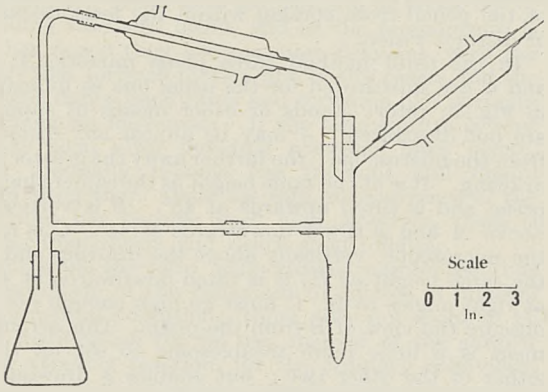
Nov. 21.

Rapid Determination of Water in Animals and Plants

IN a recent communication, Lowndes[1] has pointed out the advantages attained by applying the Dean and Stark method[2] for the determination of water to plant and animal tissues.

A modification of this well-known method has been used for the determination of water content of tumour tissue in these laboratories. The main disadvantage experienced in the use of the normal type of the Dean and Stark apparatus with solvents lighter than water lies in the fact that droplets of water adhere

to the condenser column. This adhesion of water is recognized in the method of water determination covered by British Standards Specification, 756—1939, in which the recommendation is made that it should be removed to the receiving column by a soft camel hair brush. We have eliminated this disadvantage, however, by modifying the apparatus as shown.



The condensed water is washed into the receiver by succeeding portions of liquid, whilst the return flow takes place through a lower connecting tube. The second condenser is introduced to prevent any loss of solvent. Connexions are made by synthetic rubber ('Neoprene') tubing, which is resistant to organic solvents, across butt-end glass joints. We are indebted to Mr. L. G. Wilkinson for the construction of this apparatus.

In our determinations benzene (b.p. 80°) was used rather than xylene (b.p. 135°), as it was considered that use of the former would give results more comparable with those obtained by dehydration at 105°. A determination on a 5 gm. sample takes approximately one hour.

The accuracy of the method is limited by error in reading the volume of water (for example, an error of 0·05 c.c. on a 1 c.c. reading will produce a percentage error of five), and its use is therefore restricted to bulk samples from which 5–10 c.c. of water can be obtained. Experience showed that the use of a measuring tube narrower than that illustrated was unsatisfactory, as the globules of water imprisoned benzene in the lower part of the tube.

For small samples (up to 1 gm.) the method of dehydration at a 100° has been employed.

The tissue, weighed into a combustion boat, was introduced into the inner tube of a small horizontally placed Liebig condenser. Heating is effected by passing steam through the outer jacket. A current of air dried by bubbling through sulphuric acid is passed over the sample. The moisture taken up by the air is absorbed in two tared calcium chloride tubes. Since the weight of water in the tissue is much greater than the dry tissue weight, a very accurate determination of water can be effected on small specimens.

The modified Dean and Stark method has been particularly useful as a means of obtaining average values for the water content of mouse tumours (Twort carcinomata).

Surplus moisture is first removed by laying the tissue on filter paper. In one batch of mice the moisture content of six tumours, estimated by the second method described, gave values of 80·0, 81·5, 72·4, 76·9, 77·6, 84·8; the Dean and Stark method applied to the remaining twenty-three tumours, taken four or five at a time, gave the figures 79·1, 78·9, 79·0, 78·8, 78·9, 78·8.

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Nov. 20.

[1] Lowndes, A. G., NATURE, 148, 594 (1941).
[2] Dean and Stark, *J. Ind. Eng. Chem.*, 12, 486 (1920).

A RAPID method for the estimation of water in animals and plants consisting of distillation with an immiscible liquid has been suggested[1]. The liquid used was xylol, and some charring of sugar occurred. If toluene (b.p. 110·7° C.) is substituted for xylol, the amount of decomposition and charring is much reduced and is scarcely appreciable even with sugar-containing substances such as jam, honey, fruit extracts, and confectionery products. The boiling-point of toluene is sufficiently high to ensure rapid and complete vaporization of all water present, and the method gives results comparable with those obtained by drying *in vacuo* or by oven drying after the addition of alcohol, and higher than those obtained by 'straight' oven drying, at 105–110° C.

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Nov. 24.

[1] Lowndes, A. G., NATURE, 148, 594 (1941).

Employment of Physicists

IN view of the statements made in recent articles in NATURE regarding the employment of scientific workers in connexion with the national effort, the following statement of the situation as it concerns members of the Institute of Physics may be of interest.

With negligibly few exceptions all our members are at present engaged in a professional capacity, practically all of them on work either directly or indirectly connected with the war effort. Owing to the pressure for greater output from all works and factories, a certain number of our less senior members with substantial research experience are now engaged on more or less routine work (testing, servicing, and so on) which does not exercise their abilities to the full. It must be remembered, however, that the work they are doing is essential to the maintenance of quality and output, and that both would suffer if the men were taken for higher duties before suitable juniors had been trained to replace them. It may be pointed out, in this connexion, that the present intensive drive for the production of radio experts will inevitably mean that fewer fuller trained physicists will be turned out by the universities.

