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ORGANIZATION OF PRODUCTION

THE interest with which the recent debate in the House of Commons on production was followed indicates how thoroughly the importance of the issues is understood in Great Britain, and the anxiety that there shall be no further weakness in either administration or in policy. The limitations of man- and woman-power, and also of materials, are much too severe for there to be complacency over waste either through individual slackness at the level of the operatives or through inefficiency at that of management. The speech made by Mr. Oliver Lyttelton as Minister of Production was clear and encouraging. He has an exact notion of what is to be accomplished, and he made the new arrangements sound more reasonable than they did in the Prime Minister's formal announcement.

The Minister of Production faces three major tasks. One is to ensure that the domestic production programme of Great Britain is both balanced and efficient. The second is to integrate it with the programmes and needs of the other united nations, and particularly with those of the United States. The third is to ensure "a complete fusion between military plans and thought and production plans and thought", not only in the realm of strategy, but also in that of battle tactics. It is this task, probably the most urgent, that has for some time been the special concern of scientific workers. It has been the burden of conferences arranged by the Association of Scientific Workers on science and the war effort. It was voiced by Sir Henry Tizard at the annual luncheon of the Parliamentary and Scientific Committee, and it was the main theme of Prof. A. V. Hill's long speech in the House of Commons on the war situation on February 24.

Mr. Lyttelton's statement that to accomplish this purpose there is to be what he described as a general staff of war production goes some way to meet Prof. Hill's plea for a general staff with executive functions, including a full-time technical section of able officers of all arms who have grown up with modern weapons and equipment, to deal with the general strategy of the War. The body described by Mr. Lyttelton is designed to be an exact parallel to the Chiefs of Staff Committee on the military side. It will consist of his Chief Adviser on Programmes and Planning, Sir Walter Layton, the assistant chiefs of staff of the three Services, together with the highest technical officers of the three Production Ministries, and will be the servant on war production matters of the Defence Committee.

The Joint War Production staff will be served by a Joint War Production Planning Group concerned with the planning of what is to be produced, and composed of Navy, Army and Air Force officers and representatives of the Production Ministries working together in the same office. These proposals forestall some of the recommendations in the Eighth Report of the Select Committee on National Expenditure, dealing with the organization of production, which has since appeared, particularly those relating to a balanced plan, to an adequately staffed

Intelligence and Programmes Branch, and to the examination as a matter of urgency of means of formulating with precision, and so far as possible in advance, the demands of the Fighting Services. The Joint War Production Staff with the Programmes and Planning Division will work in close touch with, and supply information required by, the combined Anglo-American organization. Arrangements are being made to include a study of the war production and requirements of the Empire, and Mr. Lyttelton was at pains to stress that the object of the new organization is to ensure that production is closely and continuously related to strategical requirements as well as battle tactics.

This section will be in the charge of Sir Walter Layton, and will also be intimately concerned with such combined problems facing the United Nations as the dovetailing of the British supply of raw materials and British manufacture of munitions into the programme of the United States. A special Raw Materials Division will deal with general policy on the development of raw materials, on the control of import of raw materials, the allocation and releases of stocks of raw materials, with an Empire clearing-house and with the relations between the British Raw Materials Committee and the committee in the United States which deals with the combined raw material requirements and supplies of the United Nations. A further Production Division will be a small technical division in the charge of an industrialist with wide general experience. To him will be attached a technical officer from each of the three Production Departments, so that the closest touch will exist between the Production Division and the Department. The main functions in the industrial field of this Division will be those subjects which affect all three Production Departments simultaneously.

Mr. Lyttelton will address himself particularly to the problems of steady production in the face of changes in the enemy's strategy, in the geographical theatres of war, the accession of new allies, the appearance of new enemies, and the interruption of sources of raw materials, which may oblige us to substitute one type of munition for another. Moreover, he recognizes the importance of relieving the natural concern and anxiety of workers who may find idle time on their hands from such causes. The new Minister of Production is clearly resolved to see that enforced idleness, whether it springs from the loss of shipping carrying essential supplies, the necessity of substituting a new type on a sudden message from the battle-front, or delay or destruction due to enemy air attack on factories or communications, does not become the breeding-ground of suspicion and misgiving.

