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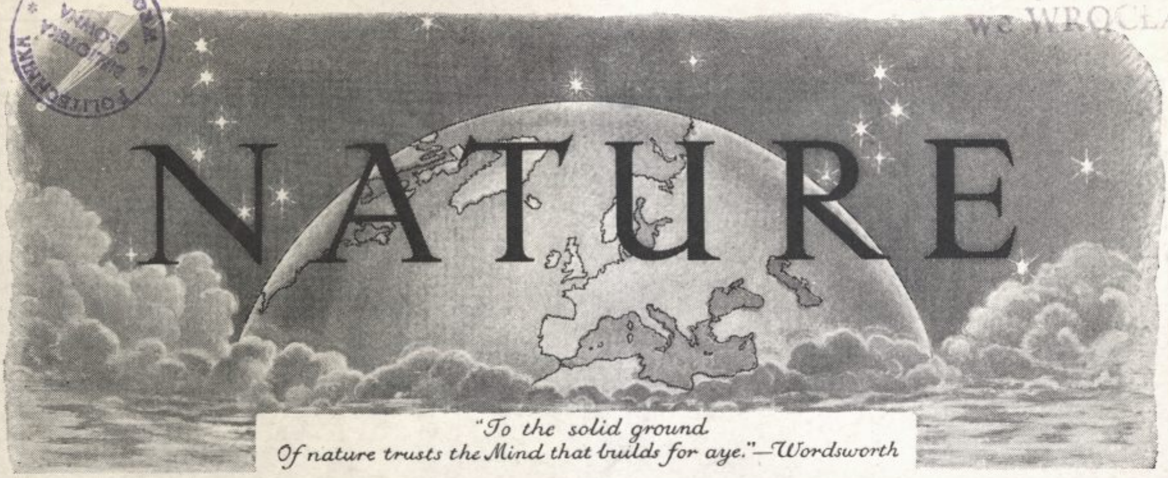

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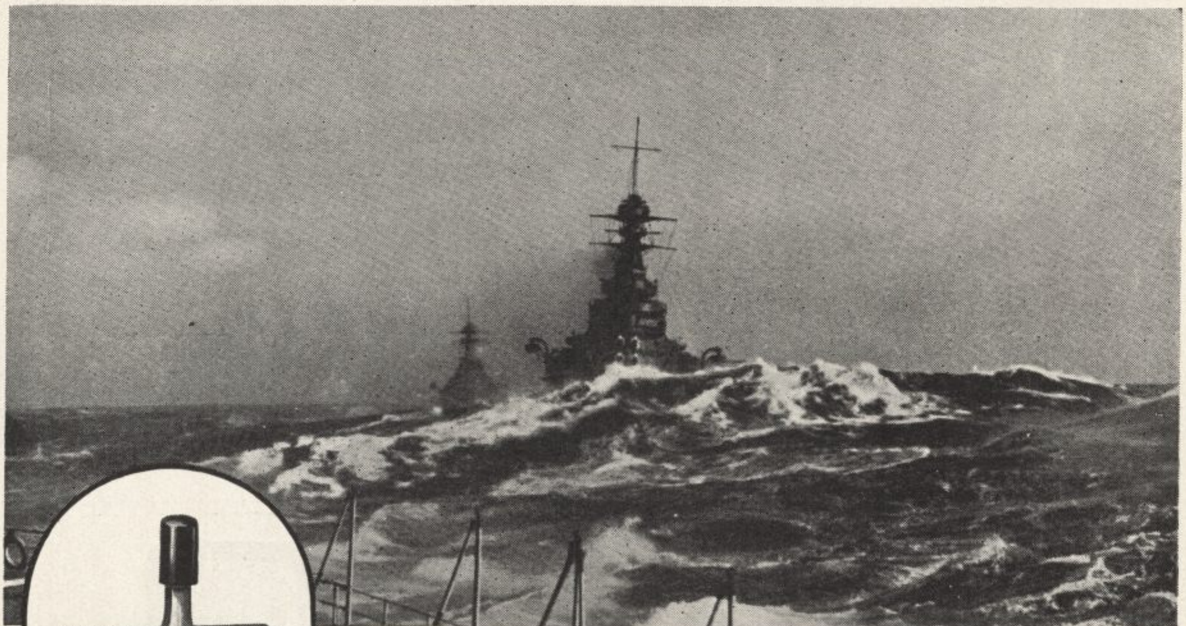

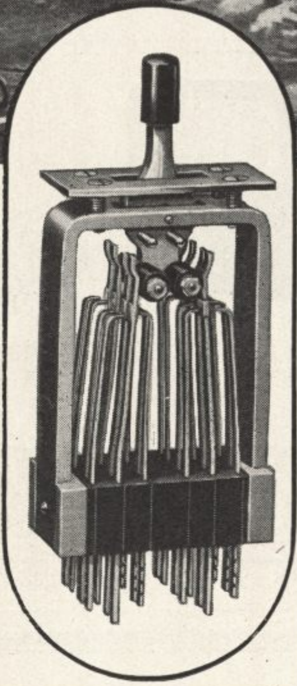

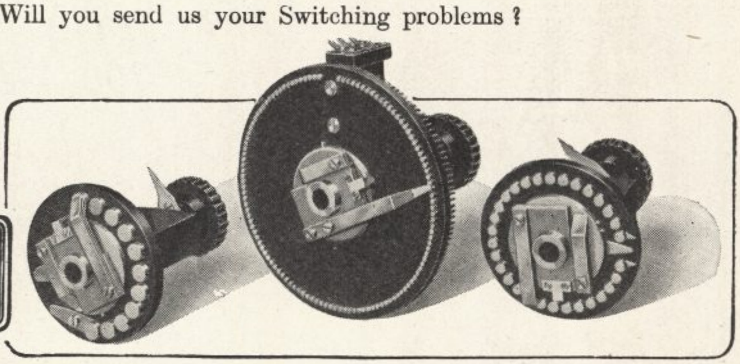

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MEN OF SCIENCE AND THE WAR

SINCE the War, and in the months preceding it, it has been repeatedly urged in these columns that the times demand the maximum use of science and the full recognition by men of science of their social responsibilities. A year before the unstable international situation resolved itself into the present disastrous conflict, pages of NATURE were devoted to statements by the scientific leaders of the country about the urgent need for scientific workers to undertake these responsibilities, but little of practical import has resulted so far. If the War succeeds in arousing certain men of science to a realization of the social implications of their work, then it may be said that some good has come out of it, and it is to be hoped that such will be lasting. Men of science are proving invaluable at the present time; may their value still be recognized when the time for reconstruction comes.

With the War, the country implicitly assumed a reorganization so profound that the full realization of its meaning only dawned in most minds after the disasters of Norway, Flanders and France, and with the victorious onrush of the German war-machine. To-day no persuasion is needed to impress on people the necessity for making all possible use of the country's powers and resources. That message rings in our ears daily. But no efforts, however heroic, however widespread, and however energetic, will succeed in their objects without right direction—and such direction demands the full use of science.

The Germans have demonstrated that this is a mechanized and technical war. It is not sufficient therefore for us to have limitless material resources; it is essential to use them in a thoroughly planned and integrated way. Until now (and this is still the case), planning has been the task of our political and industrial leaders and of the Civil Service alone. There is no need for us to dwell on the results of their efforts. As men of science our responsibility to-day is to see that things get done, not to blame others if they have not been done.

The important part that men of science have already played in this War has been amply recognized in these columns. The Scientific and Research Departments of the Services, the Department of Scientific and Industrial Research and its kindred bodies, and the Medical Research Council, fortified as they have been by the addition of many academic men of science, have been fulfilling their appointed duties. But many scientific workers have not been used at all, and others, who have for long been in Government service, or who have been recruited since the War, are not being used to their fullest capacities. The fundamental reason for this (and this is the fundamental defect of the whole organization) is that the functions of science have been generally conceived, to a large extent even by men of science themselves, in altogether too restricted a way. A general scientific point of view is foreign to the direction of the country, and in particular to its administrators. If this defect is to be remedied, men of science themselves must show the way.

On p. 112 of this issue is reviewed a book which deals with this very problem. One of its lessons is that in order to discover what are the urgent problems before us, and to determine their order of importance, it is first necessary to survey the whole field of national resources and national effort. This object will not be successfully achieved by administrative methods alone, and such methods so far constitute the only treatment of this particular question. They can lead no further than to a statement of the most apparent facts, whereas there is little doubt that a scientific approach would often reveal key problems, the solutions of which would advance matters more rapidly, and with less effort than any amount of energy directed along traditional paths. But if we are to achieve the best from a scientific approach to a fundamental survey of the problems before us, it is essential that the man of science should be given effective authority to make comprehensive inquiries, to formulate and to solve problems and, not less, to see that the solutions which he suggests are embodied in practical measures.

The above-mentioned book provides several examples where this approach has already been used successfully (for example, in dealing with the magnetic mine and with war diseases), and it indicates several others where it could be applied with all promise of success (for example, in dealing with the menace of tanks and providing an adequate food supply from domestic sources). It is apparent that the book refers, partly for reasons of space and partly because of the limitations imposed by the need for secrecy, to only a few of the many problems which could be tackled more vigorously than they seem to be at present; and the issues discussed are mainly detailed ones. More general problems are only hinted at, for clearly without the proper general fundamental survey no one is in a position to state them explicitly.

Since May, the circumstances for making full use of science have grown more favourable than ever before in the history of Great Britain. Complacency has given way to an acute appreciation of the fact that we have urgent unfulfilled needs, and failure has shown the inadequacy of traditional methods. Blame has very rightly been laid on administrators and industrial leaders for failing to achieve the desired results; but for us the lesson is rather in the failure of men of science to realize both the power that lies in their hands and their responsibility for using it. Men of science can no longer be complacent about neglect, or content with such notice as merely seeks their advice about particular issues. With few exceptions they have not regarded it as their duty to force on an unscientific administration their reading of the dangers and of the means for counteracting them. They have regarded their functions as served when their advice has been sought and given. It was not for them to see that it was acted upon. As "J. S. H." points out on p. 113, "half the battle in science consists in asking new questions which the non-scientist cannot be expected to think of".

More than this is demanded to-day. "Go to it," in the words of the new Government slogan, applies not only to the factory worker carrying out his routine duties. It applies even more to the scientific worker—demanding of him initiative, organizing ability and drive, and the clear realization that only with the help of these can the forces of reaction and inertia be turned aside, and our war effort rapidly brought to a successful end.

HOURS OF WORK AND EFFICIENCY

DURING the nineteenth century, industrial development was governed by the claims of machinery rather than of man. It was a period of gradually increasing control of the environment through machines; at the same time, the studies made in the natural sciences and the growing knowledge of the mechanism of the body all tended to focus interest on man's likeness to a machine. Being *like* is not, however, equivalent to being *nothing but*.

The phrase "the human machine", which rightly interpreted refers to part of man's structure, became by implication rather than by design synonymous with man himself. The idea is very old, but the actual form of the expression dates from the eighteenth century when La Mettrie published "L'Homme Machine"; he also wrote "L'Homme Plante", but nobody seems to have been interested in man as a plant.

The almost incredible result of this point of view is reflected in the treatment of industrial workers at the beginning of the nineteenth century, when even children worked in the mills for nineteen hours a day. One might indeed argue that human beings were considered inferior to machines, since care was taken to keep the latter fit.

The problem of munition production during the War of 1914–18 challenged the adequacy of this point of view. Industrial operations at the beginning of the period were implicitly based on a misguided application of arithmetic. If one unit of work could be done in one hour, then 2 would be done in 2, 3 in 3, 8 in 8, 10 in 10, 12 in 12. The physiological necessity for sleep limited the indefinite extension of this principle. It was therefore an easy problem to find out how many units would be done in 100 hours by 100 men. The discrepancy between the expected and the observed output led to inquiry, resulting in a change of interest from the machine to the worker of the machine. The Health of Munition Workers' Committee was set up "to consider and advise on questions of industrial fatigue and other matters affecting the personal health and efficiency of workers in munition factories and workshops". The Committee found that "the ordinary restrictions on hours of employment were widely relaxed. Sunday labour, previously forbidden for women and young persons, and practically unknown for men, except for a few continuous processes, became common". Men were employed for 70–90 hours a week as a common occurrence, more than 90 hours were not infrequent, and there were cases of even 100 hours.

After investigation, the Committee reported that the "munition workers in general have been allowed to reach a state of reduced efficiency and lowered health which might have been avoided without reduction of output by attention to the details of daily and weekly rests".

The research work conducted by this Committee into the relationship of output to hours of work is now historical. It is, of course, true that, within certain limits, an increase in the hours of work will increase the output ; more work can be done in five hours than in two hours, but if eight hours work produces eight times as many units of work as one hour, will ten, eleven and twelve produce the equivalent increase ? A study of munition work in the War of 1914–18 showed that, in the long run, it did not.

After the War, a number of trades were studied from this point of view and confirmed the wartime experience that : (1) An extension of the usual hours of work—except for short emergency periods—does not give a proportional increase. (2) After a prolonged period of overtime which has led to reduction in output, a return to the normal number of hours does not result immediately in improvement. In some cases three months were required before normal output was restored.

The using up of too much reserve energy left the worker unable to put out his maximum effort, or rather his maximum effort was much below his previous maximum. The effect of excessive hours does not show itself always or solely in a reduction of quantity ; in some processes the quantity might be maintained but the quality could be affected, or sickness absence might be increased, and just when adequate nourishment was most important, workers would describe themselves as "too tired to eat". These general statements are the expression of a number of statistical surveys and numerous interviews.

A group of people frequently overlooked in discussions on output and hours are the highly skilled individual workers and those holding managerial posts. The reason is that, owing to the nature of their work, it is impossible to obtain statistical evidence. Since it is a hard fact that continuous human activity, whether physical or mental, is associated with diminished success at that activity wherever it has been measured, these workers will, as others, be subject to this diminished success. The well-known work curve, that is, gradually increasing success, followed by stability and then gradually diminishing success, has been shown to be true of various activities both physical and mental. On the mental side, fatigue may show itself as irritability ; should the irritable person be the head of an organization or department, the consequences of his irritability, probably directed against his subordinates, may be very serious. Work demanding close attention, high intelligence always alert, and swift impersonal decisions will be very much affected by the condition resulting from physical and mental fatigue.

The expressions of fatigue, namely, diminished efficiency, weariness and an appearance of listlessness may be present when the work is light and hours normal. This condition is due not to the using up of reserve energy, but to lack of interest due to absence of change. Modern methods of production have tended in a number of processes to reduce the opportunities for relaxation and change. Work becomes monotonous and the worker is bored. The remedy for this condition is change either in the work or in the conditions of the work.

In a letter from the Association of Scientific Workers published in NATURE of June 29, it is stated that scientific staffs have, during the recent emergency, been working the same long hours as the factory workers. One reason for this may well have been psychological. Assuming that an organization employs a considerable number of scientific workers in the same building as the factory workers, it would have been worth while, for the sake of the general morale, to make no difference for the emergency period between the different staffs, even though the extra hours were not so urgently necessary in all departments. It needs little imagination to hear a tired factory worker working a seven-day week and seeing the scientific staff going off as usual express his views of the latter in strong language. It is also possible that, for the emergency period, the extra hours were necessary for all staffs. At the risk of some fatigue, the effort that by general consent was urgently needed at that moment had to be made. In any event, emergencies are not occasions for explanations.

From several of the statements which have been made during the past few weeks, it has been clear that the Minister of Labour, Mr. Ernest Bevin, is fully aware of the possibility of defeating the end by excessive hours. The explanation is probably in the fact, not generally realized, that Mr. Bevin was for several years a member of the Industrial Health Research Board. Relaxation of the original heavy demands were made after a very short interval, and now we have the announcement that the restrictions imposed by the Factory Acts are to be re-imposed next month.

Experimental evidence on the relation of hours of work to mental work is much more difficult to determine, since an adequate standard of comparison is lacking. Where output cannot be measured, indirect measures, never so convincing practically, have to be used. In the industrial world, sickness absence and labour wastage are useful indexes at times. It is rare though that adequate records are kept for those whose work is generally called 'mental'. In two fairly large scientific organizations with sickness records that were strictly comparable, one had a low sickness rate and the other a high one, the reasons being as usual complicated.

Some years ago an experiment was conducted by a scientific worker with the aim of showing the relationship between loss of sleep and mental efficiency. Since the loss of sleep involved working extra hours—merely being awake acquiescing in existence was avoided—the results may be relevant. The mental efficiency was measured by tests involving speed and accuracy of movement, close attention, memory for rational relationships and mechanical memory, for all of which the normal variations had been determined over a period of many weeks. The results of a number of experiments showed that both speed and accuracy were reduced, that the capacity to see relationships was weakened and that memory became increasingly fallible. It also appeared that there was a disproportionate period of reduced efficiency after the loss of sleep had been compensated. This is quite in harmony with the industrial findings using output as a measure. This example may have some bearing on the problem of the intellectual worker, though since it was limited to one person, its results cannot be generalized.

It is perhaps worth noting that fatigue in itself is not bad but has an important and positive function in protecting the organism against its own tendency to excess. As the Health of Munitions Workers' Committee put it: "The true test of an excessive fatigue is its progressive character, so that during normal rest and recreation the effect is not abolished".

Another point to be remembered in all discussions on hours of work, is that most of the general statements that are valid statistically refer to large numbers engaged on the same work, so that the final expression represents the general trend of a group. Where in addition individual output curves are obtained, there is found to be considerable individual variation in the form of output curves.

If organizations employing scientific staffs as well as others arrange their work on the model of routine workers, they run the risk of having routine scientific workers whose initiative and creative ability has been denied expression and who are therefore a loss to the community. Thus while we make no claim on behalf of scientific workers for preferential treatment at a time like the present, it is clear that their reactions, and those of others normally engaged in intellectual, as distinct from manual work, to long-continued and regular increase of hours, are not established, and care must be exercised lest increased hours defeat the purpose in view. Decrease in effectiveness, or of output, will result from undue pressure, whether it is imposed from outside or by the worker himself; and this must be guarded against if the efficiency of our war-effort is to be maintained.

McLENNAN: A PIONEER OF CANADIAN SCIENCE

Sir John Cunningham McLennan

A Memoir. By H. H. Langton. With a Chapter on his Scientific Work by E. F. Burton. Pp. viii + 124 + 13 plates. (Toronto: University of Toronto Press; London: Oxford University Press, 1939.) 11*s*. 6*d*. net.

IT requires a mental effort for the present generation of Englishmen when they see the highly industrialized communities on the other side of the Atlantic to realize how rapidly these have grown up. At a dinner given to the contributors to the eleventh edition of the "Encyclopædia Britannica", there was a printed paper of extracts from the first edition, and the entire article on Canada ran somewhat as follows: "*Canada.* A vast wilderness to the north of the American Colonies." When Sir John McLennan began his career, Canada had indeed made some progress in geology, and perhaps in other branches of natural history—but Canadian physics was practically non-existent. His biography is a valuable contribution to the history of how it came into being, and his work, combined with the work of Callendar and Rutherford at Montreal, is perhaps the most important part of the story.

In this book, we can learn what has scarcely been known in England, the story of his early years and the difficulties he had to overcome to get such training in physics as could then be had in his native country. It is an interesting question how far men with real scientific aptitude can be kept back for want of early opportunity. McLennan, though of course scarcely to be classed with Faraday or Pasteur in achievement, accomplished fine work with little more initial advantage than fell to them. It was when he arrived at the Cavendish Laboratory in 1898 that I first had the privilege of knowing him. His manner had the same quiet impressiveness as later. Not that he, or any of us, were unduly solemn for our years: I remember Rutherford asking if he had brought his scalping knife with him.