Only the Cabinet and its advisers can be in a position to know the relative importance at the moment of research, industrial production and operational control (either with or outside the armed forces). So far as physics is concerned, the available manpower is already fully engaged, but it would certainly be possible to increase the research potential, if that is desired, at the expense of other forms of war service.

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MODE OF ACTION OF CHEMOTHERAPEUTIC AGENTS

THE Biochemical Society held a discussion meeting on the mode of action of chemotherapeutic agents on November 29 at the Courtauld Institute of Biochemistry, Middlesex Hospital, Prof. E. C. Dodds being in the chair.

Dr. G. M. Findlay, in opening the discussion, said that chemotherapeutic action can be classified as direct or indirect. Except in the case of parasites present in the intestinal canal, it is essential that the chemotherapeutic drug should be absorbed into the body, that it should penetrate to the site where the parasites are acting, and that it should not be excreted or converted too rapidly into an inert form. Time must be allowed for chemotherapeutic action, and in some cases for the conversion of the compound from an inactive into an active form.

When once the drug and the parasite have been brought face to face, three stages can be distinguished, adsorption, interference with metabolism, and death or such injury to the parasite that it is destroyed by the phagocytes of the host. An absorbed chemotherapeutic drug may prevent an essential food factor from being adsorbed or it may cause a breakdown in metabolism by combining with a specific substrate or by competing with an essential cell metabolite for an enzyme or coenzyme. One break in the chain of metabolic reactions may rapidly give rise to others. Specific immune serum and sulphapyridine do not compete for the same receptor group in the pneumococcus and may therefore enhance one another.

Parasites may be killed in the body without the aid of phagocytes, but usually when a parasite has been damaged it is destroyed by the normal defence mechanism of the host.

Indirect action produces such changes in the environment that parasites can no longer grow. Physical changes may prevent growth, the temperature or the *p*H reaction may be altered, the formation of immune bodies may be stimulated or the character of the cells may be altered, as in the treatment of gonococcal vulvovaginitis in children with œstrin preparations. The highly specific action of certain drugs and the no less specific reactions of certain closely allied parasites can be explained by postulating that, after adsorption of the compound at the parasite/solution interface, the nature of the interference with the metabolism of the parasite depends on what groupings in the molecule of the compound come within the influence of other acceptor groups in the parasite: there is thus a multipoint action.

Prof. A. Fleming, continuing the discussion, said that in 1929 he applied the name penicillin to an anti-bacterial substance of unknown constitution elaborated by *Penicillium notatum* when grown in ordinary bacteriological media or in a modified Czapek-Dox medium. The action is mainly bacteriostatic and shows a marked degree of specificity. Pyogenic cocci, Clostridia and some other bacteria are sensitive, while the coli-typhoid, hæmophilic chromogenic bacilli and others are insensitive. Pathogenic Gram-negative cocci (Gonococcus, Meningococcus and *M. catarrhalis*) are sensitive, while saprophytic varieties, for example *M. flavus*, are insensitive, thus differing from the sulphonamides.

The action of penicillin is not interfered with by substances that inhibit sulphonamides, bacteria, bacterial extracts, pus fluids, tissue autolysates, peptones and *p*-aminobenzoic acid. Penicillin is non-toxic to leucocytes and animals, but in low dilutions it affects the morphology of bacteria and interferes with division. As penicillin and also gramicidin are apparently of a different constitution from the sulphonamides, the isolation and synthesis of the pure active principles will open up a new chemotherapeutic field.

Prof. Warrington Yorke described the action of the aromatic diamidines which were evolved by Dr. Ewins, after it had been shown that synthalin (decane diguanidine) acts on trypanosomes not by reducing the sugar but by direct toxic action. Some aromatic diamidines exhibit a remarkable trypanocidal activity. The most active are 4 : 4′-diamidinostilbene, 4 : 4′-diamidino-diphenoxy-propane and 4 : 4′-diamidino-diphenoxy-pentane. Cases of kala-azar have now been successfully treated by diamidinestilbene—Indians, children in the Mediterranean area and patients with the Sudanese variety, which is resistant to antimony. Babesia infections in dogs have been cured by the stilbene and propane derivatives, the stilbene being highly active against *Trypanosoma congolense*. The compounds have a highly specific action. Drug resistance appears to be due to a change in the surface layer of the parasite. Trypanosomes resistant to a number of compounds have now been prepared, including a diamidine preparation. It has also been possible to prepare a diamidine-resistant Babesia and a plasmoquine-resistant strain of *Plasmodium knowlesi* in the monkey.