The importance of taking the workers into the Government's confidence in this respect, in order to achieve the extra production and with it the aggressive spirit in industry as well as in the Fighting Services, is not easily overstressed. It will go far to eliminate the bad discipline which is another source of inefficiency, and in itself it should be a spur to more efficient management where required. Mr. Lyttelton promised that no defects will be glossed over, and that where something is proved to have been wrong, such measures as are possible will be taken to put it right.

Mr. Lyttelton said little himself about management efficiency, but the whole tone of his speech implies that he is prepared to countenance disciplinary action against management as well as against worker where required. There is already the precedent of the War Agricultural Committees in dealing with inefficient farmers, and if similar measures were applied to the managements of workshops or factories where required, and in backward establishments there were enforced those simple rules upon which the health and efficiency of labour so largely depend, much would have been done to remove suspicion of unfairness and to create the conditions for effective team-work upon which so much depends. The new Regional Division, the most radical change announced by Mr. Lyttelton, is an attempt to raise the standard of organization of production among the many smaller firms, and like the works committees, will depend for its success largely upon such a spirit of co-operation. Local organizing ability will be given a chance to show itself, just as the works committee can be used as a clearing-house for explanations and suggestions and for levelling up practice in all the shops of one trade.

But team-work must be forthcoming from more than the workers and the factory management. Mr. Greenwood's observation that in the past there has not been the full team-work and co-operative spirit in the Production Departments without which maximum effort is not possible should be taken to heart at the very top as well as at the bottom. In this connexion the Seventh Report of the Select Committee on National Expenditure, which has since appeared, points out that so far the organization of labour supply has not been undertaken with that breadth of conception and firmness of execution which are necessary for the creation of our maximum military strength. The Minister of Production's spirit of co-operation and open mind must be widely shared if we are to solve all the difficult strategic problems of production and of man- and woman-power, perhaps especially those involved in the increasing use of women in industry and the exploration of the use of part-time labour.

Mr. Lyttelton's clear conception of the powers attaching to his office—his supreme authority over raw materials and over machine tools, and a co-ordinate authority over labour—and the machinery which he has superimposed on that already existing, interlocking the affairs of the workers with those of the fighters, have already engendered high hopes of the instrument in his hand. Whether he is to wield it effectively for the destruction of the enemy depends on more than Mr. Lyttelton's own personality and ability. It depends on the support and co-operation which he receives from the Cabinet downwards, and the more boldly he uses his authority the more loyally he will be supported.

Organization alone will not secure the full production that is desired, though that is no reason for tolerating inefficient administration, bad management or defective organization. The shortage of efficient administration makes it essential, as Sir John Wardlaw-Milne insisted, to use the large number of men of fifty and above who have wide administrative experience but are largely unused. But to knit Government, management and workers into one harmonious team keyed up to its maximum effort and efficiency, we need a new spirit of aggressiveness.

There may be differences of opinion as to whether that new spirit will spring, at least directly, from the self-interest which Sir John Wardlaw-Milne stressed in this connexion. There is likely to be wider support for Sir William Beveridge's view in his plea for a new spirit in grappling with total war, that if war is to be waged offensively against evil, for the ideals of tolerance, fair play, freedom of thought and speech, kindliness and the value of the individual soul, it must be in the spirit and passion of a crusade, in a spirit of service, transcending the thought of duty alone.