We were all impressed in those early days with McLennan's dogged tenacity in the rather difficult piece of work assigned to him. This book brings out what great energy he put into everything he set his hand to. It is interesting to learn that he sometimes had regrets that he had not found his way into politics. He might well have succeeded in it, for he was at least as much at home in dealing with men as in struggling with physical apparatus. In particular, McLennan had genuine interest in, and friendship for, young people, and at once established the right relation with them. No doubt this was a great factor in his success in building up the School of Physics in Toronto.

His best scientific work was his identification of the origin of the green auroral line. This and other parts of his scientific work are relegated for the most part to an appendix by his successor, Prof. E. F. Burton. I think, however, that it is a pity that this subject was not treated more freely and fully. The way that this line appears bright and apparently isolated when the aurora is examined in a pocket spectroscope, while at the same time not a trace of it can be seen in the spectrum of any of the atmospheric gases, or of air itself as ordinarily observed, formed a most stimulating mystery, far more intriguing than the artificial mysteries of detective stories. It had puzzled two generations of physicists. McLennan solved it, and this by itself ensures that his name will not be forgotten.

The work that was done in the Toronto laboratory was nearly all published by McLennan jointly with younger authors. He explained to me that he was only too glad to let them work out their own problems in their own way and publish independently if they were able; but he found that they nearly always came to him for guidance as to what they should do, and how they should do it. He sat up late night after night reading contemporary papers from the literature, to get suggestions for the work to be done, and the burden of this, on the top of teaching and administrative duties, became very heavy as the years went on. In the early days of his retirement, he appreciated the relief of discontinuing it. But his retiring years were clouded by domestic anxiety and bereavement. He bore up bravely, and as well as he was able. But he said that things no longer seemed worth while.

It is a matter of satisfaction that a connected account of his career should now be available. We could have wished that more of his talk, his methods of work, and his reaction to things and people could have found a place in the record. Kindly though he was to his friends, he was not averse to explaining how he had got the better of anyone who opposed or obstructed him. But it is regrettably seldom that anything of that kind finds its way into a biography. The difficulty is that for so long as such things are fresh in living memories which can relate them, there are the susceptibilities of living people to be considered.

RAYLEIGH.

SCIENCE IN WAR

Science in War

(Penguin Special, S. 74.) Pp. 140. (Harmondsworth: Penguin Books, 1940.) *6d.*

THIS is a tract for the times, which every scientific worker should read. There will often be disagreement with the views advanced, but it is eminently desirable that they should be aired. The main thesis of the book is that Great Britain has not learned the scientific lesson of the war of 1914–18 nearly so well as Germany, and that part of the responsibility for this state of affairs lies at the door of men of science themselves.

The real scientific lesson of 1914–18 was not that science should be more liberally employed by this or that department for particular problems, but that a scientific approach is needed to the problem of war in its entirety.

This book, which is by twenty-five anonymous scientific authors, begins by reminding its readers of some of the successful applications of science to war in the past: Haber's nitrogen process making it possible for Germany to survive for four years in the last war, Bergius' oil-from-coal process providing Germany in this war with a respectable fraction of her petrol needs, the success of aerodynamic research, the virtual abolition of typhoid and paratyphoid among armies in the field, the prompt countering of the magnetic mine by the de-gaussing girdle, and so on.

But the bulk of the volume is concerned with suggestions as to the ways in which science could render more aid in this war. It is recognized that in certain fields, such as blood transfusion, aerodynamics, or the physiology of high-speed flying, the scientific situation is excellent. But elsewhere it is not. A leading article in NATURE of June 22, p. 949, is quoted to show that the question of camouflage is being fumbled: the underlying scientific principles are not being applied, and the direction of the work is being entrusted to artists and Civil Servants instead of to the scientific experts. The new types of wounds, such as splinter-wounds, and recent discoveries in the physiology of growth and regeneration call for better co-ordination and larger scale work in relation to wound treatment. Endocrine research might be devoted to the problem of inducing more rapid growth in livestock. The large wastes in various crops which arise from our inefficient methods of seed-production could be markedly reduced by proper organization, once the underlying scientific principles are grasped. The utilization of miniature methods of radiography would enable every recruit for the services or for industry to be X-rayed as a simple matter of routine, so permitting the diagnosis of early tuberculosis reducing wastage of man-power, and improving national health. In the building of factories, considerable waste of steel is taking place through a neglect of scientific principles of design and the frequent employment of spans much in excess of what is needed. In purely military affairs, it is claimed that a scientifically conducted survey of the anti-tank measures adopted in the Spanish War would have enabled us to prophesy the comparative uselessness of our anti-tank guns, and would long ago have indicated the lines along which successful weapons are to be found.

These are a few of the specific examples which the anonymous authors adduce. In other cases, what is lacking is not so much specific research or scientific application as a general scientific approach. This is well illustrated by the chapter on food. It was only after nine months of war that the scientific advisory committee on national food requirements was appointed (NATURE, June 8, p. 887). Policy up till then had been a compromise between tradition, specific scientific advice, the views of the National Farmers' Union, and various interests concerned with food production and food marketing. The agricultural advisory services and research institutes were scarcely used to advise on the ploughing-up scheme. A lead is still lacking as to the amount and type of fertilizers required for maximum production. Only half-hearted attempts have been made to ensure maximum human efficiency by seeing that everyone gets enough protective food substances (it is stated that a 'vitamin biscuit' giving adequate amounts of the ten most important vitamins and the three or four essential mineral salts could be provided daily for every man, woman and child at a cost much less than, for example, the pre-war sugar beet subsidy).

The man of science sees the problem as a twofold one: first, to ensure a national diet adequate for full physiological health, and secondly, to save as much shipping space as possible by substituting home production for importation. There may, of course, be cases where economic foreign policy demands that certain imports be retained, where certain types of boats (for example, banana boats) cannot be converted to other uses, where to cut down drastically on certain foods (for example, meat) would be bad for morale; but these involve merely adjustments of the main principle. Once such a unified approach is agreed upon, sectional interests and traditional inertia must and can be overcome.

However, a still more general approach is possible. What is needed is the recognition that the world we live in is a technological world, and that success in it therefore depends primarily upon the utilization of scientific knowledge and of scientific method. This is just as true of war as of peace, of human affairs as of engineering or bacteriology. Scientific management is as necessary as, say, chemical warfare research. But the main need is the integration of all aspects of the war—strategy and tactics, supply and food, propaganda and morale—in a comprehensive scheme of scientific planning with proper facilities and proper co-ordination.

Traditionalism is one enemy of technical efficiency. Tradition may be extremely valuable: it becomes dangerous when the assertion is made that it *must* be valuable. Another enemy is the ignorance and sometimes mistrust of science still to be found in many important quarters—in business, farming, the Civil Service, among military authorities. This has expressed itself very frequently in the relegation of the man of science to an advisory role. He sits on an advisory committee, which gives answers to such questions as may be asked it. But the authorities are under no obligation to ask questions, and the result may be the partial or total sterilization of science in that field. In any event, as every research worker knows, half the battle in science consists in asking new questions which the non-scientist cannot be expected to think of.

The authors conclude that somehow means must be found for short-circuiting the present devious and dampening routes between science and the problems to be solved—or, in other words, between men of science and the men with difficulties to surmount. The authors have some hard things to say about the refusal of many men of science to look beyond their specialisms and face their social responsibilities. This conclusion can be generalized for other walks of life: "What must be realized is that the time has definitely passed when individual responsibility could be regarded as ending with the proper carrying out of traditional functions or administrative orders. Merely doing one's duty in a conscientious and blind way is not what the situation demands. Thought, ordered and organized thought, directed to speedy decisions, is the first requirement".

The publisher in his foreword informs us that "Science in War" was conceived, written, printed, and published in less than a month. This abbreviated gestation, more characteristic of a rodent than of a human being or a book, though very remarkable, has had certain unavoidable defects. The book betrays its composite authorship rather too obviously, and there are a number of misprints (of which "The Ministry of Poland", referred to on p. 13, is presumably one !). Nevertheless it is a valuable contribution, which should be widely read and, let us hope, acted upon. J. S. H.

MICRO-DIFFUSION IN CHEMICAL ANALYSIS

Micro-Diffusion Analysis and Volumetric Error
By Prof. Edward J. Conway. Pp. xiii+306. (London: Crosby Lockwood and Son, Ltd., 1939.) 25*s*. net.

THE development of new methods of chemical analysis brings often in its train the discovery of new facts and the opening up of new fields of investigation. This is particularly true of biochemistry, where the accurate estimation of small quantities of substances in biological material may be of fundamental importance. There can be little question that the rapid progress in biochemical achievement owes much to the invention of microchemical methods of analysis applicable to biological material.

Prof. Conway's admirable book describes the application of a relatively new technique, that of microdiffusion, in chemical analysis. The Conway unit, in which the microdiffusion principle of analysis is embodied, is now well known to biochemical workers, particularly for the estimation of ammonia. With this simple apparatus distillation and aeration are eliminated and the passage of ammonia takes place by diffusion from one chamber in which it is generated into another chamber in which it is absorbed. Details of the conditions controlling this diffusion so that an accurate estimate of the diffusible substance can be made, together with details of the apparatus employed, are fully described and explained in a most interesting section of Prof. Conway's book. The microdiffusion procedure has been found already to be of value in the estimation of the following substances: ammonia, total nitrogen, urea, adenylic acid and adenylpyrophosphate, adenosine, aliphatic amines, chloride, bromide, carbon dioxide, acetone and alcohol. Prof. Conway fully describes the application of his unit to the estimation of these substances in tissues and biological fluids. This impressive list of substances will doubtless be enlarged in the future as the principle of microdiffusion in analysis becomes more widely recognized and employed.

Micro-titrations involve the use of accurate volumetric apparatus, and a knowledge of the errors to be found in volumetric analysis is obviously essential for an appreciation of the limits of the accuracy obtained in such estimations. One third of Prof. Conway's book is devoted to a very complete and valuable treatment of the errors of volumetric titration, of the errors encountered in the use of pipettes and burettes and of the corrections which have to be applied for accuracy.

A chapter on the principles of colorimetry and spectrophotometry as used for micro-analytical work, and one on the micro-techniques of Kirk and of Linderström-Lang and Holter, are useful additions to the book.

This volume is of great value to all workers interested in microchemical technique. It is excellently produced and printed, with copious drawings, curves and references. Its only drawback is its relatively high price, which might put it out of the reach of many of the students for which it is intended. J. H. QUASTEL.

PROBABILITY AND RELATIVE FREQUENCY

Probability and Frequency
By Prof. H. C. Plummer. Pp. xi + 278. (London: Macmillan and Co., Ltd., 1940.) 15*s*. net.

THE approach to probability adopted in this book is conventional, but cautious. The two definitions, the one *a priori*, based on equally likely aspects of a system, the second *a posteriori*, based on relative frequency in repeated trials, are stated and criticized, the first being preferred, but with qualifications. In the first two long chapters sixty illustrative examples of the most varied kind, divided equally between discrete and continuous problems, are posed, solved and commented upon. The reader who has worked through these will have learned a great deal about cards, dice, the Problem of Points, the St. Petersburg Paradox, Laplace's Law of Succession, Buffon's needle and many ingenious and interesting problems in geometrical probability; he should indeed be able to attack almost any reasonable problem of the kind.

In the long chapter on the Theory of Errors the normal law is derived first by Herschel's considerations, then by other sets of postulates, the conclusion being that it is "an empirical rule which is supported by experience in general, but which in the last resort must be verified by the same test". The principle of Least Squares is derived from the assumptions of normal distribution of error, and maximum probability; the other derivation, by minimum variance of consistent linear estimate, is mentioned, but as of secondary importance. (The present reviewer cannot agree with this assignment, nor with the statement at the end of § 168, p. 162, that "the basis of probability" is abandoned in this second approach; and incidentally it is not necessary for its validity that the law of error should be symmetrical.) The treatment and notation follow classical tradition.

The statistical distributions in one variable treated in Chapter iv are those of Poisson, the Type A Series with the cubic correction term, and Pearson's system, introduced by way of the limiting case of the difference equation of the hypergeometric distribution. The point of view of curve-fitting is empirical. "The results have only to be justified by success."

The criterion of "success", Pearson's χ^2, nominally appears in Chapter v, devoted to correlation, including the normal correlation function in two and three variables, correlation ratio and contingency, but also containing derivations of the distributions of χ^2, of the estimate of variance, of Student's ratio and of the ratio of two mean squares, and finally of R. A. Fisher's distribution of r, with the hyperbolic tangent transformation to approximate normality. The inclusion of these distributions adds very considerably to the value of the book. Tables of $\log_{10}\Gamma(x)$ and of the normal probability integral (in the form in which the modulus of precision is the parameter) are appended.

The book is a welcome addition to the rather exiguous list of text-books in English on the subject. Lack of space is doubtless the cause of the omission of certain important topics, such as the theory of estimation of parameters in a probability function. In a few places more precise statements could have been made. For example (p. 250), in the matter of the χ^2 test with reduced degrees of freedom, it should be stressed that the relations used in fitting the curve should be *linear* in the class-frequency deviations. Again (p. 226), for r to be zero it is not necessary that one or other of the distributions of x and y should be symmetrical; their independence is sufficient. And lastly the reviewer, holding as he does that to keep an open mind is to assign no probability whatever, must demur to the suggestion (p. 3) that "ignorance may be an element conducing to equal likeliness". These, however, are mere *obiter dicta*; the book is at all times interesting, and punctuated with dry common sense. A. C. AITKEN.

PHYSICAL EDUCATION IN GREAT BRITAIN

By Sir George Newman, G.B.E., K.C.B.

THE debate in the House of Lords on July 12 on the subject of national physical training —introduced by Lord Samuel, discussed in an admirable expository speech by Lord Dawson of Penn, and answered on behalf of the Government by Lord Clifden—has again directed public attention to the urgency of a problem which was first officially raised by the Physical Deterioration Committee of 1904, so long as thirty-six years ago. It will be remembered that that Committee held a grand inquest on the physical condition of the English people, the greatest inquiry of its kind since the Royal Sanitary Commission of 1868: "The people perish for lack of knowledge." It thus set going the action of the State to remedy matters, and recommended the medical inspection and feeding of school children, with the hygiene and physical training of boys, girls and adolescents. Indeed it made fifty-three separate recommendations, some fifty of which have now been adopted or discharged. Their beneficial effects were recognized during the War of 1914–18 by the Ministry of National Service and its Galloway Report on the physical examination of recruits in 1917–18. Now the War recalls us once more to tackle the same old problem.

From the beginning we must be clear about this problem. It finds its source in the advance of medical science, and its solution in social organization and its wise administration. First, as to its science. When Harvey demonstrated the circulation of the blood in 1616, he opened the door to an intelligible understanding of the physiological mechanism of man's body and the purpose of the blood. We now know that "the blood is the life" because it carries food, oxygen and hormones to all parts of the body, and we know also that its circulation is regulated and controlled by the operations, central and peripheral, of the nervous and muscular systems. "Through the motion of the blood," said Harvey in his famous ninth chapter, "the various parts of the body are nourished, cherished, and quickened by the warmer, more perfect, alimentive blood, which discharging its functions quickens the whole body and is indeed the foundation of life and the source of all action." Thus the first purpose of bodily exercise, whether formal or informal, whether of voluntary or involuntary muscle, is the attainment and maintenance of the growth and strength of the body structure as a whole and of its several parts. Secondly, by physical exercise we increase and develop the physiological functioning and nervous regulation of the various organs of the body, to produce a single harmony and a constant balance.

We know by experience that the living body requires food, fresh air (oxygen), warmth, muscular exercise of all its parts, and periodic rest. This has been proved to be the way, and the only way, to health and wholeness; even to survival. The heart is a muscle, the blood vessels have muscular walls, breathing is controlled by muscles, and likewise the digestive system, and thus the body becomes the power-house as well as the muscular engine of living; if we are to live, all these functions must be kept in health and vigour, in tone, readiness and quality by full and continuous stimulation. Finally, exercise keeps the body and mind one single total unity. Though its primary purpose is physical, the culture of the material body and its harmony and control, it is a means of discipline of the mind and spirit of man, to make the body its obedient instrument. Banish the exercise of heart and body and you banish life.

The practice of a regimen of voluntary exercise led the Greeks to devise systems of exercise, followed long afterwards in our own day by Swedish, German, Czech and British methods and physical philosophies. It is a feature common to them all that their social objective was scarcely less than their physical. Their greater end was health and human development, something religious, political, defensive, national, educational. This is strange but true, both in a historical and philosophical sense. Their purpose, expanding beyond the physical realm, thus became infinitely larger than merely the making of athletes or gymnasts. It was to induce manliness, to make and discipline men, to obtain a ready and perfect obedience, as Plato taught, "mainly for the sake of the soul".

Such being the basic science of physical education, there grew up, as civilization advanced, an ever-widening social purpose in its application. It is instructive to note that such purpose became the primary objective of the official recommendations of the Committee of 1904 and of the Ministry of National Service in 1919. Both of them saw poor physique, prevalent disease and high mortality, and they advocated hygiene and physical exercise as preventives; they saw unnecessary industrial fatigue in the factories delaying and reducing output, and crying for relief; they saw an urgent necessity for healthier and stronger recruits; they saw a 'half-baked' academic system of education of mind separate from body—and they both found, unanimously, that in disciplined physical education conjoined with the practice of hygiene there was a sovereign remedy, a true method both of healing and of health. Both knew that this was the task and duty of statecraft, and to its application we must now turn.

Nothing in the nature of organized physical education existed prior to 1861, when the army authorities began the physical training of recruits. It was a wooden and rather perfunctory plan of 'setting-up' exercises with dumb-bells and rifles, later amended by an infiltration of Swedish exercise. In 1871, the Education Code (following the Education Act, 1870) introduced school drill, as a meagre and half-hearted recognition of the need for physical training, following the so-called 'model' of the Army. In 1907, when the Board of Education embarked upon the medical supervision of school children, the whole subject was fully and officially explored, and in 1909 a scientific and comprehensive syllabus of instruction was issued by the Board, and physical education became for the first time an essential and integral part of the elementary school curriculum. This has developed into a complete system, with physical training organizers and trained teachers, comprising every kind of exercise, games, dancing, swimming, etc., for the elementary, secondary, technical, continuation schools and evening classes. The effect became almost magical and swept joyously through England, and, in association with medical inspection, hygiene, open-air schools, and school meals has revolutionized the health and physique of the children and young people. A comparison of the physical condition of the school children to-day with that of thirty years ago is patent, arresting and obvious to everybody.

This then is the enduring foundation of national physical education. *But it does not yet continue after school days.* The extremely precious age-period of adolescence has, with two exceptions, been neglected. For the army, navy, and air forces an excellent professional physical training has been available, and for the growing boy and girl Baden-Powell's scout movement came to the rescue, a voluntary movement which has inspired and revitalized the education of youth. Those two exceptions have saved the situation, for they have exerted an indirect effect upon the health education of the nation beyond compute. Concurrently, there has been for a long time past an enormous expansion of voluntary associations for games and sports of all kinds. Thus we have in England (*a*) the physical education of all school children, (*b*) professional physical training for the national services, and (*c*) a vast congeries of voluntary and varied agencies of leisure-time physical training following the free will and predilection of the individual. That is the three-fold scope of the English position. *It is good, but not good enough.*

Compare it with the modern German system under the Third Reich and its limitations are apparent: it is not universal, not a compulsory imposition, not for all classes and conditions, not one vast national practice which changes and unifies the character, purpose and aim of a whole people. Yet though the German system has produced a remarkable generation of vigorous and purposive youth, the English people have no desire to imitate it. For its dangers exceed its merits owing to one grave and universal defect: it ignores the individual education, growth, capacity and development of the personality, it is mechanical and 'dragooning', it is subversive of individual freedom and suppressive of national liberty, it is misdirective in purpose and ideal, for it seems to be designed solely to invent and retain a machine-made man for military service, and thus it becomes soul-destroying.