Discussing trypanocidal substances, Dr. F. Hawking said that from the phenomenon of drug resistance four kinds of receptors on the trypanosome are recognized. Trypanocidal action comprises fixation of the drug, secondary chemical reactions inside the cell and death. Only about the first process is much known: it occurs quickly in a few minutes and is reversible. With arsenical compounds, fixation apparently depends on the tervalent arsenic atom linked to a benzene ring. Certain side chains ($-NH_2$, $-OH$) prevent fixation on animal cells but not on normal trypanosomes: the receptors of resistant trypanosomes are modified. Over a wide range, the amount of drug fixed is proportional to the concentration in the surrounding fluid: in the case of acriflavine the partition ratio (concentration inside the trypanosome/concentration outside) is 8,000 for normal trypanosomes, 60 for resistant trypanosomes. Fluorescent compounds, acriflavine and diamidino stilbene, are concentrated in the blepharoplast and cytoplasmic granules of the trypanosome.

The importance of having a theory of chemotherapeutic action was emphasized by Sir Henry Dale, who congratulated the Society on arranging a discussion meeting in war-time. It was one of Paul Ehrlich's great contributions to the subject to have produced theories which, though they will probably not survive unmodified, have given tremendous stimulus to research; thus, his explanation of the action of certain dyes on infection by trypanosomes as due to injury of the reproductive power of the trypanosomes, without affecting their other vital functions.

At the time, this suggestion seemed artificial and unconvincing, but when Dobell and Laidlaw found a method for growing *Entamœba histolytica* in permanent culture *in vitro*, it could be demonstrated that the action of emetine was just of this type. The 'factor of persistence' is also of importance in chemotherapeutic activity. This seems to be the reason why a quinquevalent arsenical on one hand, or an arseno-compound on the other, is a better chemotherapeutic agent than the arsenoxide produced by reduction from one or by oxidation from the other, although the arsenoxide is recognized as the directly parasiticidal agent. In the same way, sulphaguanidine seems to owe its effectiveness in bacterial dysentery to its poor solubility, enabling it to remain in solid form in the intestinal contents and to keep up a steady, low concentration in contact with the infected mucous membrane. Aromatic diamidines, the brilliant promise of which has been made clear by the results reported by Prof. Warrington Yorke, may similarly owe part of their superiority to their limited solubility. Sir Henry suggested, as problems the solution of which might greatly accelerate advance in parts of the field of chemotherapy, the discovery of a method of keeping trypanosomes alive and reproductive indefinitely in artificial culture, and the discovery of a method of treating a strain of trypanosomes which has acquired a drug resistance, so as to restore the normal susceptibility.

Dr. D. D. Woods spoke of the interference of antibacterial agents and essential metabolites. This interference may be due to the formation of a compound between the antibacterial agent and the essential metabolite, as between mercury salts and —SH compounds, or by inhibition of an enzyme reaction involved in the synthesis or utilization of an essential metabolite. An example of this is the competitive inhibition by sulphanilamide of an enzyme reaction involved in the further utilization of *p*-aminobenzoic acid, this inhibition occurring by virtue of the chemical relationship of sulphanilamide and *p*-aminobenzoic acid. The latter has been isolated from natural sources and is a growth factor for *Clostridium acetobutylicum* and higher organisms. Following out this hypothesis, the following substances all chemically related to a known essential metabolite, the latter shown in brackets, have been found to have some antibacterial activity; pyridine-3-sulphonic acid and amide (nicotinic acid and amide); aminosulphonic acids (analogous amino-carboxylic acid); sulphonic acid analogue of pantothenic acid (pantothenic acid); indole-3-acrylic acid (tryptophan); barbituric acid (uracil).

Dr. H. McIlwain said that an organism which is deprived of the use of enzymes or metabolites by various types of interference is nutritionally more exacting than in its normal state. *Bacterium coli* and *Streptococcus hœmolyticus*, inhibited by acriflavine components, require for further growth two types of material not normally required. Type 1 is best replaced by nucleotides, type 2 by a concentrate of amino acids but partly by phenylalanine. In the presence of type 2 compounds, but not without, artificial hydrogen carriers are further active against inhibition of *Bact. coli*. Type 1 compounds form complex salts with acriflavine components. The inhibitors probably inactivate enzyme systems of which type 1 compounds are essential parts, of which type 2 compounds are substrates or products and of which some can be replaced by the hydrogen carriers.

The relationship between chemical constitution and bactericidal action in certain amino-acridines was described by Dr. W. H. Linnell. Among the isomeric diaminoacridines, a 1-amino group causes complete loss of bactericidal activity and reduces toxicity; a 2-amino group increases activity and this is further enhanced by another amino group in the 2-, 3-, 4-, (in the other ring) or 5-positions, accompanied by increased toxicity in the case of a second 2-substituent. When two 3-amino groups (= 3 : 7) are present, activity is moderate but the 3 : 8 diamino acridine (= 2 : 7) is as active as proflavine but less toxic. A 4-amino substitutent confers small activity, while position 5 is highly active, but probably leads to increased toxicity. Albert has shown that similar differences in activity exist among the five isomeric-amino acridines, their activity paralleling their strength as bases and their partition coefficients between oil and water. The corresponding acridones are inactive, as are certain amino derivatives of 5 : 10-dihydroacridine and of iminodihydroacridine, suggesting that the intact acridine molecule is necessary.