There are few scientific workers who would not respond to Sir William Beveridge's noble plea in his recent article in *The Times* for the casting aside in this time, and for the building of the peace when victory is won, of the obsolete party allegiances and ideals, of profit and of selfish and money-making motives. These are the obstacles to full comradeship and trust, in production as in arms, and Lord Hankey's weighty words on the machinery of government in the House of Lords point to a weakness in government, to which Sir William Beveridge also referred, through the attempt to construct the Government more on the balancing of party considerations than on grounds of national efficiency. Service rather than gain should be the main motive of war effort in Government and in industry as in fighting. There can be no doubt of the response of the nation to great leadership ; it is earnestly to be hoped that the new production machinery will be boldly and imaginatively used, that constructive ideas will come from above, and that inspired leadership will kindle a new comradeship and loyalty which shall carry us swiftly to full victory.

MODERN THEORY OF CHEMICAL REACTIONS

The Theory of Rate Processes

The Kinetics of Chemical Reactions, Viscosity, Diffusion and Electrochemical Phenomena. By Samuel Glasstone, Keith J. Laidler and Henry Eyring. (International Chemical Series.) Pp. ix+611. (New York and London : McGraw-Hill Book Co., Inc., 1941.) 42*s*.

PHYSICAL chemistry started with van t' Hoff's discovery (1884) of the reaction isochore, which, fundamentally, stood on the same ground as the gas theory of Maxwell and Boltzmann. In the field of reaction rates the ideas of this period produced the mass action law of Guldberg and Waage and the exponential equation of Arrhenius.

Planck's quantum theory (1900) led to a new departure in physical chemistry. Its application to thermodynamics resulted in the third law, which defined in principle the position of chemical equilibria in absolute terms. There occurred, however, no corresponding progress in the field of reaction rates; in fact, for the time being, the nature of chemical change became rather more obscure. Between the classical Maxwell-Boltzmann view of atoms in perpetual motion passing continuously through every conceivable configuration, and the rigid set of stationary states postulated by quantum theory, there was an essential contradiction which paralysed, rather than stimulated, inquiries into the ways by which atoms can pass from one molecular partnership into another.

Quantum mechanics opened a third phase of physical chemistry, in which the theory of reaction rates received a new stimulus. Heitler and London's theory of the electron-pair bond and London's treatment of the three-electron and four-electron problem gave a general— though to begin with naturally somewhat crude—conception of the way in which atoms may become engaged and disengaged in the course of chemical reactions. Since 1929 a steady development has been going on from this starting-point, in which the work of H. Eyring has played the most important part. "The Theory of Rate Processes" was written, as the introductory chapter tells, in the conviction that this last phase has now reached some conclusive results. The book is meant to demonstrate this.

We are thus presented here with a survey which attempts a synthesis of many single contributions in the light of one set of propositions. It is an authoritative effort carried out with vigour, skill and profundity, and its result is a unique achievement. There can be no doubt that all future inquirers in the field of reaction theory will have to start by consulting this work.

Yet there remains the question : Does the book, and the work reviewed in it, fulfil the desire for a theory of chemical reactions ?

The answer is not simply affirmative. There is no single new law claimed here of the kind of the reaction isochore or the third law. We could predict all chemical reactions, if we could solve the quantum mechanical equations ; but that, of course, is a truism. The purpose of the new theoretical apparatus is in fact to find approximate solutions for specific classes of integrals, often circumventing part of the problem by introducing empirical values for terms which cannot be evaluated from first principles. The quasi-empirical method for calculating activation energies, the theory of the activated complex, both in its statistical and its thermodynamical forms, represent a scaffolding by which the general theorems of quantum mechanics can be brought to bear on concrete 'rate processes'. The real question is, therefore, how far they have succeeded in this function.

One claim, I think, can now be made in this respect without much danger of a challenge to the contrary. The modern theory of reaction rates has finally succeeded in establishing itself as an indispensable method of thought. It has become the recognized tool for any detailed speculations in the mechanism of chemical change ; in fact for any intelligent appreciation of the subject. I think that in addition to this a good deal of sound semi-quantitative confirmation has also been obtained. But I would hesitate to pronounce on its finality. In many cases we are clearly yet at the stage where we must be satisfied to account for the observed phenomena, without claiming much certainty for our explanation.