What then should we do? There are three things to do forthwith. First, we must be vigilant to maintain and make absolutely efficient our school system of a broadly conceived and wisely administered system of physical education in every school area of Great Britain, even in these difficult days of evacuation and disturbance of school education. Every child in the country, rich and poor, should receive thorough training in the practice of health and physical exercise, at the hands of competent teachers. Secondly, this inestimable advantage should be carried on through adolescence, by means of some form of continuation school or otherwise. Thirdly, the voluntary movements in physical education should be warmly encouraged, organized and co-ordinated by one central body. Fortunately, such an organization already exists, and has abundantly justified itself —the Central Council of Recreative Physical Education (58 Victoria Street, London, S.W.1). This Council is fully representative of all forms of physical training, games and sport. It has done quite invaluable pioneer work in education and demonstration in all parts of the country. It should receive sufficient financial support from the State and the local authorities to make it a still more effective instrument. What the nation needs in this problem is not more inquiries, new bodies or departments, but more united effort, power and imagination to devise ways of co-operating and utilizing the existing means and agencies.

REINFORCED WHITE FLOUR

By Dr. T. Moran and Prof. J. C. Drummond

In the House of Commons on July 18, the Parliamentary Secretary to the Ministry of Food announced that very shortly the white loaf would be fortified with a supplement of vitamin B_1 (aneurin) and a calcium salt. It is understood that the vitamin B_1 will add approximately 100 I.U. to the daily intake, whilst the addition of calcium will ensure that all classes of the population are receiving at least the daily requirement of approximately 0·60 gm. Both constituents will be introduced into the flour stream at the mill, where accurate control can easily be achieved. This decision will probably not satisfy the advocates of brown or wholemeal bread; but it is a compromise which is sound on nutritional grounds and inevitable from the practical point of view.

The present-day straight-run white flour (73 per cent extraction) has a B_1 content of 0·30 I.U. per gram against 0·75 and 1·3 for 85 per cent extraction and genuine (100 per cent) wholemeal, respectively. These are only average figures, since the amount in different wheats varies from about 0·6 I.U. to 3·3 I.U. per gram. Taking the average consumption at 60 oz. a week, white flour at present contributes approximately 80 I.U. a day; the new flour will increase the figure to 180 I.U.

Dietary surveys have established that the nation as a whole is not receiving sufficient B_1. The League of Nations Technical Commission on Nutrition gave the figure of 300 I.U. a day as the daily need of an adult male. There is now, however, considerable evidence to show that this figure is low and, excluding the particular case of pregnant women, the minimal requirement per weighted head of the population is 400–500 I.U. per day. An analysis of Sir John Orr's 1936 survey shows that the intake of 50 per cent of the population falls below this figure, whilst a more recent survey gives the average per head figure as approximately 300 I.U. per day. The proposed supplement to white flour should, therefore, greatly reduce B_1 deficiency. Furthermore, such a step is particularly important at the present time when the deficiency is likely to be aggravated because of the possible reduction in the consumption of meat and dairy produce.

The decision to increase the calcium content of bread is of particular interest because flour—either white or wholemeal—is not an important source of this mineral: on the basis of a requirement of 0·60 gm. per day, flour only contributes about 10 per cent of this amount. There is good evidence of calcium deficiency in many diets, and obviously flour is a convenient vehicle to make it good. The ratio of calcium to phosphorus in white or wholemeal flour is 1 : 6½–10 and is, therefore, not well suited to the needs of the animal body—which are best met by foods with a ratio of 1–2 : 1. This is an argument against the addition of calcium phosphates, although they would, in fact, tend to correct the balance. One possibility is calcium carbonate which, introduced at the rate of ½ lb. per sack (280 lb.) of flour, would raise the calcium intake of Orr's lowest income groups to roughly the minimal level. Incidentally, this quantity of calcium carbonate would have no adverse effect on the palatability or general quality of bread.

The introduction of the new white flour will undoubtedly stultify the controversy about white versus brown bread, since it is mainly in respect of B_1 that the white loaf has been open to attack. There is not the same evidence that we are deficient in vitamin E or the members of the B_2 complex, which are present in wholemeal flower, while, as regards the mineral constituents, the relative merits of the two flours are uncertain because of the higher phytic acid content of wholemeal flour. The practical objections to wholemeal bread, however, are, at the moment, overriding. The evidence is that the bulk of the people prefer white bread; it is certainly true that only 5–10 per cent of the bread sold is brown or wholemeal. Again, any increase in the extraction would reduce the amount of wheat offals available for feeding stuffs and, in particular, jeopardize our milk supplies. Finally, white flour keeps very much better than brown or wholemeal flour and need not be turned over so frequently. This is particularly important at the present time on account of the vast stocks of flour that are being stored as a war reserve. Nevertheless, Mr. Boothby made it clear that wholemeal bread will still be available to those who prefer it and at the same price as that for white bread.

The increased intake of B_1 should materially improve our general health. Beriberi is rare in Great Britain, but the effects of partial deficiency, including loss of appetite, physical vigour and disorders of the alimentary tract, the nervous system and cardiovascular system, must be widespread. It is always difficult to relate suboptimal health to the lack of a particular nutritional factor, but the recent direct experiments of Jolliffe in the United States are particularly striking. He gave a daily ration to five healthy subjects, containing only half the minimal dose of B_1, and found that, within five days, four of the subjects showed characteristic signs of B_1 deficiency, including fatigue and lassitude, anorexia, precordial pain, burning of the feet, muscle cramps and palpitation. The introduction of an increased amount of aneurin into the diet caused all these symptoms to disappear within three days.

So much for the nutritional aspect. As regards the appearance and palatability of the new bread, careful tests have shown that aneurin is absolutely inert and has no effect on the dough, the volume of the loaf or the crumb character of the bread. Furthermore, due to the acid pH of flour, approximately 5·4, the aneurin is quite stable and there is no loss during doughing or baking. The flour will, therefore, be indistinguishable in appearance and handling properties from the present-day flour.

The introduction of the small amount of aneurin necessary will present no difficulty. It will be first mixed with a suitable quantity of flour, and this concentrate will be added at the rate of 1 oz. per sack. Equipment is in existence for doing this, and tests have already been made showing that there will be no difficulty in obtaining uniform distribution of the aneurin throughout each sack and in the entire flour stream. Determination of the aneurin in the flour and bread is possible by the thiochrome test with an accuracy of at least 4 per cent.

The new loaf, which has been under consideration for some time past by the milling industry and the Ministry of Food, now has the support of the Scientific Food Committee under the chairmanship of Sir William Bragg. Viewed from the general aspect of the nation's food, it is a revolutionary advance, because it can only mean that, in the future, whilst the preferences of the public will always receive first consideration, steps will be taken to make good any nutritional deficiencies both in individual foodstuffs and in our diet as a whole. The new loaf, in fact, with its supplement of vitamin B_1 on one hand and calcium on the other, embodies this general policy. There will now be two outstanding examples of fortified foodstuffs, bread and margarine—incidentally, both of first importance in the food of the poor.

PLANT DISEASE IN RELATION TO THE PUBLIC*

By PROF. W. BROWN, F.R.S.,

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

THE term 'plant disease' is used in somewhat different senses. As typical examples one would cite such troubles as rust, mildew, damping-off of seedlings, etc., in which the higher plant is attacked by a parasitic fungus or similar plant organism. The destruction of fruit blossom by a late frost or the failure of a crop from drought or malnutrition are not commonly looked upon as the effects of disease; but it is logical to extend the term to include such cases. This has been the practice in human pathology where, for example, a group of 'deficiency diseases' is well recognized. Similar troubles occur also in plants. One speaks, therefore, of the physiological as against the parasitic type of disease, a division which is convenient, though in practice it is not possible to draw a hard and fast line between them.

Again, it is customary to distinguish between diseases and pests; for example, rose mildew is a disease, rose aphis is a pest. It is usual to apply the term 'pest' when the parasite is an animal, but again there are exceptions. Thus one speaks of the eelworm disease of narcissus, though the causal agent is an animal. The line of demarcation is distinct in theory, but pests and diseases are often interlinked, as in many virus diseases of plants.

For the present purpose, the effect on the crop is the matter of chief interest, and this may be the same whatever the causal agent—whether it be fungus, bacterium, virus, insect, nematode, etc., or whether the cause be strictly physiological. The effect may be sudden, leading to death of the plant at a very early stage, even before germination; or the plant may flourish for a long time and then be crippled or destroyed as it reaches

* From a Chadwick Public Lecture delivered on June 20.

maturity ; or finally the product of the plant may be attacked in storage. Again, according to the nature of the causal agent, the damage may be unavoidable, or it may be partially or completely eliminated by proper precautions or treatments. Such details are for the consideration of the technical expert ; the public are concerned with the final result, namely, that for one reason or another there is a material reduction of the quantity or lowering of the quality of the particular product.

Plant diseases occur in varying intensity from year to year and place to place and cause a general wastage of plant material. It is, however, when they occur in epidemic form that they excite the public interest. Such was the great Irish potato famine of 1845–47. In 1845 Ireland carried a population of more than $8\frac{1}{4}$ million, consisting mainly of peasants whose staple crop was the potato. There had been partial or local failures of this crop previous to 1845, but in this year appeared a new disease which blighted foliage and tubers. In the following year it came earlier and in severer form. Contemporary accounts speak of the suddenness of the outbreak and of the devastating effects over large areas. By 1847 the severity of the disease had somewhat abated, but distress and disorganization were now widespread. There was absolute starvation in certain districts and nearly half the population were in receipt of relief. An outstanding result of the epidemic was a wholesale emigration to Britain and America, so that the population of Ireland had fallen in 1853 to a little more than 6 million.

Other noteworthy examples are the coffee rust epidemic in Ceylon which ruined the coffee industry in that country and forced the planters to turn their attention to tea cultivation, and the many rust epidemics of wheat which have occurred on the continent of Europe and in North America.

The risk of a world-wide scarcity of important plant products, which may arise from disease in epidemic form, has been much reduced by the opening up of large new areas of production in the various continents, and by great improvements in methods of storage and transport. Within the past twenty years the problem has at times been rather the converse one, namely, the incubus of too much of certain important plant products. Thus one read of coffee beans being used as fuel in Brazil, of fields of cotton being ploughed under in the United States, and of British farmers being penalized if they planted more than a certain acreage of potatoes. It is curious to reflect that a widespread drought in North America, which led to an extremely low yield of cereal crops, was hailed by the commercial world as a blessing, as it tended to "right the statistical position". In such conditions the biological worker, who aims at devising methods for increasing the productivity of the earth, may wonder what his function may be. Perhaps he can fortify his mind by doubting the reality of those surpluses which weigh upon commerce, and by asking, for example, whether a surplus of wheat means that no person is underfed.

Attempts are often made to assess the losses in money value which follow from particular plant diseases, but it is doubtful if much significance can be attached to calculations of that sort ; the relevant data are difficult to obtain and may be difficult to interpret. The conditions which govern the trade in the commodity have an important modifying effect, as the following examples will show.

A reduced yield of wheat in Great Britain, by whatever cause it is produced, has a very small effect on the world price of wheat. The supply of wheat to the British market is not materially reduced, since wheat is easily transported and in fact Britain depends to a large extent upon imported wheat. The consumer, therefore, is scarcely affected, whereas the British producer loses more or less in direct proportion to the shortage of his crop. Now contrast this with the effect of a shortage or a surplus of the potato crop. Britain is practically self-contained with respect to potatoes. If the crop is abundant, prices fall. There is little tendency to increased demand, as potatoes are among the cheapest of foodstuffs and fluctuations in the retail price have little effect upon the quantity consumed. When, however, as a result of drought or blight or wastage in store, the crop is insufficient to meet the year's requirements, the price rises in a remarkable manner. Thus in consecutive years it may vary from about £2 to £10 per ton, that is, from a price which gives no profit to the farmer to one which is very profitable. It is notorious that, under the conditions which prevail in Britain, the potato crop yields a profit to the grower only in years when disease (in the wide sense) is most prominent.

A curious illustration of the effect of disease on prices was seen on comparing the market prices of a number of vegetables at the beginning of March 1940 with the corresponding prices a year earlier. Apart from effects arising from the War, a substantial difference was that the severe frost in January and February of 1940 had destroyed practically all the green winter vegetables. Nevertheless, the rise in price of the latter was no more than about 50 per cent, whereas such vegetables as parsnips and carrots, which suffered to a much less extent, were quadrupled in price. Obviously there was a general change-over in demand from one type of vegetable to another, and the effect of the frost cannot, therefore, be assessed on the basis of the change in price of the products primarily affected.

In the three examples just given the effect upon price of reduced quantity, as caused by disease, has been considered. Another aspect of the question is illustrated by the relation of scab disease to the market value of apples. In its severest form this disease renders apples totally unmarketable, but more usually the effect is that the fruit bears superficial blemishes which detract somewhat from its appearance without in any way impairing its eating quality. Nevertheless, the presence of traces of scab brings about a remarkable lowering of the market value. This is partly because of popular fancy, but the main reason is that fruit, even if only lightly scabbed, cannot well be kept in storage—on account of water-loss through the scabbed areas—and must, therefore, be thrown upon the market during the period of glut. Scab-free fruit, on the other hand, can be held in storage for several months, and marketed in an orderly manner in a period of relative scarcity. The effect of disease in this case is primarily upon the quality of the product, which controls the quantity available at certain times of the year.

The aim of the research worker in plant diseases being to reduce the ravages so caused, it may now be asked—who is it that benefits by any advances which are made? From the national point of view, in times of peace but more especially in times of war, there can be no question as to the benefit. If a 50 per cent yield is by some technical advance converted into a 90 per cent one, then 50 acres are made to do the work which formerly required 90, and to that extent the effective productive area of the country is extended. From the consumer's point of view the benefit is also obvious, as increased supply leads in general to freer and wider consumption and to a rise in the standard of living. It is when we come to the producer that we meet with a mixed reaction. Producers are competitors, and it is undoubted that an advance in methods of dealing with plant disease may bring immediate loss to some of them. The more skilled or the more fortunately situated may lose some of their former advantages. Two examples will make the point clear.

The disease known as 'reversion' was for many years a limiting factor in the production of black currants. Effective methods of combating reversion are now known and put into practice, with the result that the cost of producing the crop has been reduced by nearly one-half. It is stated that whereas in the past certain growers—presumably those with special knowledge—made handsome profits, nowadays there are too many growers who possess the necessary information, so that profits have become much more ordinary. The benefit, as is usual, has come to the consumer in a cheapening of the fruit.

The second example relates to the potato industry. On account of the prevalence of certain virus diseases in the warmer parts of Great Britain, stocks of potatoes lose their productive capacity and require to be replaced by more vigorous planting material from the colder and wetter parts of the country: hence the seed-potato industry of Scotland and Ireland. It is obvious that if an effective economic method were devised whereby the cropping power of English seed potatoes could be maintained, the inevitable result would be the elimination of an established industry in Scotland and Ireland.

Examples of this sort could be multiplied. Plant disease is largely conditioned by differences in climate, soil, cultural methods, etc., and thus varies in importance from one district to another. While it is to the interest of the individual producer that the diseases from which his own crops suffer should be suppressed, it does not follow that the group of producers is equally interested. It is important to recognize this fact, especially in its relation to the initiation of research on plant disease. It may seem a plausible suggestion that the farming class should subsidize research, for the reason that it is their crops which are damaged by disease. This argument is in many cases fallacious, and it would be more correct to say that the initiative should rest with the central authority in its capacity of guardian of the general public.

Plant disease plays an important part in determining the location of various crops and the manner of their cultivation. Climate and soil may be the predominant factors, but these often operate through associated plant diseases. A striking example of this relationship is seen in the location of the seed-producing areas. These tend to develop in parts which have a low autumn rainfall. Seed-bearing plants are extremely liable to damage by fungi in wet weather, especially after the flower has faded, with the result that the yield is lessened, the seed is of poor germinative capacity and is liable to carry infection to the new crop. The location of the 'seed'-potato industry, already referred to, affords a second illustration, though here the favouring conditions are precisely the opposite, seed potatoes of high cropping quality being produced in the wetter, colder areas. The explanation of this apparent anomaly is simple. Loss of cropping power in potatoes is caused by a number of virus diseases which are transmitted by aphides. The latter are much less abundant where the climate is cold and wet, and therefore the tendency to dissemination of virus diseases is much reduced.

A further impact of plant disease upon agricultural trade is seen in the various restrictions which legislatures have imposed in the attempt to prevent or limit the spread of infective plant diseases. These operate between one country and another or even between different parts of the same country, and take the form of quarantine regulations, embargoes, systems of inspection and certification, etc. It is a controversial point how far such legislative interference achieves its primary object and how far it is liable to be abused for purely commercial purposes.

Advances in the practice of combating (in technical language 'controlling') plant diseases are necessarily slow. Even when the investigator has the good fortune to devise a promising method, it must be fully tested over a range of seasons, and in relation to the variety of cultural systems which prevail in practice. Years may be spent in perfecting details, and there may in fact be no finality in this respect. When the method has been elaborated and shown to be effective and economical, it will still fail to be accepted unless the operations involved are such that they can reasonably well be fitted into the routine of cultivation. Too often the 'control measures' freely suggested in plant pathological text-books fail in this respect—they are utterly impracticable. On the other hand the urgency of controlling certain plant diseases may be so great that the go-ahead grower is prepared to modify drastically his system of cultivation in such a way as to facilitate the application of methods of disease control. This may be a very lengthy process indeed, and may require a long continued co-operation of practical grower, plant breeder, plant pathologist, entomologist and other experts. The recent history of the apple-growing industry in England illustrates this type of development, and as the public has gained very notable benefits thereby, a sketch of the 'evolution' of production may suitably conclude this article.

The old-fashioned apple orchard was planted with 'standard' trees, widely spaced, intercropped at first with bush fruit, and as a rule finally laid down to grass. The trees were expected to grow to a large size and to come into production in 10–15 years. The large size of the fully grown trees made spraying difficult and pruning very laborious. Pests and diseases tended to become rampant; much of the fruit was tunnelled by insect larvæ and, if not prematurely shed, finally invaded by rotting fungi; scabbed apples were the rule; the growth of the tree became quite unregulated; and at the best the harvest was a mass of ill-assorted fruit, unattractive in appearance, which was in the main thrown upon the market immediately after being picked. Much of it never reached the market at all, and as far as the public was concerned, English apples were abundant for about two months in the autumn, after which they were seen no more.

Consider now the more modern method. The type of tree favoured is the dwarf. This is obtained by grafting on certain types of rootstock, and so thoroughly has the interaction of stock and scion been studied that it is now possible for the grower to select the combination which will in due course produce the tree of desired size on his particular soil. The dwarf tree being closely planted and coming into early bearing, the complications which follow in practice from undercropping with bush fruit are avoided; the trees are easily shaped and pruned; growth is regulated so as to admit a maximum of sunlight to the centre, thereby enhancing the colour of the fruit and affording a partial control of fungoid diseases; the trees are manured according to well-defined principles, with considerable effect on cropping power and fruit quality; spraying against insects and fungi is systematically carried out, the smallness of the trees making such treatment highly practicable; the crop if too heavy is suitably thinned and spaced; the trees being small and sturdy, damage to the fruit from autumn winds is reduced to a minimum. The final crop may not equal in quantity what was from time to time obtainable by the old methods, but the quality is much higher.