L. G. Goodwin said that the uncertain action of antimony in protozoal diseases, of which the resistance of Sudanese kala-azar to antimony is an example, is an added difficulty in investigating its mode of action. The active form of antimony may be the stibinoxide grouping, but while this is probable in trypanosome and schistosome infections, it is unlikely in leishmaniasis, where quinquevalent compounds are the most effective and massive dose therapy is successful.

Excretion of antimony after doses of the quinquevalent compounds or of stibophen is much more rapid than with tartar emetic. There is indirect evidence that the rapidly excreted fraction of the drug passes through the body unchanged.

Both direct toxicity action on parasites and stimulation of the hosts' defence mechanisms are produced by antimonials. Increased phagocytosis may be of primary importance in leishmaniasis, though histological work on the spleens of infected hamsters injected with a quinquevalent antimony compound suggest some degree of direct action.

Dr. E. Chain described the chemical and physical properties of penicillin in relation to its bacteriostatic action. It is a strong acid with two, or a multiple of two, acid groups. A purified barium salt gives a carbon content of 55 per cent and a hydrogen content of 6·3 per cent: only carbon, hydrogen and oxygen are present in the molecule. Methoxyl groups cannot be detected but two hydroxyl groups are present. The dried barium salt of penicillin keeps indefinitely and in watery solution is most stable between *p*H 5 and 7. With heavy metals, except $Fe^{\cdots}$, it forms water-soluble salts. The antibacterial action is lost by oxidation with hydrogen peroxide and potassium permanganate. Dr. E. P. Abraham said that the instability of penicillin necessitates three methods of purification dependent on distribution between solvents, adsorption and reduction. The crude barium salt obtained from an amyl acetate extract of the medium has an activity of 15–25 units per mgm. Distribution between water and ether at *p*H 2 and *p*H 6, adsorption of impurities by charcoal and chromatographic analysis on alumina yield a light yellow barium salt with an activity of about 150 units per mgm. On reduction of this material in neutral solution with aluminium-mercury couple the remaining pigment is adsorbed by alumina. The

white barium salt obtained from the supernatant has an activity of 240 units per mgm. It completely inhibits Staphylococcus in a dilution of 1 in 5,000,000, partially in a dilution of 1 in 16,000,000.

The behaviour of sulphanilamide, *p*-aminobenzoic acid and chemically related compounds, aniline and sodium benzenesulphonate, at the surface of *Bact. coli* has been studied by Dr. F. R. Bradbury and D. O. Jordan by electrokinetic methods. The shapes of the curves relating variation of mobility with time of contact for sulphanilamide and *p*-aminobenzoic acid are quite different from those of the curves for aniline and sodium benzenesulphonate. The curves for sulphanilamide and *p*-aminobenzoic acid are similar, suggesting that the two compounds behave in a like manner at the bacterial surface.

Prof. A. St. G. Huggett said that dyes such as chlorazol sky blue *F P S* (Chicago blue) and chlorazol fast pink *B K S* are excellent anticoagulants. Structurally, they resemble afridol violet, from which Bayer 205 is derived; they have a trypanocidal action while Bayer 205 has an anticoagulant action. The dyes act at two points in the clotting mechanism as antikinase and antithrombin. Their anti-enzyme action with blood clotting may have an analogy to their mechanism as trypanocidal agents.

CO-ORDINATION OF SCIENTIFIC AND TECHNICAL WORK

At a conference organized by the Association of Scientific Workers and held at Birmingham on December 6, the need for greater co-ordination and collaboration in all fields of applied science was urged. The essential part which the scientific worker has to play in the modern community was emphasized by Mr. D. P. Riley, who opened a discussion on "The Responsibilities of the Scientist to the Community". Not only most of the greatest industries but even agriculture are dependent upon his work if they are to develop rapidly enough to satisfy the needs of the whole community, and in time of war it is even more important that this should be recognized, particularly in view of the five years' start which our enemies have over us in the application of science to war problems. As an interesting example of the need for the proper understanding of the scientific facts underlying certain decisions by those entrusted with executive power, Mr. Riley took the case of the encouragement of the consumption of wholemeal bread on account of its vitamin B content. The fact that this bread also contains an appreciable amount of phytic acid, the calcium salt of which is insoluble, and the consequent danger of avoiding vitamin B deficiency only at the expense of incurring calcium deficiency, has apparently not yet been given attention in public policy. Not only are many scientific workers still not occupied to their full capacity, but they are even in some cases urged to give their attention to the development of post-war plans, as well illustrated by an advertisement in a well-known daily paper describing a sewing-machine made largely of plastics and saying that now is the time to plan its post-war production.