I regret that the juncture between the new theory of reaction rates and the 'electronic theory' of Flursheim, Lapworth, Robinson and Ingold still does not seem very close. The future valuation of the new ideas may largely depend on the extent to which they will prove able to explain more of the remarkable rules which the organic chemist has discovered and has not yet related with any degree of precision to the interplay of atomic forces.

In the light of present achievement and in the hope of further advance, we may recall for a moment the general expectations which have been entertained on the subject of theoretical chemistry for the last thirty years or so. It was about 1912 that I first heard it said in jest, that "You need not bother any longer to learn chemistry, because soon it will all be predicted mathematically". I have heard this kind of joke many times since. Meanwhile it seems to become quite clear that chemistry will never become predictable mathematically; and that, in fact, we have rather to make mathematical physics —in a sense—more chemical. We have to discover a set of empirical simplifications—corresponding to the nature of the chemical properties of matter—which will allow us to crystallize the general equations of atomic physics into a form readily applicable to chemical changes. The "Theory of Rate Processes" will long remain a landmark on this line of progress.

M. POLANYI.

PARACELSUS AS PHYSICIAN

Four Treatises of Theophrastus von Hohenheim called Paracelsus

Translated from the original German, with Introductory Essays, by C. Lilian Temkin, George Rosen, Gregory Zilboorg, Henry E. Sigerist. Edited, with a Preface, by Henry E. Sigerist. (Publications of the Institute of the History of Medicine, the Johns Hopkins University, Second Series: Texts and Documents.) Pp. xiii+256. (Baltimore, Md.: Johns Hopkins Press, 1941.) 3 dollars.

"THE most striking figure among the physicians of the sixteenth century, perhaps in the whole of medical history, is Theophrastus von Hohenheim, called Paracelsus (1498–1541)". This is the considered verdict of the best English historian of medicine. Paracelsus died at the age of forty-eight, after a wandering life, part of which was spent in the mining town of Villach, where he not only studied the diseases of miners, but also acquired a knowledge of chemistry. Some three hundred works have been attributed to him, of which one third have been printed and perhaps not more than fifteen are genuine. He borrowed much, without acknowledgment, from Basil Valentine.

A keen student of the natural sciences, but of a wild and violent temper, Paracelsus attacked Galen and the Galenic tradition with unbalanced aggressiveness. In this way he acted as a kind of bomb, demolishing the old structure that it might be rebuilt by William Harvey and his successors. He was, however, too much of a religious mystic, with his four "pillars" of medicine—philosophy, astronomy, alchemy and the virtue of the physician—to become the founder himself of a new order of medicine. He speculated as rashly as did Galen, far more so than the Hippocratics, whose works present a remarkable contrast in their scientific soberness to the fanciful dogmas of this physician born two thousand years later.

The book under review, the first modern translation into English of any works of Paracelsus, is a labour of love to mark the four-hundredth anniversary of his death. Like all such labours it has been carefully and well done by the four collaborators. From it the reader may gather both the merits and faults of "Lutherus medicorum", as Paracelsus was styled, his interest in drugs, occupational diseases and psychiatry, his self-assurance, conceit and tendency to wild speculation. The fourth treatise of the book is scarcely medical at all, but throws light on the mystic belief in sylphs, nymphs, pygmies and salamanders, the spirits living in the four so-called elements.

Paracelsus was no bigoted adherent of the doctrine *nihil in intellectu nisi prius in sensu*. He was convinced that there is a higher knowledge than that coming through the senses, a knowledge coming direct from God through the agency of the Holy Spirit. A similar belief has been held by many great minds with the religious instinct strongly developed. It inspired the work of Plato and St. Paul, while in a humbler sphere it has guided the lives of millions of simple folk, who have been as sure of its truth as of their own existence.