The improvement in method goes much farther. Fruit of the quality described is capable of being stored. Much physiological research has been devoted to solving the problems of storage diseases, and new methods have been devised. The final result, therefore, is that the produce of the modern orchard is marketed steadily over a period of many months. The progressive grower has benefited financially by the change, but the greatest benefit has come to the consuming public, which can now satisfy its appetite for English apples over eight months of the year instead of two months as formerly. Stated in another way, the essential difference is that a very high proportion of the apples from the modern orchard reaches the consumer, whereas much of the crop grown by the old method was merely wasted. For this meritorious advance the plant pathologist shares the credit with other technical workers, and it is along such co-operative lines that further progress is to be sought. Lest it should be assumed that the above rosy picture applies to all crops, it may be added that there is room for further advances. There are still many crops in which the proportion of waste is extraordinarily high, and it remains for the research worker of the future to point the way to a desirable improvement.

OBITUARIES

Sir Arthur Harden, F.R.S.

BIOCHEMISTS the world over will have heard with sincere regret of the death of Arthur Harden on June 17 in his seventy-fifth year. By his late colleagues at the Lister Institute and by a host of old pupils from many lands who learnt at his feet or at one time collaborated with him, his loss will be particularly felt, for Harden who, on his retirement in 1930, had completed thirty-three years of service as head of the Biochemical Department, was in himself an institution and a veritable tower of strength in the Lister community.

A pupil of Roscoe and a lecturer in chemistry at Owens College for nine years, Harden came in 1897 to London to take charge of the Chemical and Water Laboratory of the Lister Institute, then the British Institute of Preventive Medicine with its laboratories in Great Russell Street, in succession to Mr. Joseph Lunt, who had received the appointment of assistant in physics to the Astronomer-Royal at the Cape. The Institute was then young, financially very insecure, and struggling to justify its existence to a somewhat impatient generation unused as yet to the trained professional prepared to play his appropriate part in concerted attacks on basic problems of preventive medicine. Soon, however, the position was to change for the better, for in May 1898 the Institute was able to remove to the new buildings in Chelsea Gardens and in December of the same year, the Council of the Institute was happy to accept the munificent donation by the late Lord Iveagh to the Institute's funds.

Harden's training and research experience in chemistry at Manchester and at Erlangen had been, up to the time of his joining the Institute, on strictly orthodox and classical lines, and it was on this sound foundation that he was soon to build the high reputation he later enjoyed as a pioneer of biochemistry in Great Britain.

On his arrival in October 1897, Harden found the then director, Dr. Allan Macfadyen, actively engaged in the study of the fermentative activities of the *coli* group of organisms, and at Macfadyen's suggestion he embarked on an investigation of the breakdown products of glucose. One of Harden's earliest publications on this subject appeared in 1899 in a volume not now readily accessible (*Trans. Jenner Institute Prev. Med.*, Second Series, Macmillan and Co.) but it was a subject to which he often reverted in later years. His great knowledge and practical experience of bacterial enzymes and bacterial metabolism generally enabled him to survey this whole field in masterly fashion for the "System of Bacteriology" (1930).

Certain circumstances of the time, however, drew Harden inevitably to the problem of the chemistry of the yeast cell, which formed the chief preoccupation of his working life for some thirty years. In 1897 Buchner had demonstrated the fermentation of sugar by the pressed yeast juice, while the interest taken by certain members of the Council of the Lister Institute in industrial fermentation processes had led in 1899 to the establishment of a Hansen laboratory under the direction of Dr. G. Harris Morris. This laboratory was, a year later, merged in the general chemical laboratory directed by Harden. Further, the efforts of Macfadyen and Rowland to secure the juices of pathogenic bacteria by grinding at the temperature of liquid air, an elaborate plant being available for this purpose, represented at least cognate inquiries to those on which Harden and his first collaborators, Sydney Rowland and W. J. Young, embarked with yeast juice as the object of test.

Here is not the place to follow in detail the story of the discoveries made by Harden and his collaborators in the course of their many years study of the chemical processes involved in the fermentation of sugar by yeast juice. That study is truly classic, and its issues have not only illuminated our knowledge of the chemical processes within the yeast cell but have also provided clues to the chemical dynamics underlying such seemingly remote processes as muscular activity and ossification of bone. For his work on alcoholic fermentation Harden was in 1929 awarded the Nobel prize in chemistry, shared with von Euler.

The yeast cell has been a gold mine to many kinds of diggers, and not least to those immersed in vitamin studies. It is not surprising, therefore, that Harden towards the end of the War of 1914–18 entered the nutritional field for a time, and with his colleague Zilva contributed a series of valuable papers on the antiscorbutic and antineuritic vitamins and their occurrence in various foods and drinks, not excluding beer.

Harden's outside links and interests were numerous, but perhaps his services as editor-in-chief of the *Biochemical Journal* for twenty-five years from 1913 until 1938 deserve special mention ; for the influence he was able to exert in this capacity on the development of biochemistry in Great Britain has been incalculable.

Many honours came to him ; an honorary LL.D. from Manchester and from Liverpool, an honorary D.Sc. from Athens, the Davy Medal of the Royal Society awarded him in 1935 and the honour of knighthood in 1936. Until some nine months ago, Harden continued to visit the Institute every day from his home in Bourne End and his interest in all the activities of the Institute never flagged. At his death he had been for nine years a valued member of the governing body of the Institute. A widower for twelve years, Sir Arthur leaves no family. To his sisters we would extend our sincere sympathy.

J. C. G. LEDINGHAM.

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Mr. E. R. Gunther

IT is barely two months since NATURE regretted the passing of Dr. R. T. Gunther; now comes the untimely death of his eldest son, Eustace Rolfe Gunther, at the age of thirty-seven, accidentally shot while on active service. This tragic event robs oceanography of one of the most virile of its younger workers. Educated at Winchester and Caius College, Cambridge, he was appointed as zoologist in 1924 to be one of the original members of the scientific staff of the Discovery Committee set up by the Colonial Office to investigate the resources of the antarctic seas, particularly in regard to the factors, biological and physical, governing the great whale fisheries of those waters.

It was my privilege to be closely associated with Gunther on the R.R.S. *Discovery* on her voyage of 1925–27, on the smaller ship R.R.S. *William Scoresby*, and afterwards in the joint authorship of an extensive report upon the ecology of the antarctic plankton. He was a man of sterling qualities. Working with him day and night, often under the difficult conditions presented by the Southern Ocean, one was continually impressed by his deep sense of duty, his devotion to his work, and his tireless energy. His enthusiasm was always combined with a scrupulous regard for accuracy: both in the field and the working-up of data. After working at the nets and water-bottles for thirty-six hours on end, except for odd moments snatched for hurried meals, it was only the fear of being inaccurate in the readings and recordings, not fatigue itself, which persuaded him to rest. He had a love of the sea and the open life; he was a real deep-water oceanographer, with the determination to bring back results.

In 1931 on the R.R.S. *William Scoresby*, Gunther led a highly successful expedition to investigate the Peru Coastal Current (sometimes called Humboldt's Current) and published in 1936 a comprehensive report on its physical, chemical and biological aspects. Later he again visited the Antarctic on a whale-marking expedition to study migrations, and made valuable observations on the swimming and breathing habits of whales (a paper now in the press). Much of his time before the War was spent in working on the material collected during a trawling survey, partly carried out under his direction, on the extensive banks lying between the Falkland Islands and South America. It is to be hoped that all the work he put into this will eventually be published.

In addition to his wide interests in zoology and oceanography, Gunther was always delighted to record any unusual natural phenomenon; his recent letter in NATURE on the ice storm in Wiltshire is an example of this. Colour and scenery were a great joy to him, and he did splendid water-colour drawings, both sea and landscape, as well as accurate colour studies of marine animals. Many will treasure his privately printed "Notes and Sketches made during two years on the Discovery Expedition".

It was characteristic of Gunther's capacity for work that his long leave after the 1925–27 expedition should have been spent in the Department of Biochemistry at Cambridge, undertaking researches on the fatty and vitamin content of plankton (published in collaboration with G. Collin, J. C. Drummond and T. P. Hilditch). His published work, while extensive, is no real measure of his industry. He was always being attracted by side branches which he felt it his duty to explore, and only when he had carried them a long way did he realize he was being taken too far from the main issue; reluctantly they were put on one side for some later available time—alas, now no more.

In 1937, distressed by Great Britain's unpreparedness for war, Gunther joined the territorials as a sapper and was commissioned a year later. On inquiry about the best use a man of his training might be, he was advised to enter the searchlight service, and his keen powers of observation were of particular use in training spotters. He was born on September 20, 1902. In 1929 he married Dr. Mavis Carr and leaves a son and two daughters. He was essentially happy in his work and family life, and was devoted to both. He has been a worthy upholder of the tradition set by his father, his grandfather, Dr. A. G. L. G. Gunther, F.R.S., and his great-uncle, Prof. W. C. McIntosh, F.R.S.

A. C. HARDY.

Dr. Wilhelm Stekel

DR. WILHELM STEKEL, the well-known psychoanalyst of Vienna, who died in London on June 27, was born at Bojan in Bukowina on March 18, 1868. He received his medical education in Vienna, where he was one of Krafft-Ebing's pupils, and qualified in 1893. After some years general practice he devoted himself entirely to neurology and psychiatry. He was one of the first medical men to be interested in psychoanalysis, and from 1896 until 1912 when, like Adler, Breuer and Jung, he assumed his independence, he was one of Freud's chief supporters. He was a very prolific writer. His principal works, which were all translated into English, are "The Beloved Ego" (1921), "Psychoanalysis and Suggestion Therapy" (1923), "Peculiarities of Behaviour" (1924), "Disorders of the Instincts and Emotions" (1929–1930), and "The Homosexual Neurosis" (1933). From 1910 until 1913 he was co-editor with Freud and Adler of the *Zeitschrift für Psychoanalyse*, and in 1924 became editor of *Fortschritte der Sexualwissenschaft und Psychoanalyse*.

WE regret to announce the following deaths:

Prof. J. G. Dusser de Barenne, Sterling professor of physiology in Yale University, on June 9, aged fifty-five.

Mr. C. Rawson, head chemist of the British Cotton and Wool Dyers' Association during 1917–20, aged eighty-one.

Prof. D. Riesman, professor of the history of medicine in the University of Pennsylvania, on June 3, aged seventy-three.

NEWS AND VIEWS

Ideals of Democracy

MR. ROOSEVELT's broadcast, on accepting the nomination of the Democratic Convention for election to a third term of office as president of the United States of America, was inspiring in its note of lofty and patriotic self-sacrifice, no less than in its determination to maintain unswervingly in foreign policy the sympathy and moral and material support of all free peoples resisting the aggression, which has "wiped out ancient liberty-loving, peace-pursuing countries". Mr. Roosevelt contrasted the totalitarian States—"a relapse into ancient history"—with the democracy which can hold the votes of "the common people . . . only when it adequately respects their dignity by so ordering society to assure to the masses of men and women reasonable security and hope for themselves and their children". He went on to say that the democracies, both that in the United States and those still unconquered, "would never willingly descend to any form of that so-called security of efficiency which calls for the abandonment of other securities more vital to the dignity of man". Point is added to the clear-cut contrast by recent German propaganda culminating in the speech of Herr Hitler in the Reichstag on July 19. From these emerge a picture of Europe in the peace of the Chancellor's professed desire in which the non-Germanic peoples are the helots of a conquering caste—a reversion to the tribal domination of the Germanic migrations and invasions, which is the cardinal fact in Hitler's view of European racial and national history. It is well that he recognized that this conception of a European policy is so far incompatible with the ideals of democracy as to make inevitable the complete and final destruction of one or other of the two antagonistic systems.

Re-organization

WHILE it has been stated with every shade of emphasis and in constant reiteration that the democracies fight for freedom and justice, the need has been felt to counter German propaganda by a more concrete expression of the manner in which these ideals will be given effect in a post-War world. Although for the moment the immediate future is alone the matter of vital concern, yet science can afford, and indeed must, take a longer view even at this critical moment. The mistakes of the period immediately after the War of 1914–18, which sought to re-create a pre-War society that had for ever passed away, must not be repeated. The problems which will have to be solved after the present War must be approached with a complete change of heart from that of the vanished pre-War period. Narrow concepts of national self-sufficiency in political and economic relations will perforce have been dissipated. In their place the ideal for which we must strive with a burning enthusiasm more potent than the fanaticism to which Hitler attributes his present successes, is not merely our continued existence as a people. We must be prepared to sacrifice our all in the cause of the right of every individual man and woman to participate fully and freely in the duties no less than in the privileges of a world order based on mutual help and trust and not on force, a world in which the concept of the State has broadened into that of an instrument of the well-being of the individual citizen and not an overriding end in itself.

Man's Passion for Freedom

GENERAL SMUTS in his well-considered and judicial broadcast from South Africa on July 21, drew a favourable augury for the outcome of the coming attack on Great Britain from the indomitable spirit and unfailing courage of Allied troops in the withdrawal from Dunkirk. Against such a rock the waves of attack will beat in vain. It is, however, the spirit which informed the broadcast by Lord Halifax on July 22 which will bring victory—"the unconquerable passion of man for freedom". Hitler's policy he denounced as the gospel of hate, the policy of brute force, his message to mankind the enthralment of the human spirit under ruthless tyranny. It is perhaps permissible to suggest here that the fanaticism of Germany's irruption over the peoples of Western Europe admits a second comparison with 'ancient' history—the great fanatical spread of Islam. Then in east and west, in Spain and in Palestine, it fell to the peoples organized under the banner of Christianity to turn back the tide of invasion of an alien faith. The present war also is a struggle of the *spirit* of Christianity against the brutal force of paganism. As Lord Halifax said, "We must march together in this crusade for Christianity. We and our great Dominions oversea stand, and shall continue to stand, four-square against the forces of evil".

Advisory Research Council of the Chemical Society

THE Advisory Research Council of the Chemical Society (A.R.C.C.S.) still finds itself unable to suggest work of national importance to all of the large number of chemists who have volunteered their services, although more than a hundred topics have already been allocated. Hence it would be appreciated if research committees under Government auspices could make known to the Council the existence of chemical problems just below the level of priority which justifies the expenditure of public funds in the attempt to find a solution. There is in particular a dearth of worth-while problems of a physico-chemical nature.

At its last meeting the A.R.C.C.S. decided to interpret its functions in an elastic manner, and it is now prepared to organize the preparation, in laboratories of universities and technical colleges, of fine chemicals required for any purpose by Government departments, institutions or services or even for approved research purposes in other universities. It is a *sine qua non* that such substances are not available commercially and that the manufacturers of fine chemicals are unable, or do not find it convenient, to meet the need. The arrangement proposed is that the substances shall be made and supplied on a cost price basis, and it is understood that purchases made in this way will require no special Treasury sanction, being in fact acquisitions to stores. The secretary of the Advisory Research Council is Mr. S. E. Carr, Chemical Society, Burlington House, Piccadilly, London, W.1.

Registration of Chemists

COMPULSORY registration on the Central Register of the Ministry of Labour, which was applied last week to engineers, has now been extended to chemists, physicists, and quantity surveyors. The order referred to all possessing a science degree of a university of the British Empire including chemistry or physics and, in certain circumstances, those who passed the corresponding intermediate examination, or have similar standing in these subjects; also to those who have received training as quantity surveyors. These registrations will supplement the names of those already voluntarily on the Central Register.

Physical Problems in Industry

IN order to assist professional men who in the present emergency find themselves presented with technical problems in applied physics of which they do not happen to have had previous first-hand experience, it has been decided to extend the facilities of the Institute of Physics' panel of consultants. Through this medium inquirers are put into touch with those physicists most likely to be able to offer immediate practical suggestions in any particular case. In the first instance the contact is quite informal; subsequent arrangements are a matter for private agreement between those concerned. The subjects which can be dealt with cover all branches of physics, both pure and applied, including, for example, physical measurements and testing, the design and supply of scientific instruments for special purposes, and the control of processes by physical means.

By acting as a clearing house in this way and supplementing existing official and unofficial organizations, it is hoped to help in the national effort by directing attention to existing solutions of difficulties which, while appearing to be new problems, are often already well-known in other fields. A typical example will serve to illustrate this point. A recent inquiry related to possible means of measuring the flow of certain animal secretions having complex physical properties, which prevented the use of more usual methods. It happens that certain printing inks have somewhat similar properties, and an informal introduction to a physicist in that industry has proved of great assistance. Inquiries about this scheme should be addressed to the Secretary of the Institute of Physics at the University, Reading.

The B.P. Standard for Ipecacuanha

FURTHER modifications in monographs of the British Pharmacopœia have been effected by way of notice in the *Gazette* of July 5. The chief one is an alteration in the standard for the alkaloidal content of ipecacuanha. The direction in the B.P. 1932 requires the root to contain not less than 2 per cent of the total alkaloids of ipecacuanha, calculated as emetine, of which not less than two thirds consists of non-phenolic alkaloids, calculated as emetine; the change now made is the substitution of "three fifths" for "two thirds". Although the reduction in the standard is but slight, it will have a marked effect upon the availability of a drug which is regarded by the medical profession as an extremely important one, whether prescribed in the form of Galenical preparations, or as its alkaloid emetine, which is a specific in tropical dysentery. The 1932 test excluded from official recognition large importations of the root from Bahia and Minas Geraes, eastern States of Brazil, and virtually restricted the source of the standard drug to the western State of Matto Grosso. With the requirement as to the alkaloidal content reduced by a fifteenth, a substantial proportion of the shipments from the eastern States of Brazil will now conform to the B.P. standard. Thus the security of ipecacuanha root will be relieved and a reduction in the cost may be expected.

Air Raid Precautions

FOLLOWING the issue of the popular pamphlet "Your Home as an Air Raid Shelter", of which more than 700,000 copies have been sold, the Ministry of Home Security has now issued a second pamphlet called "Air Raids: What You Must Know: What You Must Do". This pamphlet is a complete 'potted' A.R.P. course for the general public. It tells the ordinary man and woman everything he can need to know for the protection of himself and his family in air raids, and to enable him to help his neighbours. It deals with such subjects as protection against bombs, behaviour during and after a raid, how to deal with incendiary bombs and war gases, and contains a simple first aid course. It tells the householder all about the warning system, how to make repairs to his house after a raid, and contains a wealth of practical information on all these subjects. The book is fully illustrated with photographs and diagrams. It can be obtained through any newsagent, price 3*d*., or price 4*d*., including postage, from the Stationery Office, York House, Kingsway, London, W.C.2. The pamphlet will be invaluable to members of factory and other A.R.P. squads.

Utilization of Aliens in National Work

SIR JOHN ANDERSON, Home Secretary, in a written answer to a question in the House of Commons on July 18, stated: "I have already given instructions to the police which I hope will prevent the internment of specialists or 'key' workers engaged in connexion with Government contracts or essential export trade. If in any individual case such a person should nevertheless be interned, it is open to his firm to make representations to the appropriate Government Department, and I am always ready to consider the question of releasing any internee who is certified to me by a Government Department as willing and able to render services of importance to the community."

Czech Culture under German Rule

DR. BENEŠ has written a restrained but authenticated account of some of the Nazi crimes in a pamphlet (London: Allen and Unwin. 6*d*.) which has just appeared. It was the pride of the Czech nation that its culture, bound by numerous traditional ties with Britain and the West, was acknowledged by the whole civilized world. Now, after more than a year of German occupation, relics alone remain. The Nazis have attacked all sections of cultural life in an attempt to destroy the fundamentals of Czech national ideals. Besides the universities and colleges, many schools are closed and modern educational buildings used as barracks, so that the education of Czech children is impossible. The dictum of the Nazi commissioners is that "for the Czechs as an *Arbeitervolk* elementary schools are sufficient". These serve for mass Germanization. School books have been "revised", and new ones with Nazi theories are systematically imposed upon the nation.