The Association of Scientific Workers, which is working to secure the fullest application of science in the service of the community and a responsible status for men of science, is trying to meet the need for organization without which the individual man of science can do little in his attempt to ensure that his work is used for the war effort. In particular, the Association wishes for any evidence of definite misapplication or inefficiency in the use of scientific man-power, since it has been requested by the Ministry of Supply to prepare a report on this subject.

The immediate problems of producing and maintaining equipment for our armed forces was dealt with by Mr. Swann in his address on "The Role of the Scientist in the National Effort". He produced figures to demonstrate the superiority of Germany and the occupied countries over ourselves and the U.S.S.R., including also the help given by the United States, leaving no ground for optimism. He mentioned the dissipation of effort in competition between private firms, the operation of the 'cost-plus' contract, inadequate pooling of information and the determined grip of firms on their trade secrets as some of the many factors combining to hold up production, and criticized the feeling of complacency fostered by Russia's successes and America's promises of support. He urged the formation of production committees, where these do not already exist, on which technical staff should play an active part, and the need to provide the Ministry of Supply with all relevant facts as to means to eradicate inefficiencies.

Mr. J. A. Henley pointed out how, as the industrial scientist has passed from the position of being an independent consultant or even his own manager to that of one wage-earner among many in a large firm, it has become necessary for him to co-operate with his fellows in a professional organization which could look after his interests and his status. This need has become peculiarly great since the outbreak of war; hence it is not surprising that the Association of Scientific Workers has grown very much faster since its registration as a trade union than formerly.

After discussion, the following resolutions were passed:

"The Birmingham Conference of Scientific and Technical Workers reciprocates the expressed desire of the scientists of the U.S.S.R. for the fullest possible co-operation in the fight against Fascism, and pledges its maximum efforts to this end.

"This Conference, realising that maximum efficiency in the war effort will be achieved only as a result of fullest possible co-operation between technical staffs, work-people, and those in control of production, supports all activities leading to this end, in particular the setting up of production committees.

"This Conference calls for complete pooling of technical information between manufacturing companies with similar problems.

"This Conference stresses that the present anomalies in conditions of working and remuneration must lead to grievances that seriously hamper the war effort."

SOCIETY OF AGRICULTURAL BACTERIOLOGISTS

THE Annual Conference of the Society of Agricultural Bacteriologists, held at the Midland Agricultural College during September 12–13, covered a wide range of subjects. The papers may be classified, somewhat arbitrarily, into those concerned with dairying and those with other fields.

Instances of the economic importance of the sulphate-reducing bacteria included the formation of the black colour in the mud of certain districts, the evolution of hydrogen sulphide in sewage, and the discoloration of paper pulp. The role of these bacteria in the underground microbiological corrosion of metals was considered in some detail. Another paper described how the principle of the activated sludge process may be applied to an aerated culture of nitrogen-fixing bacteria so as to build up continuously a stock of bacterial protein from carbohydrate and atmospheric nitrogen.

Media containing thallium salts have been found to yield excellent results in the diagnosis of streptococcal mastitis and in the isolation of lactic streptococci from milk and fæcal streptococci from water samples.

Papers of considerable interest to water bacteriologists dealt with investigations on the bacterial flora of lakes and streams. In lakes during the winter months, when the waters are in circulation, the counts of bacteria tend to be much the same at different depths, while during the summer, when the waters are stratified in two layers, counts in the upper layer are of a higher order than those in the lower layer, where they tend towards a low constant value. Coliform bacteria in relatively pure lakes and streams, though smaller in numbers than those in waters subject to pollution, show unexpectedly a higher proportion of the fæcal type.

Items of general interest included recommendations for economy in the war-time use of peptone for bacteriological media, and the role of statistics in the planning of experiments and in computing the error of the plate count.

In the field of dairy bacteriology, there were several papers on the methylene blue and the resazurin tests for bacterial quality of milk. A high correlation has been observed between the plate count and the methylene blue test and between the reduction of methylene blue and the reduction of resazurin to the vivid pink stage. Two causes of anomalous results in these tests are: (*a*) the growth of cryophilic bacteria during storage of milk samples in the refrigerator; and (*b*) the decrease, during storage, in the reducing power of milk containing large numbers of leucocytes. For pasteurized milk a reduction time of six hours or less in the test at 15·5° C. has been found to indicate either contamination by coliform bacteria or poor keeping quality.

The phosphatase test, applied to milk pasteurized in bottles, has revealed the fact that in one of three commercial plants examined a high proportion of samples had probably been underheated. The acid-producing bacteria which predominated in the freshly pasteurized milk were rapidly supplanted by alkali-forming types and played little or no part in spoilage during storage. Heat-resistant cocci which survived pasteurization appeared to consist largely of *Micrococcus luteus* and were not derived from the cow's udder.

Several papers were concerned with the bacteriology of starters and cheese. Infection of starters with bacteriophage is found to be an important cause of general slowness in cheese-making in Great Britain, even though mixed starter cultures are customary, but the incidence of the trouble may be reduced by observing certain precautions and by adopting a 'vitality' test as a measure of control.