W. H. S. JONES.

THE INDIAN FARMER

Sons of the Soil

Studies of the Indian Cultivator. Edited by Dr. W. Burns. Pp. ix+128+44 plates. (Delhi: Manager of Publications, 1941.) 2.6 rupees; 4*s*.

INDIA and her politicians, not without good reason, have been much in the news during recent months, but, in the long view, it is her peoples, comprising a vast and varied agricultural population, who will dominate the historic scene. For this reason the attractive and well-illustrated little volume, edited by Dr. Burns, agricultural commissioner with the Government of India, should be carefully read at the present time. The Indian cultivator "is India outside of the towns". His agricultural difficulties are great and of long standing; they are as varied as the territory in which they arise. The object of the sketches in the volume under review is, among other things, to get rid of the idea of the Indian cultivator as a person or type, and to show something of the variety of individuals and classes who cultivate the soil of this immense country.

The several sketches or essays have been written by competent people possessing intimate knowledge of particular regions and their inhabitants, both British and Indian names appearing in the index of contributors. It is a rich and colourful assemblage, in which one notes many points of difference but, fundamentally, with a vein of similarity throughout. From the objectively written articles one forms an impression of an essential plainness of life wherever the cultivator is at work, a similar hard wrestling with the difficulties of soil infertility and the uncertainty of climate; but throughout there is a philosophy and attitude of mind which, financial indebtedness notwithstanding, enable those sons of the soil to live their lives cheerfully and in a spirit not lacking in neighbourly helpfulness.

A THEORY OF THE STRENGTH OF METALS*

By SIR LAWRENCE BRAGG
O.B.E., F.R.S.

THE shear stress at which a metal passes beyond the elastic range and begins to yield is ill-defined. It is very small for highly perfect single crystals, and less for an annealed polycrystalline specimen than for one which has been hardened by cold work. It has often been pointed out that there is no elastic limit in a typical plastic metal, since the apparent stress at which the metal begins to yield depends upon the sensitivity of the means for detecting very small rates of flow. Nevertheless, the elastic limit and ultimate strength of metals can be stated in round figures; were it not so, the engineer would have no basis for his calculations.

It is generally accepted that the effect of plastic deformation by cold-working is to break down each of the crystalline grains, which are seen in polished and etched specimens, into a mosaic of much smaller crystal fragments with different orientations. These fragments have been termed 'crystallites' by some X-ray workers, though this term was originally coined for crystal skeletons, and is so used by the metallurgist (cf. Desch, "Metallography", p. 137), or is used in some countries to denote the crystal grains themselves. They will be termed 'mosaic fragments' here, in order to avoid specifying too clearly their physical nature. Their size may be estimated by the broadening of X-ray diffraction lines which they produce. Progressive plastic deformation of an annealed metal at first breaks down the crystal grains into ever smaller fragments, but there appears to be a limit to the process. An excellent summary of the X-ray diffraction phenomena was given in a paper in 1938 by H. J. Gough and W. A. Wood in the *Journal of the Institution of Civil Engineers*. The changes in crystalline structure during the progressive cold-working of pure copper, silver, nickel, aluminium, molybdenum and iron have been studied in a series of very interesting papers by W. A. Wood[1], and he gives estimates for the lower limiting size of the 'crystallites' ranging from 10^{-4} cm. for aluminium to $0{\cdot}7 \times 10^{-5}$ cm. for copper. Some speculations about the nature of this fragmentation and the factors which govern this lower limiting size are put forward at the end of this paper.

It is not easy to separate the effects of strain, lattice curvature and crystal size upon the X-ray line broadening. However, a picture such as is represented in Fig. 1 will be assumed, where the heavy outlines are those of the original crystal grains revealed by etching, and the pattern inside the grain represents the mass of mosaic fragments or crystallites produced by the deformation, with orientations shown by the hatching, which may vary over a certain range (30° in the figure) or in an extreme case may be quite random.