Meanwhile, twenty thousand students have been driven from their lecture rooms, and those employers who tried to alleviate their lot by giving them employment have been punished. Scientific equipment has been destroyed, valuable libraries wrecked and books and volumes of scientific journals burned or at best carried off to Germany. Results of years of research by Czech professors lie as rubbish on the floors of the lecture rooms and laboratories. The professors (some hundreds) and their assistants (about a thousand) were not allowed to take even their private possessions and note-books from their rooms; many have been sent to concentration camps and others given minor duties in administrative offices for which they were not fitted. The pamphlet merits the attention of learned men throughout the world and should arouse them to the danger now facing civilization.

Seasonal Mortality in England and the United States

SEASONAL variation of mortality has long been a fact of common knowledge, and its cause the subject of speculation. The maximum invariably falls in the first quarter of the year and the minimum in the third quarter. The difference between the two quarters is considerable; in 1931–35 the maximum was 60 per cent greater than the minimum. Is there any way, it may be asked, of reducing this difference, or is the winter excess due to causes of death over which at present we have little means of control? A comparison of the mortality figures of England and Wales with those of the United States shows that the winter peak is higher in the former, although in summer they fall to a lower point than the United States figures.

This seasonal difference of mortality in the two countries has been the subject of a detailed statistical study by Dr. Lewis-Faning (Medical Research Council, Spec. Rep. Series, No. 239. H.M. Stationery Office, 1940. 1*s*. net). He reaches the conclusion that the winter disadvantage and the summer advantage of Great Britain are not due to climatic factors only, but are both also dependent, at least in part, on factors of mortality preventable in some degree. Thus, the main contributors to the British unfavourable winter balance are influenza, respiratory tuberculosis, bronchitis and pneumonia, and it has long been held that the last-named is at least partially preventable. The two most important contributors to our summer advantage are diseases of the heart and deaths from violence. The former shows a large decline in summer in both countries, the latter reveals no decided seasonal variation in Great Britain but a large summer rise in the United States. The relatively high rate of mortality from this cause in the United States is clearly one that may be open to attack.

Cambridge University Botanic Garden

BOTANICAL gardens contribute living interest to the teaching of plant science, and it is significant that their development began in the earliest days of the study of botany. The University of Cambridge was not one of the first bodies to recognize the value of providing living plants for study, but it had some early associations with botanical science. Mr. F. G. Preston has published an interesting paper on the history of the gardens now under his charge (*J. Roy. Hort. Soc.*, 65, Pt. 6, June 1940). The famous Gerard attempted to establish a botanical garden at Cambridge in 1588, but without success. John Ray studied the Cambridgeshire flora, and later handed his mantle to the University's professor of botany, John Martyn, who extended the floral studies to other counties, and lived to see the first botanic garden at his University. In 1762, Dr. Walker, vice-master of Trinity College, obtained about five acres of land, on the advice of his friend, Philip Miller of Chelsea. The garden remained in poor condition until 1831, when Prof. Henslow was successful in obtaining the present site, and transferred the plants to their new surroundings. The names of Babbington, Lynch, Marshall Ward and Sir Albert Seward show to what extent the directors of the garden have contributed to the development of modern science, and in more recent times W. Bateson and Prof. R. C. Punnett have worked there. Development after the War of 1914–18 was along the lines of closer contact with the teaching of botany, and was associated particularly with the names of Reginald Cory and Humphrey Gilbert-Carter.

Accessions to the Fitzwilliam Museum, Cambridge

THE annual report of the Fitzwilliam Museum, Cambridge, for the year ending December 31, 1939, includes in a considerable list of accessions in the period a number of no little archæological interest and importance. Among these a bequest of an Egyptian bronze cat of the Twenty-sixth Dynasty by the late Claude G. Montefiore is said to be "the best of the type in the department". A steatite figure of Amen-ra and a hæmatite amulet of Ta-urt given by the director (Mr. L. G. C. Clarke) were the only further additions to the Egyptian antiquities apart from a valuable collection of choice specimens given by Mr. G. D. Hornblower. Mr. Hornblower was also the donor of two Chinese paintings on silk, a makimono and a sketch-book by Hokusai, another Japanese sketch-book, two Persian miniatures and a Coptic iron cross.

The Oriental Department also received some notable examples of Chinese ceramic art made specially for export, among these a porcelain bowl made for the Siamese market, given by Prof. Ellis H. Minns, of Pembroke College, and from the Hon. Lady Darwin another porcelain bowl which had been made for the European market, while an unusual punch bowl, intended for the same destination, was bequeathed by the late Lieut.-Colonel K. Dingwall. A Kutahia cup was a donation from Prof. Percy E. Newberry. In the Greek and Roman Department the most important acquisition was a fine south Italian bronze cinerary urn of the late sixth century B.C., purchased at the W. R. Hearst sale out of the Greek Antiquities Fund. Miss Winifred Lamb, honorary keeper of the Department, presented a Falisean skyphos of the fifth or fourth century B.C.

British Museum Library Extension

THE 'Iron Library' extension, which is now being completed at the British Museum, London, by H.M. Office of Works, is an interesting development in the introduction of welded steel work. The present structure is in the nature of an innovation, as it is the first example of an all-welded structural frame to be adopted by the Office of Works. The main factors influencing this decision were the greater neatness of the welded joint and the saving in head-room which it permits. It was designed to augment the bookshelf capacity of the Library. The extension occupies the north-east quadrant of the rectangular plot surrounding the historic Circular Reading Room and replaces a part of the existing structure of wrought iron and timber. In *Electric Welding* of May 1940, published quarterly by the Quasi-Arc Co., Ltd., of Bilston, Staffs., an instructive technical description, with photographs, is given of the building during the process of construction. Messrs. Dorman Long and Co., Ltd., are the constructors for the structural steel-work. They prepared and rolled the special sections ; more than 500 tons of steel-work were necessary. Each welded joint was made in three runs from a No. 10 gauge electrode. The total number of welds in the structure exceeds 60,000. The welding has been carried out with a maximum of ten operators, who between them have used about 47,000 quasi-arc electrodes. The necessary welding current was drawn from quasi-arc Diesel, petrol and transformer units.

Meteorology in Southern Rhodesia

THE meteorological report for Southern Rhodesia for the year ended June 30, 1939, by R. A. Jubb, acting chief meteorologist, is dated January 1940, but follows the general lines of those of pre-War years. Seasonal forecasts of rainfall of the type made by Sir Gilbert Walker, based on past departures from normal of meteorological elements in selected action centres in other parts of the world, were continued, and were very successful in this year. The average rainfall over Southern Rhodesia during those months that correspond roughly with the winter of 1938–39 in the northern hemisphere, that is, Southern Rhodesia's summer rainfall of 1938–39, was forecast as 11·8 in. above normal ; actually it proved to be 12·2 in. above normal. This was the third year in succession during which the method was strikingly successful, and it is easy to believe that, as stated in the report, the forecasts are being found to be of practical value ; there appears to be no sign that the correlation coefficients on which the forecasts are based are becoming smaller, as is sometimes the case after a considerable number of years of high correlation, for the least successful forecasting period of three years ended four years earlier. In Southern Rhodesia rain is of paramount interest, and it is satisfactory to note that whereas thirteen observing stations closed down, the number of new stations was forty-one.

Map of the Karakoram

A NEW map of the Karakoram has been published by the Royal Geographical Society (7*s*. 6*d*. or R. 5). Produced under the direction of Prof. K. Mason, it incorporates all published results of exploratory work up to Mr. E. Shipton's expedition of 1937. The scale is 1 to 750,000 and the size of the sheet is about twenty by twenty-three inches. The great altitude range from about 3,000 ft. to 28,000 ft. presented a difficult problem in representing relief. The layer colour system had to be abandoned. The contours in a region of such high relief are too close and the tint of the layer merged into the colour of the contour line. Moreover a satisfactory scheme of colour could not be found. Hill slopes are shaded with brown and purple on a general ground tint of yellow and generally the shading is cast from the north-west, but the direction varies slightly to suit the slope of the ground. Blue shading is used for snow and glaciers are white. Valleys have a layer tint of greyish-green. There are altogether eight colours and the map is a most effective piece of work. Heights are given in feet and the names employed are those decided on by the Karakoram Conference of 1937 and approved by the Surveyor-General of India.

Metal Water-Jet Pump

ALTHOUGH metal filter-pumps have been in common use for some time, the majority were imported. A new model developed and produced in Great Britain is now available. Metal filter-pumps are unbreakable and easily cleaned. In addition, the jet of the new model has been re-designed so that a high pumping speed can be reached even with pressures as low as 15 lb. in the water supply. Under suitable conditions, pressures of 15 mm. or less of mercury are reached. The new pump should therefore prove of great service in general laboratory work involving distillations, filtrations or aerations and in hospital and surgical work. The pump and further details can be obtained from Messrs. W. Edwards and Co., Ltd., Southwell Road, London, S.E.5.

Physic and Literature

UNDER the title of "Books about the Doctor in Physick and Literature", Schuman's of 738 Fifth Avenue, New York, have published an annotated spring catalogue consisting of five parts devoted respectively to medicine in literature, medical biography, history of medicine, medical portraits and Beaumont lectures. The first part, which will probably appeal to the largest number of readers, contains a long list of *belles lettres* which have reference to medicine, including in alphabetical order Aristotle's masterpiece, Balzac's "Médecin de Campagne", Sir Thomas Browne's "Urn Burial", Burton's "Anatomy of Melancholy", Casanova's "Mémoires", Defoe's "Journal of the Plague Year", Pepys's "Diary", plays of Shakespeare, and Voltaire's "Candide". The relation of medicine to art is represented by Leonardo da Vinci's drawings and the works of Eugen Holländer. The works on medical biography include those of Bland-Sutton, Jerome Cardan, Harvey Cushing, Sir Henry Holland, Edward Jenner, William MacMichael and Thomas Young. Under the heading of medical history we find works by Allbutt on Greek medicine in Rome, Donald Campbell and Leclerc on Arabian medicine, W. G. Black on folk-medicine, Sir Michael Foster on the "History of Physiology during the Sixteenth to Eighteenth Centuries", August Hirsch on "Geographical and Historical Pathology", Osler on the "Evolution of Modern Medicine", J. F. Payne on "English Medicine in the Anglo-Saxon Times", and histories of medicine by Max Neuburger and Sudhoff.

Earthquake in Tibet

ON July 15 an earthquake of considerable severity accompanied by floods was reported in *The Times* to have caused havoc in the Chumbi Valley in southern Tibet. Villages from Yatung southwards suffered considerable damage, and the telegraph line from Yatung to India over a distance of six miles has been destroyed. All the bridges over the Amachu River have been demolished and, in all, two hundred people are believed to have perished. The epicentre appears to have been near lat. 27·5° N., long. 89° E., which is a little to the south of the epicentre of the strong earthquake of January 3, 1935, and to the south-west of that of January 7, 1937.

Earth Tremors in Great Britain

ON Sunday, July 14, at about 11.59 p.m. B.S.T. a slight earth tremor was felt in Birmingham, Coventry and Leicester. No damage was done. The epicentre was probably just to the north of Coventry. Earth tremors appear to be slightly more frequent in an area somewhat to the north of Leicester, that is, nearer to Nottingham, where one was experienced on May 3, 1935, though one was felt at Birmingham on October 23, 1924. On July 16 at about 5.35 p.m. B.S.T. an earth tremor lasting several seconds was felt very strongly in the Denny district of Stirlingshire and for some miles around. In the epicentral area, a man is reported to have been thrown from his chair. The shock threw crockery from shelves and moved chairs and desks in Glasgow offices; it was felt more strongly at the top of high buildings than in the street below. No serious damage has been reported. Slight earth tremors are very occasionally felt in this district, though the area most affected by earth tremors in Scotland is near Comrie in Perthshire, where the British Association has shock recorders in action. Both the recent Coventry and Denny tremors were probably caused by slipping along local fault systems.

The Night Sky in August

NEW moon occurs on August 3 at 20h. and full moon on August 17 at 23h. U.T. The moon is in conjunction with Mercury on August 2, with Saturn and Jupiter on August 24, and with Venus on August 29. Jupiter and Saturn rise after 22½h. at the beginning of the month and shortly after 21h. at the end, the two planets remaining within 1½° of each other. Although conjunction between them occurs on August 15, their closest approach (1·2°) is on August 7. Venus is the brilliant morning star, at greatest brilliancy on August 2, when it rises shortly before 1h. 45m. U.T. At the time of conjunction with the moon on August 29, it may be looked for in daylight north of the moon. A telescopic view of the planet will show it to be crescent-shaped throughout the month. Mercury, an elusive object at most times, should be easily seen in the east before sunrise, especially on August 10 when it reaches its greatest elongation (19° west). On August 10–12, the Perseid meteors reach their maximum frequency. Their radiant point moves from Andromeda to Camelopardus. The Milky Way and its associated constellations, rich in interesting objects for telescopic or binocular study, is well placed near the meridian after dark, especially towards the end of August, when the moon does not rise until the early morning.

Announcements

DR. WILLIAM W. WATSON has been appointed professor of physics in Yale University, in succession to Prof. John Zeleny, who retires this year.

THE degree of D.Sc. has been awarded by the Queen's University, Belfast, to R. C. Pink (chemistry) and C. T. Ingold (botany).

THE National Council for Mental Hygiene, 76 and 77 Chandos House, Palmer Street, London, S.W.1, has arranged for a conference to be held on July 30 at the British Medical Association House, Tavistock Square, W.C.1, to discuss psychological problems arising out of war conditions as they affect the teacher.

THE first volume in Braille dealing with botany has been prepared from a series of broadcasts on "Botany for the Amateur" made in the United States by Miss Jesse Fiske, State seed analyst of the New Jersey Experimental Station, New Brunswick.

LETTERS TO THE EDITORS

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

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

Influence of Substitution on Organic Bond Strength

ATTEMPTS to establish the strength of organic bonds by studying the rate of decomposition of gaseous compounds have been made with success by F. O. Rice[1], but no systematic information on the influence of substitution on bond strength has been obtained. The problem was approached by R. A. Ogg[2] by a study of the breaking of the carbon – iodine bond in various compounds, and the present results were obtained in pursuing the same line by a new method. The vapour of the iodides at low pressure (0·01 mm.) and diluted with a carrier gas (6 mm. nitrogen or hydrogen) was passed through a tube maintained at 300–500° C., and the products were condensed and analysed for iodine and hydrogen iodide.

The assumption from which we started, that the rate-determining process is the unimolecular disruption of the CI bond, was confirmed for ethyl iodide by varying the experimental conditions ; in the other cases, however, it could only be shown that the rate of bond breaking was the main factor. Nevertheless, the large variation in the rates of decomposition (10,000 fold at 430°) justifies a comparison of C – I bond strength from the relative decomposition rates. The bond energies tabulated below were calculated from the approximate relationship

$$\log k = -Q/RT + 13,$$

using the values of k for the lowest temperature at which measurement was possible, the other conditions being comparable for all the iodides.

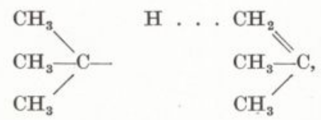
Iodide	Suggested bond energy	
Ethyl	52·5 kcal.	
Vinyl	56·6	Partial double-bond character.
Phenyl	54·0	
Allyl	39·0	Radical degeneracy
Benzyl	44·0	
Acetonyl	45·5	
t-Butyl	45·1	
Benzoyl	44·5	
Acetyl	(50·7)	

Taking ethyl iodide as our zero of reference, we note the manifestation of partial double bond character in vinyl iodide and in phenyl iodide, which is to be explained by a degeneracy of the type[3]

$$H_2C = CH - I \qquad H_2\overset{-}{C} - CH = \overset{+}{I}.$$

On the other hand, benzyl, allyl and acetonyl iodides clearly indicate the degeneracy of the free radical resulting from conjugation of the unshared electron with the double bond or the benzene ring.

These two effects appear to affect jointly the C – I bond in benzoyl iodide which is weakened, but to a lesser extent than in benzyl iodide. The somewhat uncertain value for acetyl iodide may be left undiscussed ; but attention should be directed to the strong reduction in bond strength in t-butyl iodide. This points to a degeneracy of the free radical of the type



in which the representation containing the double bond is present in nine different forms, as compared with only three forms of this type resonating in the ethyl radical[4].

The magnitude by which the bond strength appears to vary in our experiments is of the order which might be theoretically expected. For example, in the case of allyl iodide and benzyl iodide the resonance energies of the radicals were calculated at 15·4 kcal.[5] and 15 kcal.[6] respectively, while our experiments indicate values of 13·5 kcal. and 9 kcal. The agreement would be improved if the resonance energy of the ethyl radical which might amount to 2–3 kcal. were taken into account.

As regards our absolute values, we note that the average bond energy attributed to C – I of about 45 kcal. is based on a C – H value of about 87 kcal.[7] On the other hand, all estimates agree that the energy required to break the first C – H bond in methane is more than 95 kcal.[8] and that in consequence C – I in methyl iodide is at least 53 kcal. This disagrees with the value of 43 kcal. found by Ogg[9] for methyl iodide, as well as for ethyl and n-propyl iodides, and lends support to our result of 52·5 kcal. for ethyl iodide.

E. T. BUTLER.
M. POLANYI.

The University,
Manchester.

[1] Rice, F. O., *et al.*, *J. Amer. Chem. Soc.*, **54**, 3529 (1932) ; **55**, 4245 (1933) ; **56**, 214 (1934).

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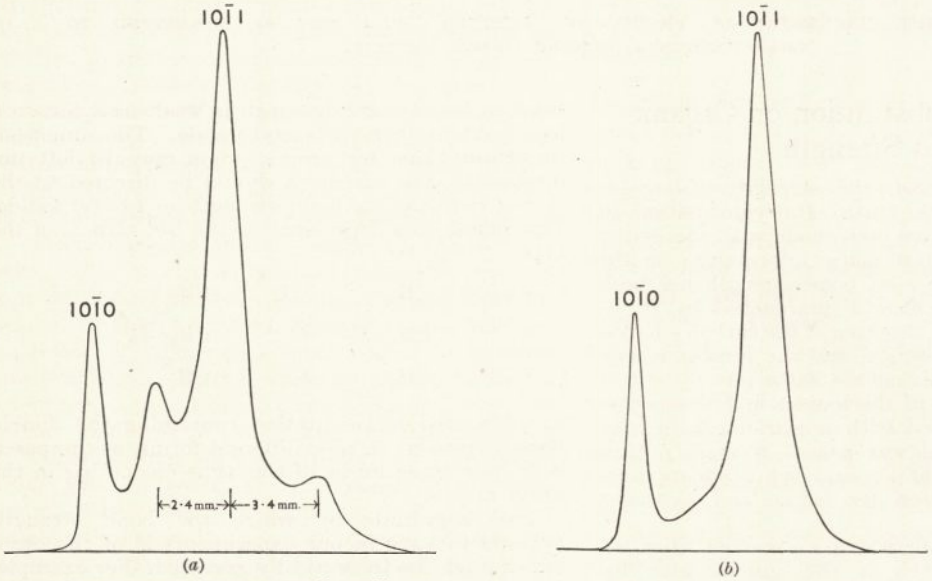
Anomalous Diffractions in the Hull-Debye-Scherrer Spectrum of Graphite

IN the course of an electron diffraction study of several graphites, Finch and Wilman[1] discovered a number of extra diffractions which could not be indexed in the normal way on the basis of the accepted crystal structure of graphite[2]. Of the extra diffractions, two embracing the $10\bar{1}1$ reflexion are



MICROPHOTOMETER CURVES, $10\bar{1}0$–$10\bar{1}1$ GROUP, FOR CEYLON GRAPHITE (*a*) CLEANED WITH HYDROFLUORIC AND HYDROCHLORIC ACIDS, (*b*) CLEANED WITH HYDROFLUORIC AND HYDROCHLORIC ACIDS, AND 30 HOURS IN CONCENTRATED SULPHURIC PLUS NITRIC ACID MIXTURE.

clearly observed and cannot easily be accounted for. Because these extra lines occurred with graphites from very different sources, Finch and Wilman concluded that the possibility of impurity could be ruled out. Their main conclusion pointed to the presence of packets of planes with a thickness of 4 unit cells (or 9 layer-planes), in the direction of the *c*-axis. This would enable lines with fractional l indices to appear, because by analogy with a ruled grating with a few lines, the subsidiary maxima would begin to have the same order of magnitude as the principal diffractions. Thus the lines on either side of the $10\bar{1}1$ would seem to be $10\bar{1}\frac{2}{3}$ and $10\bar{1}\frac{4}{3}$.