Studies in cheese ripening have disclosed the fact that lacto bacilli may assist flavour through the liberation of an intracellular lipase on autolysis of the cells, while some light has been thrown on the sources of the carbon dioxide evolved from cheese during storage in cargo. In Cheddar cheese the gas results from bacterial action, but in Stilton it is mainly correlated with the growth of the mould.

Problems in disinfection received attention from several workers. For hypochlorites to be effective in the treatment of dairy utensils, the latter must be scrupulously clean, free from corrosion and open seams, and must be agitated or scrubbed during treatment. A technique was outlined for routine disinfection in the cowshed to combat, *inter alia*, the spread of mastitis streptococci.

An item of interest to the dairy industry was the demonstration of a portable apparatus, depending in principle on measurement of *p*H value, for rapidly testing the quality of the incoming milk at a creamery.

THE FORTIFICATION OF FOODS

THE diet of man now contains a variety of foods very different from those consumed by his prehistoric ancestors. Cooking, which may wash out or destroy mineral constituents and vitamins, has long been practised, while more modern processes such as the decortication of cereals, and the extraction and refining of oils and fats, may lead, according to the results of animal experiments and clinical evidence of human disease, to dietary deficiencies. Recent advances in methods of analysis of foods and in our knowledge of man's need for some of the vitamins and essential minerals have enabled us to estimate the dietary significance of these more modern methods of preparing foods. Now that a number of synthetic vitamins or vitamin concentrates are available it is possible in some cases to fortify foodstuffs so as to increase man's intake of these essential dietary factors to the level which modern investigations have shown to be desirable.

The great interest attached to this problem of fortification was reflected by the very large attendance at a joint meeting of the Society of Public Analysts

and Other Analytical Chemists, and the Food Group of the Society of Chemical Industry held at Burlington House on December 3 to discuss "The Fortification of Human Foods by the Addition of Specific Nutrients".

The first paper on "The Principles of Food Fortification" was read by A. L. Bacharach, who defined fortification, which he held to be synonymous with enrichment, as the addition of specific nutrients. He laid down a number of principles which should govern the whole policy of fortification. The amount of enrichment should be adjusted to the need of the consumer for the specific nutrient; this might have to be altered at different times or in different areas according to the amount already available in the diet. The nutrient should be added to some widely consumed foodstuff, such as bread or margarine, in order to ensure even distribution to the whole community, and, as the need must be greatest for those of limited means, fortification should not result in an increase in the cost of the foodstuff, which might defeat the principle of general distribution. Precautions should be taken to ensure that the consumer actually received the added nutrient, which should be stable and not be physiologically incompatible with any other component of the fortified food. Due allowance should be made for any loss likely to occur during the normal preparation of the foodstuff for the table. Fortification should not impair taste or flavour and so should not be detectable by the consumer, though the analyst should be able to determine the amount of the nutrient present. Mr. Bacharach's last principle, that of disclosure, is one which has not yet received official recognition in Great Britain, though it was endorsed by all subsequent speakers. When a food is fortified with a particular nutrient the amount of this nutrient present should be stated in simple and concise chemical or biological units and not, for example, in terms of 'summer butter'.

Illustrating his principles by references to examples of fortification already in operation in Great Britain or in the United States, Mr. Bacharach pointed out that the addition of iodine to table salt was probably the first fortification which was carried out not simply to replace something lost during purification but to overcome what is, in some areas, a known dietary deficiency in iodine by distributing this element in a simple and economical manner. Thus the aim of fortification should be to remedy some known dietary deficiency, not merely to imitate some allied foodstuff; white bread fortified with calcium is a better source of available calcium than wholemeal, though it may be inferior to wholemeal in other respects; vitaminized margarine should, if the need arises, contain more of the vitamins A and D than summer butter.

Mr. Bacharach vigorously attacked the naturalist school which professes an almost mystical belief in the superiority of dietary factors present in, or isolated from, natural sources. Members of this school would, apparently, condemn the fortification of flour with synthetic aneurin, but would applaud the same fortification if made with vitamin B_1 laboriously isolated from yeast. Ascorbic acid cannot wholly replace orange juice, but it can prevent scurvy if administered in the proper amounts.

Mr. Bacharach concluded by referring to the need for extending fortification to cover other nutrients and mentioned the advances which have been made in the United States. Iron should be added to white bread, and attempts should be made to lower the cost of production of riboflavin.

The second paper, on "The Technological Aspects of Fortification" by Drs. D. W. Kent-Jones and A. J. Amos, was read by Dr. Amos, who distinguished between fortification and enrichment, preferring to reserve the former term for cases in which losses of nutrient due to purification are made good, as, for example, when B_1 is added to white flour, or when a food is strengthened with some particular nutrient to make it equivalent to some allied food, as when vitamins A and D are added to margarine. Enrichment, on the other hand, should be reserved for additions of a nutrient to a food which is not normally a good source of the nutrient.