Although the elastic limit of a metal is so ill-defined, this does not rule out the possibility of a strict relationship between this limit and the average size of the mosaic fragments. Variations in this limit from specimen to specimen of pure metal may be ascribed to differences in this size, and the increasing stress which the metal can withstand with increasing deformation may be ascribed to a corresponding decrease of average fragmentation size during the experiment. It is the purpose of this communication to establish such a relationship. The treatment bears

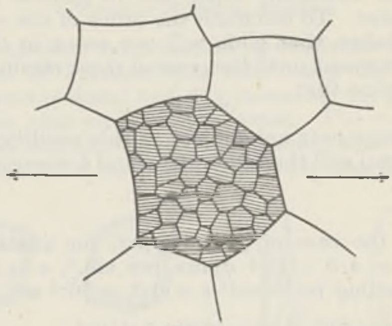
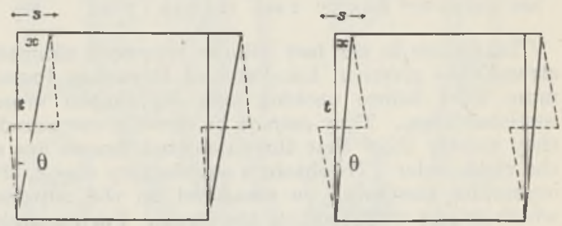


Fig. 1.

some formal analogies to the well-known treatment of the mechanism of plastic deformation of crystals given by G. I. Taylor[2], but it is based on a somewhat different physical interpretation and it is hoped that it has certain novel and suggestive features.

Relation between Elastic Limit and Average Mosaic Fragment Size

In the first place, if Wood's figures for the lower limit of fragment size be accepted, a very simple treatment shows that they lead to an estimate of ultimate strength which is of the same order as that which is observed. Fig. 2 represents a fragment, for



$x > s/2$ Strain decreased by glide — $x < s/2$ Strain increased by glide

Fig. 2.

simplicity supposed to be a small cube of volume V and side t, embedded in the metal matrix. Also for simplicity it is supposed that the general shear strain of the metal in which it is embedded is parallel to the glide planes of the fragment and is in the direction in which glide takes place. The displacement of the top of the fragment with reference to the bottom is given by $x = \theta t$, when θ is the shear angle. Let s be the interatomic distance, which is the unit of displacement of the glide process. It will be clear from Fig. 2 that the fragment, forced into this strain by the surrounding matrix, will not yield by gliding on any intermediate plane unless x is greater than $s/2$, because if x is less than $s/2$, the strain is greater after the glide than before it commenced. To put it formally, glide will only take place if it represents a release of energy, that is, if

$$\tfrac{1}{2}n\left(\frac{x}{t}\right)^2 . V > \tfrac{1}{2}n\left(\frac{x-s}{t}\right)^2 V.$$

$$\text{or } x > s/2, \qquad (1)$$

n being the coefficient of rigidity.

* Substance of a lecture delivered at the Royal Institution on March 31.

This estimate of the critical value for x is a minimum, because the direction of shear has been taken to coincide with that of glide. Actually, glide has to take place along the most favourably situated plane and direction, which are in general inclined to the shear. To calculate the order of the effect, it may be taken that glide will not occur in this particular fragment until the general shear strain reaches such a value that

$$x \sim s.$$

All the fragments are subject to this condition. The whole metal will therefore withstand a shearing stress

$$T \sim ns/t. \qquad (2)$$

To take the case of pure copper, for example, for which $n = 4{\cdot}5 \times 10^{11}$ dynes per cm.^{2}, $s = 2{\cdot}56$ A., and according to Wood[1] $t = 0{\cdot}7 \times 10^{-5}$ cm.:

$$\begin{aligned} ns/t = 4{\cdot}5\times10^{11}.\ 2{\cdot}56\times10^{-8}/0{\cdot}7\times10^{-5} \\ = 1{\cdot}64 \times 10^{9} \text{ dynes per cm.}^2 \\ = 1{,}640 \text{ bars} \\ = 10{\cdot}6 \text{ tons per square inch.} \end{aligned}$$