We have repeatedly observed the extra lines with X-rays using a great variety of natural and artificial graphites. They are *not* a phenomenon entirely associated with the electron diffraction method. With cobalt K_α radiation, a Debye-Scherrer camera 19 cm. in diameter of the Bradley type, and a fine cylindrical specimen 0·3 mm. in diameter, very high resolution of these extra lines is obtained (Fig. *a*). The fact that all the spectra are reasonably sharp and no cross-grating spectra occur indicates that the graphite crystals are at least of the order of 1,000 A. in size. Careful cleaning of the graphite until the ash was zero failed to influence the intensity of the extra lines, so that the effect of impurity could be discounted. Only a very special chemical treatment affects the graphite. After all the inherent impurities have been removed by the usual methods, the graphite is wet-oxidized in a heated mixture of concentrated nitric and sulphuric acids in a 2 : 3 ratio by volume for 24 hours. This reduces the extra lines to almost zero intensity, but the other spectra remain unchanged (Fig. *b*). No other acid combination appears to work except concentrated sulphuric acid, which required more than 400 hours to produce the same effect.

The extra diffractions may arise from the dynamic stratification of the crystals in the manner suggested by C. V. Raman and P. Nilakantan[3], who observed extra spectra in the Laue photograph taken along the trigonal axis of diamond. Similar anomalies in Laue photographs have since been reported[4]. The wet oxidation treatment may reduce the size of the crystallites (although still bigger than 1,000 A.) so that the dynamic stratification becomes unstable because of edge effects and the extra lines are unable to appear. To some extent the dynamic stratification is analogous to the static packets of planes 4 unit cells deep as suggested by Finch and Wilman. It would be interesting to see if the dynamic stratification theory can be applied quantitatively to the appearance of these extra Debye-Scherrer reflections.

A. TAYLOR.

Magnesium Elektron Ltd.,
Clifton Junction,
Nr. Manchester.

D. LAIDLER.

King's College,
Newcastle-on-Tyne.

[1] Finch, G. I., and Wilman, H., *Proc. Roy. Soc.*, A, **155**, 345 (1936). *Erg. exakt. Naturwiss*, **16**, 353 (1937).
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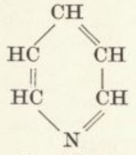
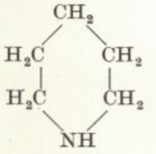
Nature of the Feulgen Reaction with Nucleic Acid

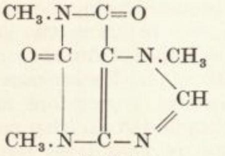
DURING the course of investigations into the probable chemical constitution of the nuclear contents in plants, many observations have been made in addition to the nucleolar staining reaction. Under existing conditions, it seems improbable that a full description of this work can be made for some time, and a note on an apparently significant point is offered here in the hope that it may lead to further useful developments.

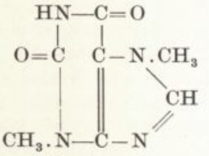
The use of the Feulgen nucleal reaction in connexion with cytological technique is proving to be of considerable importance for critical work. It is, of course, well known that this modified Schiff's reaction, now used with such marked success as a selective chromatin stain, is by no means specific for the HC : O group characteristic of aldehydes. While it is generally stated that the colour reaction is due to the available aldehyde group of the aldose in hydrolyzed nucleoprotein, it does not appear to have been previously reported that the leuco-base of fuchsine is also immediately restored to its original colour by such heterocyclic compounds as pyridine and piperidine.

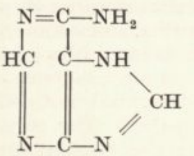

Pyridine

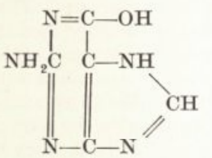

Piperidine

The significance of this observation in relation to the possible behaviour of the purine constituents of nucleoproteins will be at once apparent. Several tests were made on caffeine and theobromine with controls. The typical magenta colour was obtained with these after varying periods of time with different samples and preparations of leuco-base. Caffeine (Kahlbaum) gave a slight magenta colour after 5 minutes and a deep colour after 6 hours ; theobromine (B.D.H.) similarly gave a magenta colour after a few minutes, which deepened after standing. It was apparent from this that adenine and guanine should also produce a magenta colour with the fuchsine.


Caffeine


Theobromine


Adenine


Guanine

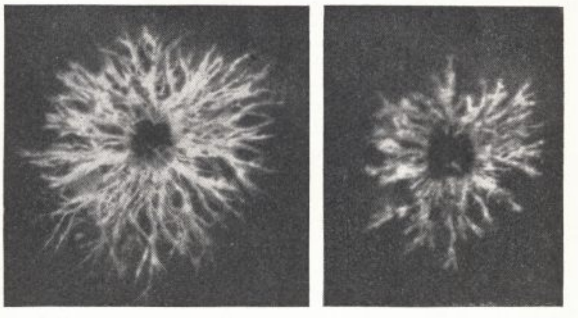
The probability was tested, using material supplied by the British Drug Houses, Ltd., and positive results were obtained, the characteristic colour appearing after 2–3 hours.

Generally, attention has been given primarily to the pentose constituent of nucleoprotein ; but the matter seems to require further consideration. Tests with other components of a nuclear extract may, of course, be affected by the presence of traces of pentose, but the possibility of the reaction with chromatin being given by the purines seems to be strongly indicated by the positive reactions obtained with pure, redistilled pyridine. The peculiar specificity of the Feulgen reaction for the chromatin complex of plant and animal nuclei seems to become somewhat clearer in the light of these observations.

C. S. SEMMENS.
King's College,
University of London
(at Bristol).
July 3.

Response of Isolated White Chromatophores of Crustacea to Change of Illumination

IT is now generally accepted that the movements of pigment in the light-absorbing chromatophores of decapod Crustacea are controlled by the secretion or secretions of some tissue in the eye-stalks. In addition, many species possess chromatophores which contain a white light-reflecting pigment, the movements of which continue after the eyes and eye-stalks have been amputated. Therefore, it has been suggested that some tissue in the rostral region may affect these white chromatophores, by a secretion which is released in darkness under the control of some exteroceptor other than the eyes[1,2]. However, the results of injection experiments have indicated[3] that the diurnal movements of the white pigment are not under hormonal control, but that the white chromatophores behave as 'independent effectors'[4].


(a) (b)

(a) AN ISOLATED WHITE CHROMATOPHORE OF *Leander serratus*, IMMERSED IN A SOLUTION CONTAINING SODIUM CHLORIDE, CALCIUM CHLORIDE AND EYE-STALK HORMONE, UNDER ILLUMINATION.

(b) THE SAME CHROMATOPHORE AS IN (a) AFTER ONE HOUR IN DARKNESS.

To test the validity of the latter theory, portions of the carapace of *Leander serratus*, bearing one or two white chromatophores, were immersed in saline media, and examined under various conditions of illumination. Quantitative estimation of the pigment movements was obtained by measuring the diameter of the pigment masses with a micrometer scale. Two measurements were made at right-angles to one another.

In sea-water, isolated white chromatophores attained maximal expansion in a few minutes, but did not afterwards contract when they were placed in darkness. In the body-fluid of *L. serratus*, however, the isolated white chromatophores of this species expanded in light, contracted in darkness and later re-expanded when they were returned to the light. It has been shown[5] that the blood of *L. serratus* is hypotonic to sea-water and has an osmotic pressure which is maintained at a value equivalent to 2·6–2·9 per cent sodium chloride. Therefore, in subsequent experiments, the chromatophores were studied in media which were approximately isotonic to the blood of *L. serratus*.

In a sodium chloride solution the chromatophores contracted in darkness but failed to re-expand under illumination. However, when the chromatophores were placed in solutions containing calcium ions (see

THE CHANGE IN SHAPE OF SINGLE CHROMATOPHORES.

Each reading represents the mean diameter of 6–12 chromatophores. The diameter of each chromatophore was first recorded in light, later after the chromatophore had been one hour in darkness, and finally after the chromatophore had been re-exposed to illumination for one hour.

Medium	Diameter of chromatophores in μ			Percentage contraction	Percentage re-expansion
	Light 1 hr.	Dark 1 hr.	Light 1 hr.		
NaCl (2·7%)	635	508	508	30·9	0
$CaCl_2$ (3·4%)	612	425	537	35·6	19·3
NaCl (2·0%) + $CaCl_2$ (0·85%)	629	316	374	49·7	15·5
NaCl (2·0%) + $CaCl_2$ (0·85%) + eye-stalk hormone	578	316	527	45·5	40·0
Leander blood	1248	749	1105	39·9	32·2
Chromatophores of intact animals	645	305	645	52·5	52·5

table), they contracted in darkness and re-expanded under illumination. The time the chromatophores took to contract when isolated was similar to that taken in the living animal. The addition of small amounts of potassium or magnesium ions did not affect the movements of the white pigment. (The importance of calcium ions in the responses of chromatophores has already been emphasized[6].) The response of the isolated white chromatophores to change of illumination was improved by the addition of a small amount of eye-stalk extract (equivalent to 1/400 eye-stalk per ml.) to the medium. The sensitivity to change of illumination was maintained for a longer period in this way. Even so, in the majority of cases the chromatophores lost their capacity to respond after they had been removed from the body for six hours, though in exceptional cases a response was obtained after twenty-four hours.

The white chromatophores of *L. serratus* are therefore independent effectors able to change their shape without either nervous or humoral control.

F. G. W. KNOWLES.

Marlborough College,
Wilts.

June 12.

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[2] Brown, jun., F. A., *J. Exp. Zool.*, **71**, 1 (1935).
[3] Knowles, F. G. W., *Pub. Staz. Zool. Nap.*, **17**, 174 (1939).
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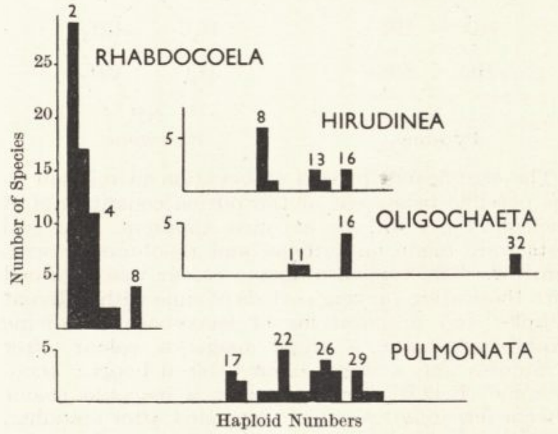
Evidence for Polyploidy in the Hermaphrodite Groups of Animals

IT is now well known that a large number of species of higher plants are polyploids, and it is reasonable to infer that polyploidy has been one of the main evolutionary methods of species formation in the angiosperms. In animals a few instances of polyploidy are known in parthenogenetic forms (for example, in the Crustaceans Artemia[1] and Trichoniscus[2], the moth Solenobia[3] and some of the weevils[4]). Apart from these cases where polyploidy is associated with a complete abolition of the sexual process, there is little evidence for its existence in animals. It was pointed out by Muller[5] that polyploidy could not be expected to occur in groups of bisexual animals, since it would upset the sex-chromosome mechanism. In groups of hermaphrodite animals, however, there seems no *a priori* reason why polyploidy should not be one of the methods of species formation, just as it is in plants. In order to determine whether this is so, I have collected all the available chromosome numbers for the four main groups of hermaphrodite animals (Platyhelminthes, Oligochæta, Hirudinea and Pulmonate Mollusca). After eliminating early determinations which must be regarded as unreliable, the remaining data were plotted in the form of the accompanying histograms. In the case of the Platyhelminthes only the data for the Rhabdocœla were utilized, since very few chromosome numbers are known for the other classes of that phylum.



DATA DERIVED FROM VARIOUS AUTHORITIES

In the Rhabdocœla there is some definite evidence for the occurrence of polyploidy. Thus in the genus Mesostoma one species has a haploid number of 2, six of 4, one of 5 and one of 8. In Phænocora one species has a haploid number of 3 and one of 6. Actually, out of 65 species included in the graph, 17 are possible polyploids, that is, they have haploid numbers which are multiples of numbers known elsewhere in the group. The actual number of polyploid species is probably less than this, since some will have 'multiple' numbers without being polyploids.

In the Pulmonata there is no evidence of polyploidy. Of the 29 species in the graph not a single one could be a polyploid of any other. The only possible exception is *Helix pomatia*; the haploid number of this species was variously stated by the earlier authors as 12, 18 or 24. Actually it seems to be 27, and the early accounts were almost certainly inaccurate[6].

In the Hirudinea and Oligochæta relatively very few chromosome numbers have been determined. In both groups there are two possible polyploids (those with a haploid number of 16 in the Hirudinea and those with a haploid number of 32 in the Oligochæta). Until more cytological work has been carried out on these two groups it would, however, be premature to draw conclusions from the meagre data available.

We must therefore conclude that polyploidy has not occurred in the hermaphrodite groups of animals to anything like the same extent that it has done in most of the families of higher plants. In one group (the Pulmonata) it seems not to have occurred at all, while in the other three it has probably played only a minor role in species formation. It is possible that some special genetical barrier to polyploidy exists in animals; one could imagine that polyploid animals might be less viable than diploids owing to their cell-size being ill-adjusted to the increased chromosome number. Alternatively it is possible that although polyploid individuals may have arisen from time to time, they have not given rise to polyploid races or species owing to the rarity of self-fertilization in hermaphrodite animals. It is worth bearing in mind that in some groups of higher plants (for example, the Gymnosperms) polyploidy likewise seems almost entirely absent.

M. J. D. WHITE.

31, Belsize Park,
London, N.W.3.
June 6.

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[2] Vandel, *Bull. Biol. Fr. Belg.*, **61** (1927).
[3] Seiler, *Biol. Zbl.*, **47** (1927).
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[6] Perrot and Perrot, *Rev. Suisse Zool.*, **44** (1937).

Practical Science in Schools

I HAVE naturally read with interest the communications from Dr. V. J. Chapman and from the Editors of NATURE on this subject.

There is no attempt on my part to get practical work abolished in schools. It is essential for such examinations as the 1st M.B., Higher Certificate and university scholarships. The science specialist should devote, in my opinion, at least half his time to practical work. In so many of our public schools, however, it seems to be felt that if there are about five hundred boys altogether it is necessary to make provision for half of them to do practical work at once. As pointed out by the Editors of NATURE a large majority of the boys complete their 'formal' education at the School Certificate stage and for this 'formal' education practical work is unnecessary. Had I my own way, and I am scarcely an anti-science teacher, I would make every boy in a public school learn Latin until he were either fifteen or had passed the School Certificate. Two good science lectures weekly with demonstrations are all that are required. The Latin learnt, however, would be the real thing and not Latin made easy. However, I will not try to dilate on this point.

Dr. Chapman's point about scholarship candidates knowing a good deal of advanced genetics but yet being unable to recognize a twig of larch leaves me almost unmoved. Experienced teachers and examiners will know of hundreds of parallel cases and they really signify nothing. No teacher, let alone the students, will tackle all parts of a vast subject with equal zest. I know of one scholarship candidate who tried to boil shrimps in a thick glass jam-jar, and another who was quite incapable of removing the gelatin from an old photographic negative. The former is a professor and the latter a fellow of his College. Both examiners and teachers might do well to remember such stories, even if they are not true, as that of Sir Isaac Newton who cut two holes in a door, a large one for the cat and a small one for the kitten. Even the greatest sometimes err and are human.

Dr. Chapman's contention that a plant or animal which has been cut up and handled can be more easily remembered, etc., though true, is open to criticism. Direct handling may be essential for the expert, but in general education it is by no means essential nor is it even always desirable. Is it even essential for a gynæcologist to have been a mother?

I certainly find myself at issue with the Editors of NATURE when they say it is not the business of schools to train academic, professional and industrial experts but rather to produce intelligent and knowledgeable citizens. The public schools make a great effort to select the very best boys and surely these particular boys should be urged to aim at the very highest standard of attainment and be supplied with the best teaching possible. Really clever boys under the expert teacher should produce a standard of work which will have a tremendous influence on the school as a whole, though obviously no school could cater exclusively for the expert. I think, however, that many public schools, not to mention a few of the universities, might do well to remember sometimes that there is such a thing as a real teaching profession. The primary duty of any teacher is surely to make his students *learn*, and when a student has learnt to teach himself thoroughly he has gone pretty far in the right direction.

The really able boys in a public school are frequently well occupied with classics or mathematics, and even those who wish to specialize in science can often postpone much of their practical work. It is for the second- and third-rate boys who are never likely to get beyond the School Certificate that one apparently requires these palatial laboratories and costly apparatus.

Surely the War should make us reconsider the matter.

A. G. LOWNDES.

Plymouth.

Common Salt as a Preservative

WITH reference to Mr. J. R. Norman's communication from Dr. Paul Chabanaud[1], I should like to support the opinion therein stated as to the value of common salt as a preservative for large specimens or when no other is available.

In the 'twenties I sent to the British Museum (Natural History) from this place, a distance of about 7,000 miles, two or three specimens of *Cephalorhynchus commersonii*, a dolphin 3–4 ft. in length, preserved with this reagent. The abdominal cavity was opened and salt stuffed in to capacity and the whole animal was covered with a heap of salt. Much of the fluid resulting ran away and as much as possible was drained off before packing in still more salt for dispatch. The method proved entirely satisfactory, the first specimen being, I believe, the original of the cast (♂) in the Whale Gallery of the Museum.

Salt was used for the preservation of the female genitalia of *Otaria byronia* illustrated in my recent paper on that species[2]. This specimen was about 14 cm. long and 11 cm. across the cornua and naturally very muscular. It was placed in a glass jar and covered with salt, fresh salt being added to keep the specimen covered as a saturated brine was formed which was poured off. More than a year later the specimen was taken from the salt, soaked in changes of fresh water until quite soft, and then very gradually brought up to alcohol of about 70 per cent. It remained perfectly flexible and was an admirable subject for dissection.

J. E. HAMILTON.

Naturalist's Department,
Falkland Islands.
June 6.

[1] NATURE, **145**, 397 (1940).
[2] Hamilton, J. E., "A Second Report on the Southern Sea Lion, *Otaria byronia* (de Blainville)". *Discovery Reports*, **19**, 121 (1939).

RESEARCH ITEMS

Stone Age Industries in Wyoming, U.S.A.