The methods adopted to carry out fortification must ensure uniform distribution without loss of the added nutrient, which should have no effect on the palatability or keeping quality of the final product. The fortification of margarine with vitamins A and D was carried out by some manufacturers long before compulsory fortification was introduced in Great Britain. In the early days concentrates were used which sometimes imparted flavour, but with the introduction of calciferol and whale oil concentrates this difficulty was overcome.

The fortification of white bread with B_1 has been achieved in three different ways, all of which are now being used in Great Britain and in the United States. In the method adopted by the Ministry of Food, aneurin is added to the flour during the milling process. The physical properties of aneurin render impossible the direct addition of the small amount required (0·2 gm. aneurin to 280 lb. flour), so a concentrate similar to flour is prepared by spray drying a suspension of flour in water containing the requisite amount of aneurin. The addition of 1 oz. of this concentrate to each 280 lb. flour is then performed without difficulty by a special mixer. In the second method of enrichment the B_1 is introduced into bread via the yeast used to ferment the dough. This yeast, obtained by cultivation in a special medium, contains about sixty times as much B_1 as ordinary yeast. The third method is based on the addition of 20–25 per cent wheat germ to flour.

The proposed enrichment of flour with calcium is not yet in operation, partly because opinion is divided as to the merits of the scheme, but also because of technical difficulties. Creta Prepærata has been chosen as the most suitable form of calcium carbonate, since it has the least effect on the hydrogen ion concentration of the dough.

The lack of stability of ascorbic acid in aqueous solution causes practical difficulties in fortification. The addition of this vitamin should be made as late as possible during the process, aeration should be avoided and care taken to exclude traces of copper and iron. If vitamin C is added to a fatty food, a water in oil suspension should be used. The difficulties encountered with vitamin C serve to emphasize the need for careful control at all stages of the fortification process. As an example of what can be done even with an unstable substance, Dr. Amos mentioned that jam for dispatch to British prisoners of war is fortified with vitamin C. The loss during manufacture is not greater than 15 per cent, while the loss on storage for twelve months in sealed containers does not exceed 20 per cent.

H. E. Cox later gave a paper on "The Machinery for the Enforcement of Standards for Fortified

Foods". Dr. Cox assumed that, in normal times, fortification will be optional and not compulsory. If optional fortification becomes general, the law will need fortification to deal with the chaotic conditions which would probably result from wild claims made for various fortified foods. At present the Ministry of Food has control of fortification, but, in times of peace this control should pass to the Ministry of Health, when fresh legislation will be necessary to empower the Minister to issue regulations covering fortification. Indeed, Dr. Cox argued that the present activities of the Ministry of Food are directly contrary to the will of Parliament as expressed in the Foods and Drugs Act 1938.

According to this Act the Ministry of Health may restrict or prohibit additions to food, but has no power to order that additions be made. When the emergency control of the Ministry of Food is ended, the new regulations should prescribe maximum and minimum limits for fortification as is now being done in the United States. These limits must be capable of detection by analysis, hence the urgent need for the standardization of methods of analysis. Eventually this analytical control should be done by the public analyst and not by nominees of the Ministry of Food. If the public analyst is to guard the public against fraudulent claims, all fortified foods must be clearly marked with the actual amount of added nutrient present in the food, and no vague claims that vitamins have been added should be allowed.

The final paper, on "Analysis of Fortified Foods", was given by H. E. Monk. As methods of analysis for minerals are well known, Mr. Monk confined his remarks to a well-balanced summary of the methods of analysis for vitamins and of the difficulties likely to be encountered by the public analyst employing these methods. Since fortification with vitamins is to be carried out for nutritional purposes, it might appear at first sight that biological assay should be used when possible. Chemical and physical methods have the advantages of speed, accuracy and cheapness and, except possibly for vitamin D, are likely to replace the lengthy biological assays. Microbiological assay such as is used for riboflavin should not, however, be excluded.

To carry out a physical or chemical estimation it is first necessary to extract the vitamin from the foodstuff, and great care is needed to ensure that this extraction is complete. Having obtained the vitamin extract, precautions must be taken against loss during the estimation. Finally, the method used should be specific for the vitamin, and in cases of doubt, alternative methods should be used wherever possible in order to guard against erroneous results due to the presence of interfering substances.

In the spirited discussion which followed, repeated reference was made to the necessity for disclosing the vitamin content of fortified foods. Thus it was stated that the vitamin D content of margarine has recently been doubled in order to make up for the lack of eggs. Only three members present admitted that they were aware of this change.

It was generally agreed that the meeting had been one of the most successful of its kind and that the knowledge of the tasks which lay ahead should inspire the chemist to investigate the accuracy of present methods and devise new methods for the rapid estimation of vitamins.

E. R. D.

FORTHCOMING EVENTS

SATURDAY, DECEMBER 20

BRITISH PSYCHOLOGICAL SOCIETY (at Tavistock House, Tavistock Square, London, W.C.1), at 11 a.m.—Discussion on "Problems Affecting the Under-Fives in Total War".