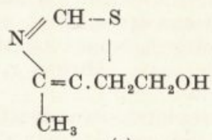
E. B. RENAUD's twelfth report (1940) on the University of Denver Archæological Survey of the High Western Plains deals with the fourth and fifth Denver-Wyoming Expeditions of 1938–39, which were directed to further research work on the stone age industries of Black's Fork Basin in south-west Wyoming. In addition to detailed accounts of field work and sites examined, a report on geological observations in 1938 and a summary of conclusions on the investigation as a whole are here included. Three distinct cultures have occupied Black's Fork Basin at different times and for prolonged periods. (1) The *Peripheral Culture*, of minor importance, sites in south-west Wyoming not being many or abundant in specimens. Though old it cannot be placed exactly in time. The artefacts are of dark chert, small and atypical, and their flaking of indifferent quality. (2) The *Sand Dune Culture* is essentially a camp culture with fireplace, one hand mano, slab metate, arrow-head, but no pottery. It resembles the Camp Culture of the High Western Plains. It is essentially a flake industry, southern and intensive in relation to the Peripheral Culture. (3) The *Typical Culture*, a complex lithic industry of which the component elements have been classified into three chert series, one of moss-agate and one, abundant, of quartzite. Four phases or periods are represented in which the relative number of flakes and unifaces as compared with biface and of sharp with smooth increases in inverse proportion to age. The sites represent extensive and very rich workshops. The artefacts have a distinct palæolithic look and display close similarity with Early and Middle Palæolithic of Europe and Africa. A pebble industry, many *coup-de-poing*-like pieces, and extensive practice of Clactonian flaking are three outstanding features of the industry. Unfortunately there is neither geological nor palæontological evidence to establish age.

Glass-making in Nupe, Nigeria

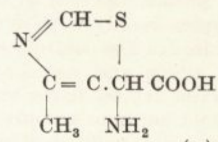
OBSERVATIONS of glass-making in Nupe recorded by Mr. S. F. Nadel (*Man* of June 1940) deal with the work of a guild of glass-makers (*masagá*) who make the real Nupe glass called *bikini* as against that which is obtained by melting down bottles (*kwálaba*). A completely new furnace must be used, not one that has been used for smelting iron. It is circular, approximating 5 ft. high and 2 ft. in diameter. It is covered on top with potsherds and broken calabashes which leave a small gap open. Four men work continuously, working the bellows in shifts, adding fuel, etc. The fire is kept up day and night for from two to five days. The raw material, sand and natron, is first prepared in two heaps in a neighbouring hut. The sand is that dug in making the furnace; the natron is bought from native traders coming down from the Chad. The sand and powdered natron are mixed to a fine powdery mixture, and a little water added to make it of a muddy consistency, the mixture then being placed on the bottom of the furnace. Wood and grass for the lighting of the fire are placed over it and left to burn for 6–7 hours. A little blacksmith's slag is added, washed down by considerable quantities of water. After about 18 hours the glass has become liquid. Samples are taken and after another eight hours the glass is said to be finished. The glass is removed as a red glowing pasty material and left to cool. The glass is stored in this form until required for use in making bangles, when it is melted and worked. In a note by C. G. Seligman it is added that a spectrographic examination by P. D. Ritchie of a mixture of one part of red earth to three of the alkaline product gives a spectrum almost identical with that of the finished Nupe glass and almost identical with that of the red siliceous earth. Only a minute trace of potash is present, the native alkali being essentially sodium carbonate, but containing a fair proportion of calcium. A portion of the mixture heated at 1200° C. for 24 hours produced a glass of poor quality containing nodules of undissolved silica from the red earth and a black glassy matrix resembling the black Nupe glass.

Biogenesis of Vitamin B_1

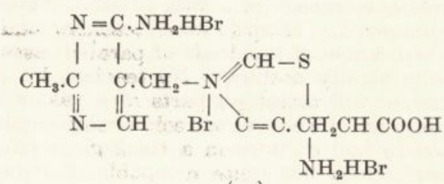
IT is of interest to discover why yeast is able to form such large amounts of B vitamins during its growth, and in particular what are the precursors of and reactions leading to the synthesis of vitamin B_1 (aneurin). C. R. Harington and R. C. G. Moggridge (*Biochem. J.*, **34**, 685; 1940) have obtained support for their earlier suggestion that the 4 methyl-5-(β-hydroxyethyl)-thiazole (I) of aneurin might arise during yeast fermentation from α-amino-β-(4-methylthiazole-5)-propionic acid (II) by a reaction analogous to the formation of fusel oil in alcoholic fermentation. The fact that yeast is a rich source of aneurin and is able to effect this type of degradation further supported the hypothesis, and it has been found that the synthetic amino-acid (II) is indeed broken down by yeast to 4 methyl-5-(β-hydroxyethyl)-thiazole.



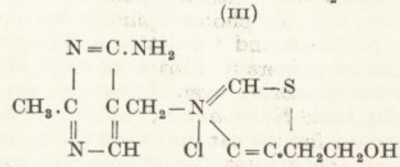
(I)



(II)



(III)



(IV)

The authors are attempting to extend the work by synthesizing the amino-acid (III) analogous to aneurin (IV). If compound (III) could be obtained its fermentation by yeast might be expected to give both aneurin and cocarboxylase (aneurin pyrophosphoric ester).

Ecology of the Estuary of the Aberdeenshire Dee

ALEC MILNE has recently published some interesting observations on ecological aspects of the intertidal area of the estuary of the Aberdeenshire Dee (*Trans. Roy. Soc., Edin.*, **15**, Part 1 (No. 4), 1939–40 ; 1940). There is no up-estuary movement (tidal) of the surface layers of water of the Dee, and thus the surface salinity changes due to tidal alterations are less, though the fluctuation at any point in the intertidal area is consequently greater. There are fewer species of the larger animals which are common in the long estuaries, the main reason being the very high salinity fluctuations and the absence of mud flats. The commonest inhabitants are *Jaera marina* and *Gammarus zaddachi*, *Balanus balanoides*, *Procerodes ulvæ* and *Nereis diversicolor* ; *Fucus ceranoides* being the commonest seaweed. Salinity is apparently the chief factor determining distribution in the Dee estuary. There are in the intertidal fauna large numbers of individuals of certain forms.

American Aphids of the Genus Myzus

Miscellaneous Publication No. 371 of the U.S. Department of Agriculture, March 1940, is devoted to an article on this subject by Preston W. Mason of the U.S. Department of Entomology and Plant Quarantine. Several species of the genus are of considerable economic importance, especially in connexion with fruit, market garden and ornamental plants. In addition to the direct injury which they cause to the plants, certain species of Myzus are vectors of virus diseases. Thus *Myzus persicæ* is a known carrier of more kinds of virus diseases than any other species of insect. It is, furthermore, one of the widest distributed of all insects and occurs in all parts of the world where aphid life can exist. *M. convolvuli* has been proved to transmit virus diseases of potatoes, and the new species *M. lilii* is a suspected transmitter of disease among *Lilium candidum*. The article is illustrated by figures showing the diagnostic characters of the various species found in America. Eight of the species dealt with occur also in Europe, and their descriptions, etc., will be found useful in cases of doubtful identification.

Spreading of Spray Fluids

THE wetting and spreading properties of certain spray fluid supplements have been determined by H. Martin (*J. Pom. and Hort. Sci.*, **18**, 34 ; 1940). Surface tension, spray retention, area of spread and contact angles on artificial surfaces were determined for twenty different water-soluble products of potential value as spray spreaders. A high degree of correlation was found between advancing and receding contact angles in the case of long-chain compounds, but the correlation was not so close with certain surface-active materials of cyclic structure. Advancing and receding contact angles are distinct entities, the former related to spreading and penetration and the latter determining wetting performance. The area of spread of a liquid droplet is related both to contact angle and spreading coefficient on a given surface, but practical difficulties arise in the use of this as a criterion of wetting and spreading properties. The volume of spray retained under standard conditions on a vertical surface is determined by the receding contact angle, and provides a suitable means of assessing the wetting and spreading properties of both aqueous solutions and heterogeneous spray systems. Chemical analysis, on the other hand, is an unreliable method of assessing spray performance.

Cultural Control of Smut Fungi in Egypt

THE particular methods of cereal culture necessitated by the geographical position of Egypt make possible the control of several smut fungi without the employment of costly insecticides (G. Howard Jones and Abd El-Ghani Seif El-Nasr Eff, "Control of Smut Diseases in Egypt with special reference to Sowing Depth and Soil Moisture", *Min. Agr. Egypt Tech. and Sci. Service Bull.*, No. 224. Cairo : Government Press, Bulâq. P.T.6. 1940). The 'herati' method of sowing in moist soil, and the 'afir' type of planting, where irrigation follows seeding in dry soil, involve differences in the relative depths of sowing, and in the moisture content of the ground. These two factors, with the effect of temperature, appear to control the incidence of flag smut of wheat caused by *Urocystis tritici*, covered smut of barley, *Ustilago hordei*, bunt of wheat, *Tilletia fœtens*, and grain smut of millet and broom corn, *Sphacelotheca sorghi*. The relatively long passage of a coleoptile from deeply sown grain through moist soil apparently gives more chance of infection than the quick shoot emergence from shallow sowings in drier soil. Infection is much greater when the average ground temperature for ten days after planting lies between 13° and 17° C. Practical suggestions for new methods of sowing are made (see also NATURE, **142**, 917 ; 1938).

Genetics and Long-day Plants

T. M. Little, J. H. Kantor and B. H. Robinson (*J. Hered.*, **31**, 73–77) show that virescent foliage and early flowering in the African marigold (*Tagetes erecta*) are both inherited as Mendelian recessives. The virescent character is pronounced under temperatures between 55° and 75°, but when hotter conditions are present the virescent plants can scarcely be distinguished from normal. But low temperatures alone will not permit the expression of the character since it is found that the virescent character does not appear in plants grown near the United States–Mexican border, where the temperature ranges from 32° to 70°, but the day is shorter. Early flowering is not influenced by temperature, but length of day greatly affects the character. In winter, all plants come into bloom in eleven weeks, but in spring normal plants take seventeen weeks to flower while the early flowering strain takes twelve weeks.

Selective Fertilization in the Raspberry

D. LEWIS (*Genetics*, **25**, 278–286 ; 1940) shows that a gene w inhibits and severely retards pollen-tube growth in the raspberry. w is linked with t and g which are also in the same linkage group as b and x. The order of the genes is B, T, G and W. It was found that the single factor ratios of $T : t$ and $G : g$ were frequently distorted as the result of the linkage with $W : w$.

Genetics of Awns in Triticum

A. E. Watkins and S. Ellerton (*J. Genetics*, **40**, 243–270 ; 1940) discuss the literature and give results of their experiments on the inheritance and behaviour of awns in wheat. They show that hexaploids usually have shorter awns than tetraploids and that there are both major and modifying genes which affect size of awn. Beardless is the bottom recessive character as compared with tipped-1, B_1, half awned $b_1{}^a$, B_2, half awned A and hooded Hd. B_1, $b_1{}^a$, and b_1 are allelomorphic with one another, while B_2 A and b_2 may also be multiple allelomorphs. The genes B_1, B_2 and Hd may be transferred to tetraploid wheats and there segregate regularly. B_1 is linked with pubescent node, square-headedness, and keeled glumes.

Plasticity Conditions for Fault Formation

A VERY valuable mathematical paper on plasticity conditions requisite for the formation of normal and reverse faults has been written by Katsutada Sezawa (*Bull. Earthquake Res. Inst., Tokyo*, **17**, Part 4, 661–674; 1939). Three idealized models were chosen: (1) spherical, (2) cylindrical, (3) plane. Sezawa inferred that when the liquid earth partly solidified, the solidified parts changed from incompressible to compressible. If there were no faults in the earth, the lateral compression in any particular place would exceed the vertical, thus giving rise to reverse faults. With the aid of mathematical plasticity the direction of the fault causing stress is obtained. On the maximum shear stress theory the inclination of the reverse fault would be 45° to the horizontal, but owing to frictional force on the sliding surface the theory has to be modified and the angle is likely to be only 10° or 20°. When the solidified earth has faults, the stress conditions are different. The plastic state is nearly the same as that of the earth with a plane surface. The horizontal compression is less than the vertical, and the formation of normal faults is highly probable. Owing to frictional force on the sliding surface, the inclination of normal faults to the horizontal is more than 45°, say 60°. Sezawa infers that it is probable that such fault surfaces as lie near so large a trench as the Japan Trench are reverse faults, which were formed at a very early stage in the life of the solid earth. The usual smaller faults on land would be normal faults formed at a relatively later stage in the history of the solid earth. It is possible that deep-focus earthquakes are in some way related to reverse faults, and in the present state of the earth's crust, plastic stresses causing reverse and normal faults might still remain.

Thunderstorms at Karachi

DURING the past three years, the study of the thunderstorms at Karachi has been followed by B. N. Desai and S. Mal, of the India Meteorological Department. Their work was first introduced to English meteorologists in a paper entitled "The Mechanism of Thundery Conditions at Karachi" (*Q. J. Roy. Met. Soc.*, **64**, 525–37). Owing no doubt to the reorganization of the India Meteorological Department, more than two years have elapsed between the time when the material of their latest paper was first communicated to the Department, and its appearance as "A Discussion of Some Aeroplane Ascents at Drigh Road (Karachi) on days of Dust Storms, Thunderstorms and Dust-Raising Winds" (*Sci. Notes India Met. Dep.*, **8**, No. 87). The observations made during these aeroplane ascents are set out on the now familiar tephigram system, both dry- and wet-bulb readings being plotted. It appears that the knowledge about latent instability of the atmosphere gained from early-morning ascents was not always found to be sufficient for the prediction later in the day of dust-raising winds owing their origin to thunderstorms, and that for this purpose the weather of surrounding regions had to be taken into account. A distinction is drawn by the authors between thundery conditions that do not result in winds of Beaufort force 6 or more, and conditions which do give such winds, because of the importance for aviation of knowing whether a dust haze or dust storm is likely to develop. There does not appear from this work to be any fundamental difference between the incidence of thunder in the peculiarly damp and enervating climate of Karachi and its incidence in a bracing climate like that of, say, East Anglia. In both regions strong thunder squalls are far more likely when the thunder is associated with winds of widely different origin than when there is only the local development of instability from unequal heating within a single air mass.

Chlorine Monoxide and Water

IT is known that chlorine monoxide dissolves in water to form hypochlorous acid, but no solid hydrate was known. C. H. Secoy and G. H. Cady (*J. Amer. Chem. Soc.*, **62**, 1036; 1940) have prepared pure chlorine monoxide (made by the action of chlorine mixed with air on yellow mercuric oxide) and find the freezing point of a freshly prepared sample, dried by passing the gas over phosphorus pentoxide, to be − 120·6°. The compositions of saturated solutions in water (20·7 mol per cent at 236·8° K. to 22·9 mol per cent at 263·8° K.) were determined. Chlorine monoxide and water form a pair of partially miscible liquids. The solid phase formed from solutions of concentration greater than 11·7 mol per cent was found to be the crystalline dihydrate of hypochlorous acid, HOCl, $2H_2O$.

Dipole Moments and Structures

MEASUREMENTS of the dipole moments of hydrogen disulphide, sulphur monochloride, selenium monochloride, selenium oxychloride, phosphoryl chloride and thiophosphoryl chloride in benzene or heptane (C. P. Smyth, G. L. Lewis, A. J. Grossman and F. B. Jennings, *J. Amer. Chem. Soc.*, **62**, 1219; 1940) have been used to obtain information of structures. H_2S_2 may be explained by H—S—S—H, but better if a small proportion of branched molecules H_2S—S are present. S_2Cl_2 and Se_2Cl_2 may be explained with difficulty by Cl—S—S—Cl and Cl—Se—Se—Cl, but better by branched structures S—SCl_2 and Se—$SeCl_2$ in the form of an irregular tetrahedron, or a mixture of extended and branched structures. The values for the moments of the bonds calculated are: SeO in $SeOCl_2$, 3·0; $\overset{+}{P}$—$\overset{-}{O}$ in $POCl_3$, 3·5; $\overset{+}{P}$—$\overset{-}{S}$ in $PSCl_3$, 2·5. The third is lowered to a greater extent by induction than the second.

Sunspots during 1937

THE Astronomer Royal has discussed the mean areas and heliographic latitudes of sunspots during 1937 (*Mon. Not. Roy. Astro. Soc.*, **100**, 6; April 1940). The results are in continuation of those given in *Mon. Not. Roy. Astro. Soc.*, **98**, 425 (1938), and are derived from the measurement at Greenwich of photographs taken at the Royal Observatories of Greenwich and the Cape and at the Kodaikanal Observatory, India. They are summarized in four tables, and it is interesting to notice that on no day in the year 1937 were sunspots and faculæ absent from the sun's disk. For the first three years of the present cycle, the southern hemisphere was the more active, but during 1937 the northern hemisphere showed more activity, the ratio of the mean daily area of sunspots, north and south of the equator, being 1·7 : 1. The mean latitudes of all spots, weighted according to the area, is 17·02°, which is 3·3° nearer the sun's equator than in 1936.

DETERMINATION OF THE SIZES OF VIRUSES AND GENES BY RADIATION METHODS

By D. E. LEA,
STRANGEWAYS RESEARCH LABORATORY, CAMBRIDGE

It has been shown recently that viruses[1,2] and phages[3] are inactivated by exposure to ionizing radiations, that is to X-rays or the various radiations from radioactive substances. It appears that the inactivation process is of a particularly simple and direct type, a single ionization or cluster of ionizations being capable of inactivating a particle of the phage or virus.

Two lines of evidence lead to this conclusion. In the first place, if the size of the virus particle is approximately known, and if the dose of radiation needed for inactivation is expressed in terms of ionizations per cm.[3] in the biological material, it is found that this dose corresponds, at any rate in order of magnitude, to one ionization in a volume equal to the volume of the virus particle.

The second argument is more precise though less direct, and is based on internal evidence from the radiation experiments themselves. These show that the effect of a given *dose* of radiation is independent of the *intensity* at which it is delivered, and further that the inactivation process follows the law of a monomolecular reaction, that is, the proportion surviving diminishes exponentially with the time for which the radiation acts. These experimental facts indicate that the inactivation is of the nature of a single unit process, the line of argument being one familiar in radiobiology (see for example refs.[3,4,5,6,7]).

The possibility is thus presented of using the radiation experiments as a means of determining the size of the virus particles. If the inactivation dose, that is, that dose leading to reduction of the proportion surviving to e^{-1}, is n ionizations per cm.^{3}, then one would argue that the volume, v, of the virus is given by the equation $n = 1/v$. Certain complications involving the spatial distribution of the ionizations lead to some modification of this simple relation. In the first place, ionizations occur in small clusters, sufficiently compact to behave as single units and averaging 3 ionizations per cluster, so that the inactivation dose becomes $3/v$ ionizations per cm.^{3}. These clusters of ionization are distributed along the paths of ionizing particles which travel in approximately straight lines through the material, and in some cases the separation of the clusters is small, so that an ionizing particle which passes through a virus particle inevitably leaves several clusters of ionization in it. If the mean number of clusters left in a virus by an ionizing particle which inactivates it is F, then the inactivation dose becomes $3F/v$ ionizations per cm.^{3} F clearly depends on the diameter of the virus ($2r$) and the mean separation (L) of consecutive clusters along the path of the ionizing particle, and may be calculated[5].

I quote in Table 1 a recent experimental determination by Wollman, Holweck and Luria[3] of the inactivation doses of phage 16 for three different radiations, and deduce for each the value of $2r$, the diameter of the phage particle, which would make the experimental inactivation dose equal to $3F/v$. To obtain the doses in ionizations per cm.^{3} from the measured doses in roentgens the latter are multiplied by a factor which varies a little for different radiations depending on the relative absorption of tissue and air, the extreme values being $2{\cdot}6 \times 10^{12}$ for α-rays and $1{\cdot}3 \times 10^{12}$ for soft X-rays.