APPOINTMENTS VACANT

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

LECTURER IN THE DEPARTMENT OF CIVIL AND MECHANICAL ENGINEERING—The Registrar, The University, Leeds 2 (December 29).

EDUCATIONAL PSYCHOLOGIST and a PSYCHIATRIST—The Secretary for Education, Education Offices, York (December 30).

TEACHER OF ENGINEERING DRAWING in the Department of Mathematics and Physics of the Polytechnic, Regent Street, London, W.1, now at Lancaster—Dr. J. Topping, Storey Institute Technical College, Lancaster.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Proceedings of the Royal Irish Academy. Vol. 47, Section A, No. 1: On the Solutions of Wave Equations for Non-Vanishing Rest-Mass including a Source-Function. By Erwin Schrodinger. Pp. 24. 1*s*. Vol. 47, Section A, No. 2: Experiments on Condensation Nuclei. By P. J. Nolan. Pp. 25–38. 1*s*. Vol. 47, Section B, No. 1: Descriptions of Five New Species of Alyshdae (Hymenoptera) and Notes on some Others. By A. W. Stelfox. Pp. 16. 1*s*. Vol. 47, Section B, No. 2: The Cytoplasmic Bodies of Drosera. By J. Brontë Gatenby and J. D. Smyth. Pp. 17–20. Vol. 47, Section B, No. 3: The Nuclear Apparatus as shown by Feulgen's "Nucleal färbung" Reaction. By Mildred M. Moore. Pp. 21–52. 2*s*. Vol. 47, Section B, No. 4: A List of the Microlepidoptera of Ireland. By Bryan P. Beirne. Pp. 53–148. 4*s*. Vol. 47, Section B, No. 5: The Neck Body in Normal and X-radiated Insect Spermatogenesis. By J. Brontë Gatenby. Pp. 149–160. 1*s*. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [2411

Other Countries

U.S. Office of Education: Federal Security Agency. Bulletin 1940, No. 6 (Monograph No. 14): Supervision of Health and Physical Education as a Function of State Departments of Education. By Dr. James Frederick Rogers. (Studies of State Departments of Education.) Pp. vi+106. (Washington, D.C.: Government Printing Office.) 15 cents. [1311

Cornell University Agricultural Experiment Station. Bulletin 748: Fertilizers and Field Crops. 1: Results of Sixteen Years of Experiments on Volusia Silt Loam in Allegany County, New York. By E. L. Worthen. Pp. 28. Bulletin 749: Fertilizers and Field Crops. 2: Results of Sixteen Years of Experiments on Honeoye Silty Clay Loam in Monroe County, New York. By E. L. Worthen. Pp. 26. Bulletin 750: Fertilizers and Field Crops. 3: Results of Twenty Years of Experiments on Volusia Silt Loam in Cortland County, New York. By E. L. Worthen. Pp. 16. Bulletin 751: Costs of Farm Power and Equipment. By J. P. Hertel and Paul Williamson. Pp. 38. Bulletin 752: Studies on the Control of Internal Breakdown of Table Beets by the use of Boron. By G. J. Raleigh, O. A. Lorenz and C. B. Sayre. Pp. 16. Bulletin 754: A Comparative Study of High-Temperature, Short-Time, and Holder Pasteurization. By A. Millenky and H. J. Brueckner. Pp. 26. Bulletin 756: Costs and Returns from Farm Enterprises. By Paul S. Williamson. Pp. 41. Bulletin 762: Controlled-Atmosphere Storage of Apples. By R. M. Smock and A. Van Doren. Pp. 45. Bulletin 766: Controlling the Pre-Harvest Drop of Apples. By M. B. Hoffman. Pp. 18. Memoir 234: Studies on Bitter Pit of Apple. By R. M. Smock. Pp. 45. Memoir 235: A Study of Dormancy in Seeds of Polygonum. By Oren L. Justice. Pp. 43. Memoir 237: Reproduction of the Field Mouse *Microtus pennsylvanicus* (Ord). By W. J. Hamilton, Jr. Pp. 23. (Ithaca, N.Y.: Cornell University.) [1311

Proceedings of the California Academy of Sciences, Fourth Series. Vol. 22, No. 11: The Templeton Crocker Expedition of the California Academy of Sciences, 1932. No. 40: The Genus Scalesia. By John Thomas Howell. Pp. 221–272. Vol. 23, No. 30: Notes on a California Earthworm, *Plutellus papillifer* (Eisen, 1893). By Gordon E. Gates. Pp. 443–452. (San Francisco: California Academy of Sciences.) [1311

U.S. Department of Agriculture. Circular No. 610: Adsorption of Mercuric Chloride from Solution by Gladiolus Corms. By R. H. Nelson and C. C. Cassil. Pp. 12. (Washington, D.C.: Government Printing Office.) 5 cents. [1311

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