TABLE 1. RADIATIONS ON PHAGE 16

Radiation	X-rays (0·15 A.)	X-rays (0·71 A.)	α-rays
Ion clusters per cm.	$2{\cdot}1 \times 10^5$	$3{\cdot}3 \times 10^5$	$1{\cdot}5 \times 10^7$
Value of F	1·44	1·82	85
Inactivation dose (ions per cm.^{3})	$6{\cdot}7 \times 10^{16}$	$6{\cdot}0 \times 10^{16}$	$7{\cdot}9 \times 10^{17}$
Diameter of phage	50 mμ	56 mμ	85 mμ

The estimate of the diameter of the virus from ultra-centrifugation and ultra-filtration experiments is quoted by the authors as 50–75 mμ, which is seen to be in agreement with the values deduced from the radiation experiments.

Table 2 shows some preliminary results[2] on the inactivation of tobacco necrosis virus by X-rays, which have been used in a similar manner to determine the diameter of the virus. The diameter deduced from ultra-filtration experiments[8] is 12–20 mμ, and this value is seen to be in good agreement with the values derived from the radiation experiments.

TABLE 2. INACTIVATION OF TOBACCO NECROSIS VIRUS

Radiation	X-rays (1·5 A.)	X-rays (8·3 A.)
Ion clusters per cm.	5×10^5	$2{\cdot}4 \times 10^6$
Value of F	1·40	2·60
Inactivation dose (ions per cm.^{3})	$1{\cdot}2 \times 10^{18}$	$6{\cdot}1 \times 10^{18}$
Diameter of virus	19 mμ	14 mμ

In the examples so far cited the knowledge of the inactivation dose to any one radiation suffices to determine the size of the virus or phage concerned, and the use of several different radiations merely serves for confirmation. We come now to consideration of a more complicated case, in which the comparison of the effects of two radiations of very different ionization density is the essential experimental datum. In experiments on the production of sex-linked recessive lethal mutations in Drosophila by irradiation of the sperm, the effect observed is due to the inactivation by the radiation of any one of the large number (N) of genes in the X-chromosome capable of being modified in this way, and since N is not known (except as to order of magnitude[9]), observations of the production of lethals by one radiation does not enable the gene size to be determined. However, the ratio of the doses of two different radiations required to produce the same percentage of lethals does not involve N, but only the ratio of the values of F for the two radiations. Since the quantity F depends on the diameter of the gene, this last may be calculated. In Table 3, it is shown that the experimental results with three different radiations may be satisfactorily fitted by assuming that there are 1,860 genes in the X-chromosome having an average diameter of 3·78 mμ.

TABLE 3. SEX-LINKED LETHAL MUTATIONS IN DROSOPHILA

Radiation	X-rays	Neutrons	α-rays
Ion clusters per cm.	2 × 10[5]	3·7 × 10[6]	1·6 × 10[7]
Value of F	1·03	1·60	4·3
% mutations per 1,000 r, calculated	2·89%	1·86%	1·08%
% mutations per 1,000 r, experimental	2·95%[4]	1·85%[10]	0·84%[11]

While these figures are to be regarded as preliminary in view of the fact that N in particular is very sensitive to any error in the experimental determination, it is likely that the radiation method will, with sufficient experimental precision, become the best method of determining the size and number of genes in Drosophila. $2r$ is, of course, strictly the diameter of the region or 'target' associated with a gene within which an ionization must be produced to cause a mutation of that gene. The closeness of the correspondence between the size of the target and the size of the biological entity in the case of the phage and virus work makes it probable, however, that the distinction between the size of the gene and the size of the target is not an important one.

Besides the inactivation of viruses and the production of gene mutations, there are other biological actions of radiation which have been interpreted in terms of the existence of 'targets' or regions of special sensitivity in the organism. It is probable that in some of these cases this interpretation is unsound, in others the size of the target has been incorrectly deduced owing to data not being available for a sufficient number of different radiations. The lethal action of radiations on bacteria, which has been investigated by many authors, provides a case in point. In the past it has been usual to assume that the target in this case consists of a single sphere, and estimates for its diameter of the order of a few tenths of a micron have been given[7,12]. When data are available, however, for a number of radiations covering a sufficiently wide range of ion density, it appears that the assumption of a single large spherical target cannot be made to fit the results, but the assumption of a large number of small spherical targets is more successful. It appears highly probable that the lethal effect of radiations on bacteria is to be interpreted as the production of lethal mutation, there being a large number of genes in the bacterium any one of which inactivated prevents the organism from developing into a visible colony when plated out. In Table 4 theoretical estimates of the lethal dose for *Bact. coli* are calculated by the same procedure as was used for the calculation of gene mutation production in Table 3, it being assumed that the organism contains 1,150 genes of diameter 8·6 mμ.

TABLE 4. LETHAL MUTATIONS IN *Bact. Coli.*

Radiation	β- or γ-rays	X-rays (1·5 A.)	X-rays (8·3 A.)	α-rays
Ion clusters per cm.	3×10[4]	5×10[5]	2·4×10[6]	1·3×10[7]
Value of F	1·01	1·16	2·00	7·65
Mean lethal dose in r, calculated	4·6×10[3]	6·9×10[3]	10·3×10[3]	23×10[3]
Mean lethal dose in r, experimental	4·6×10[3] [7]	6·5×10[3] [13]	7·5×10[3] [11]	24×10[3] [7]

While the radiation method has so far had a relatively limited application, enough examples have been given above to indicate that it is a powerful tool for the investigation of biological entities of subcellular size.

[1] Gowen, J. H., *Proc. Nat. Acad. Sci.*, **26**, 8 (1940).

[2] Lea, D. E., and Smith, Kenneth M., *Parasitology* (in the press); also unpublished results.

[3] Wollman, E., Holweck, F., and Luria, S., NATURE, **145**, 935 (1940).

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FRICTION AND SURFACE FINISH

By PROF. JEROME C. HUNSAKER,
MASSACHUSETTS INSTITUTE OF TECHNOLOGY

CONFERENCES on Friction and Surface Finish were held at the Massachusetts Institute of Technology during June 5–7 under the joint auspices of the Departments of Mechanical Engineering and Metallurgy. Representatives of the automobile, aviation, oil, machine tool, grinding, general machinery and other industries took part. The object of the Conferences was to bring before engineers associated with the many industries concerned, a summary of present knowledge regarding friction and finish, and to bring out by discussion an appreciation of what new information is needed and an indication of the most promising directions for future research. The discussion was too extensive to report here, but the following notes indicate matters which were especially interesting to those present.

A. F. Underwood (General Motors Research Laboratories) reviewed the general problem of fluid and boundary lubrication from the automobile engineer's point of view. He discussed the current practice of surface preparation of bearings, pistons, cylinders, cams and gears, and pointed out that the metals that make good bearing materials all lie in certain specific parts of the periodic table. The failure of bearing metals through fatigue was also discussed.

John Wulff (M.I.T.) has determined, by means of electron diffraction studies of the ferrite induced by cold work in 18–8 stainless steel, the depth of disturbance in a metal produced by various methods of surface finishing. The disturbance due to wet or dry grinding goes much deeper than that due to lapping or super-finishing.

Aspects and problems of lubrication and surface finish peculiar to the aircraft industry were discussed by Leonard Hobbs (Pratt and Whitney Aircraft), and D. A. Wallace (Chrysler Corporation) described the method of super-finishing and cited examples of improvement in operation of automobiles obtained thereby.

J. T. Burwell (M.I.T.) reported on the effect of surface finish on the metal worn off a journal during 'running-in' and also its effect on the friction coefficient and load capacity of a journal bearing. He finds that the load capacity increases and the minimum coefficient of friction decreases with increasing surface smoothness.

David Harris (Gillette Razor Company) discussed the surface finishing of razor blades, and described a machine for grading bonded abrasive stones and wheels.

Stewart Way (Westinghouse Research Laboratories) described the various methods of describing and measuring surface profile. These include cutting and polishing a section, optical methods, and mechanical methods. The errors and limitations of each method were discussed; none is good for measuring profiles of which the maximum deviation from a median plane is less than 10 micro-inches. H. R. Nelson (Battelle Memorial Institute) described a technique for describing surface profiles by means of nickel plating the surface and then grinding and polishing a section at an angle of 2° with the surface. The borderline in this section between the nickel plate and the specimen is a twenty-five fold magnification of the actual profile. The whole can then be photomicrographed at any additional magnification desired.

Hans Ernst and M. E. Merchant (Cincinnati Milling Machine Co.) proposed an expression for the friction coefficient between rubbing surfaces:

$$\mu = \frac{S}{H} + \tan\theta,$$

where S is the shear stress of the weld formed between the two surfaces, H is the hardness of pressure of fluidity of the weaker, and θ is the average slope of the surfaces. The first term accounts for the molecular adhesion in surface friction and the second term for the interlocking of asperities. Experiments conducted on dry, clean surfaces in a vacuum substantiate this formula.

Otto Beeck (Shell Development Company) described friction measurements using the four-ball machine of Bourlage on E.P. lubricants and also electron diffraction studies of the surface films produced by these lubricants. He finds a constant coefficient of friction below a certain critical speed for these lubricants and suggests calling this the region of boundary lubrication. The action of most E.P. lubricants is to form a metal phosphide, arsenide, etc., the eutectic mixture of which with the metal has a much lower melting point with resultant decreased resistance to shear. R. W. Dayton (Battelle Memorial Institute) described various laboratory methods of measuring wear between rubbing metal surfaces. He stated that wear due to mutual abrasion of rough surfaces is not very common, and showed that even very small amounts of adventitious dirt in a lubricating oil can greatly increase wear. He also discussed failure of bearing metals through fatigue.

O. R. Schurig (General Electric Company), who reviewed the course of the conference, emphasized that the degree of smoothness of a rubbing surface should depend entirely on the use to which it is to be put. He stated that the load capacity of a sand-blasted surface as measured in an Almen testing machine is greater than that of a fine-ground surface.

F. Morgan (Gulf Research Laboratories) described a repetition of Bowden's experiments measuring the temperature flash during the 'slip' portion of a 'stick-slip' cycle and stated that for moderate speeds a temperature rise of only 30° C. could be observed in contrast to Bowden's observation of several hundred degrees rise.

W. E. Campbell (Bell Telephone Laboratories) reported on measurements of static friction between dissimilar dry metal surfaces. He has obtained good agreement with the results of Ernst and Merchant. He finds that the presence of moisture in the air raises the static coefficient of friction, and the presence of water in a lubricant also does the same thing.

ANAEROBIC DEGRADATION OF CYSTINE AND CYSTEINE

THE bacterial degradation of cystine and cysteine under anaerobic conditions with liberation of hydrogen sulphide and ammonia has recently formed the subject of interesting papers by Desnuelle, and by Desnuelle, Wookey and Fromageot. The former author worked with suspensions of non-proliferating *B. coli*[1], whereas the latter authors used suspensions of propionic acid bacteria[2]. A systematic study by Tarr[3] of the production of hydrogen sulphide by washed bacterial suspensions showed that cysteine and cystine are decomposed anaerobically by numerous bacteria with formation of hydrogen sulphide. Desnuelle and Fromageot[4] pointed out that a specific enzyme which they termed cysteinase was responsible for the breakdown of the amino acid.

The results with *B. coli* now indicate that the following changes take place in the anaerobic breakdown of cystine:

1. $l(-)$ cystine $+ DH_2 \rightarrow 2l(+)$ cysteine $+$ D.
2. $2l(+)$ cysteine $\rightarrow 2H_2S + 2NH_3 +$ other products.

Process (1) involves the co-operation of a hydrogen donator DH_2 whilst process (2) is catalysed by cysteinase. The presence of glucose, and to a less extent fructose, greatly accelerates the formation of hydrogen sulphide from cystine, these sugars acting apparently as hydrogen donators. The presence of molecular hydrogen does not markedly affect the process, though it is known that *B. coli* is able to activate molecular hydrogen as a hydrogen donator. The presence of formate, which is a most vigorous hydrogen donator in presence of *B. coli*, has the remarkable effect of inhibiting the formation of hydrogen sulphide from cystine. The process of breakdown of cysteine or cystine by *B. coli* seems to be confined to $l(+)$ cysteine and $l(-)$ cystine.

Results with resting propionic acid bacteria also show an accelerating effect of glucose on the anaerobic formation of hydrogen sulphide from cystine, but the kinetics of the reaction differ from those obtained with *B. coli*. There is not the rigid optical specificity of reaction which takes place in the case of *B. coli*, and both *l*- and *d*-cysteine are equally well attacked. Ammonia formation does not proceed parallel with that of hydrogen sulphide ; in fact, in the presence of glucose, which accelerates hydrogen sulphide production, ammonia formation is greatly retarded. Both alanine and pyruvate inhibit the anaerobic breakdown of cysteine by suspensions of propionic acid bacteria.

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POPULATION PROBLEMS IN INDIA

THE second Indian Population Congress was held at Bombay in 1938 and its results are now published in a large volume*. Practically every aspect of the population problem is examined, with special reference to India. The numerous papers, many of them by men and women of high attainment and expert knowledge, show an increasing interest in what is probably India's greatest problem.

Among the topics considered are birth control, problems of sex, housing, vital statistics, infant mortality, the logistic law of population growth, optimum population, poverty, employment, nutrition, fertility, the primitive tribes, and marriage registration. Widely different views are expressed regarding the nature of the over-population problem in India, a few claiming that it does not exist. But most writers recognize that a serious problem needs to be faced without delay.

It is impossible to quote from such an extensive series of essays, but it may be worth while setting down a few of the relevant facts. In the 1931 census 73 per cent of the people lived by agriculture; yet with a population now probably 377 millions and an annual increase of 3·5 millions, the increase in rice production in the period 1910–35 is only 6 per cent and wheat shows a steady decline. The infant mortality is 232·6 per 1,000 and the maternal mortality 24·5 per 1,000, or six times that of England and Wales. The pressure of population is indicated by the statement that the average length of life has declined from 30 in 1881 to 23 in 1931. In every 1,000 persons, 10 are suffering from night-blindness, 6 from rickets and 4 from tuberculosis. It is claimed that India only produces 75–83 per cent of its food requirements in calories.

On the other hand, it is pointed out that there is differential fertility within the population as regards both classes and tribes. The 1931 census listed 25 million primitive peoples of many types, some of whom, such as the Todas, Kotas, Gonds, Bhils and Angami Nagas, have shown a marked decline in numbers. The process of transforming primitive tribes into Hindu castes goes on, but some of them at least continue to decline in numbers after being Hinduized. These tribes still constitute 8 per cent of the population of India.

It is clear that Indian politicians will find plenty of scope for their energies when they begin to consider seriously the vital problems of population and nutrition in India. R. R. G.

*Indian Population Problems. Proceedings of the Second All-India Population and 1st Family Hygiene Conference. Edited by Prof. G. S. Ghurye. Karnatak Publishing House, Bombay.

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

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DEPUTY DIRECTOR OF EDUCATION—The Director of Education, Town Hall, Bradford (August 5).

REPORTS AND OTHER PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

The Pioneer Health Centre, St. Mary's Road, Peckham, S.E.15. Report for 1938 and 1939. Pp. 48. (London : The Pioneer Health Centre.) [37

Llandudno, Colwyn Bay and District Field Club. A Supplement to the Proceedings. The Legend of Llys Helig : its Origin and its Significance. By Dr. F. J. North With an Appendix on the Archæological Aspect, by W. F. Grimes. Pp. v+67+8 plates. (Llandudno : Llandudno, Colwyn Bay and District Field Club.) 5*s*. [47

ASLIB War-Time Guides to British Sources of Specialised Information. No. 1 : Fuel and Allied Interests (excluding Electricity). Pp. 18. (London : Association of Special Libraries and Information Bureaux.) 2*s*. 6*d*. ; to Members, 2*s*. [47

University of London. Report of the Principal on the Work of the University during the Year 1939–40. Pp. 8. (London : University of London.) [47

The National Trust for Places of Historic Interest or Natural Beauty. Report 1939–1940. Pp. viii+128. (London : The National Trust.) [57

John Innes Leaflet No. 1 : John Innes Composts for Pot Plants. Pp. 4. 3*d*. John Innes Leaflet No. 2 : Soil Sterilisation for Pot Plants. Pp. 4. 3*d*. John Innes Leaflet No. 3 : The John Innes Soil Sterilizer. Pp. 8. 6*d*. (London : John Innes Horticultural Institution.) [57

Department of Scientific and Industrial Research. Index to the Literature of Food Investigation. Vol. 11, No. 4, March 1940. Compiled by Agnes Elisabeth Glennie, assisted by Gwen Davies and Catherine Robson. Pp. v+305–420. (London : H.M. Stationery Office.) 4*s*. 6*d*. net. [87

Other Countries

Proceedings of the American Academy of Arts and Sciences. Vol. 73, No. 9 : *Serphidæ* in Baltic Amber, with a Description of a New Living Genus, by Charles T. Brues ; *Calliceratidæ* in Baltic Amber, by Charles T. Brues. Pp. 259–270. 35 cents. Vol. 73, No. 10 : The Old World Species of the Celastraceous Genus *Microtropis* Wallich. By E. D. Merrill and F. L. Freeman. Pp. 271–310. 1.15 dollars. (Boston, Mass. : American Academy of Arts and Sciences.) [87

Occasional Papers of the California Academy of Sciences. No. 19 : The Rabbits of California. By Robert T. Orr. Pp. iii+227 (10 plates). (San Francisco, Calif. : California Academy of Sciences.) [87

Field Museum of Natural History. Zoological Series, Vol. 24, No. 12 : Notes on Texan Snakes of the Genus *Salvadora*. By Karl P. Schmidt. Pp. 143–150. 10 cents. Zoological Series, Vol. 24, No. 13 : A New Toad from Western China. By Karl P. Schmidt and Ch'eng-Chao Liu. Pp. 151–154. 10 cents. (Chicago : Field Museum of Natural History.) [87

U.S. Department of Agriculture. Farmers' Bulletin No 1829 : Insects and Diseases of the Pecan and their Control. By G. F. Morznette, C. B. Nickels, W. C. Pierce, T. L. Bissell, J. B. Demaree, J. R. Cole, H. E. Parson and John R. Large. Pp. ii+70. (Washington, D.C. : Government Printing Office.) 10 cents. [87

Transactions of the San Diego Society of Natural History. Vol. 9, No. 14a : A New Subspecies of the Western Worm Snake. By Laurence M. Klauber. Pp. 67–68. Vol. 9, No. 18 : The Worm Snakes of the Genus *Leptotyphlops* in the United States and Northern Mexico. By Laurence M. Klauber. Pp. 87–162+plate 6. Vol. 9, No. 19 : The Lyre Snakes (Genus *Trimorphodon*) of the United States. By Laurence M. Klauber. Pp. 163–194+plate 7. Vol. 9, No. 20 : Two New Species of *Phyllorhynchus*, the Leaf-nosed Snake, with Notes on the Genus. By Laurence M. Klauber. Pp. 195–214+plate 8. (San Diego, Calif. : San Diego Society of Natural History.) [87

Refractories Investigations in Mellon Institute on the American Refractories Institute's Multiple Industrial Fellowship. Pp. iv+20. (Pittsburgh, Pa. : Mellon Institute.) [87

Catalogues, etc.

The Wild-Barfield Heat-Treatment Journal, Vol. 4, No. 25, June. Pp. 9+v. (London : Wild-Barfield Electric Furnaces, Ltd.)

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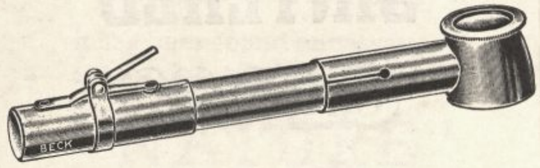

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