The figures for several pure metals for which Wood gives a lower limit of crystallite size are as follows:

	t(cm.) Wood	n(dynes/cm.^{2})	s(A.)	ns/t (bars)	ns/t (tons/in.^{2})	Observed elastic limit (tons/in.^{2}) Wood	Observed ultimate strength (bars)
Copper	$0{\cdot}7\times10^{-5}$	$4{\cdot}5\times10^{11}$	2·56	1640	10·6	—	2200
Nickel	$1{\cdot}2\times10^{-5}$	$7{\cdot}7\times10^{11}$	2·49	1600	10·3	—	5000
Silver	$0{\cdot}8\times10^{-5}$	$2{\cdot}9\times10^{11}$	2·88	1050	6·7	—	1300
Iron	$3{\cdot}2\times10^{-5}$	$8{\cdot}3\times10^{11}$	2·42	630	4·1	3·75	2500
Aluminium	$10{\cdot}0\times10^{-5}$	$2{\cdot}6\times10^{11}$	2·86	74	0·48	0·50	600

The figures in the last column represent ultimate strength as given in Landolt and Bornstein (maximum load before necking sets in) / (initial cross-sectional area). They cannot be directly compared; they merely show that the calculated figures are of the right order. To obtain a satisfactory check, the crystallite size must be measured on the material which is just withstanding the stress. For example, Wood and Smith[3] give a stress-strain curve for pure aluminium, which shows an elastic limit for tension of 1 ton per square inch corresponding to a limiting shear stress of 0·5 ton per square inch, which agrees with the value 0·48 ton per square inch calculated on the basis of Wood's estimate of crystallite size in aluminium. Their corresponding figure for pure iron[4] is $7{\cdot}5/2 = 3{\cdot}75$ tons per square inch, which also agrees with the figure 4·1 tons per square inch in the above table. Only the order of the agreement is significant.

The above simple picture of the condition which determines slipping must be modified because no account has been taken of the additional strain in the neighbouring crystallites produced by the dislocations at either end of the glide plane. Although no attempt is made here to calculate this effect quantitatively, the type of modification it will introduce can be seen as follows. Let it be supposed that the dislocation, of amount s, produces an additional strain sf at a point P in its neighbourhood when f is some function of the co-ordinates of P. The additional energy along the two dislocation lines each of length t is

$$\tfrac{1}{2}n\int\left\{(\theta + sf)^2 - \theta^2\right\}2t\,dA,$$

where dA is an area element. The total additional energy is therefore, by integration

$$\tfrac{1}{2}\,nt\,(2s\,\theta\alpha_1 + s^2\alpha_2),$$

where $\alpha_1 = 2\int f dA$, $\alpha_2 = 2\int f^2 dA$ are constants depending only on the function f. Hence the condition for slip becomes, putting $V = t^3$, $\theta = x/t$,

$$\tfrac{1}{2}\,n\left(\frac{x}{t}\right)^2 t^3 > \tfrac{1}{2}\,n\left(\frac{x-s}{t}\right)^2 t^3 + \tfrac{1}{2}\,nt\left(\frac{2x}{t}.s\alpha_1 + s^2\alpha_2\right)$$

$$\text{or } x(1 - \alpha_1/t) > s(1 + \alpha_2)/2.$$

If t becomes so small that α_1/t approaches unity, the strain cannot be released by slip; in other words, the material behaves in a brittle manner. If it is well within the plastic range, it may be assumed that $\alpha_1/t \ll 1$. This would not be true if one assumes Timpe's formula (G. I. Taylor, p. 376, *loc. cit.*), where f is of the order $1/r$, but there is probably some local atomic adjustment in all dimensions which eases the strain at the ends of the glide plane. No estimate of α_2, which measures the energy of a dislocation apart from any pre-existing strain, is made, but if it is small it follows that

$$\text{Limiting stress } T = \alpha\, ns/(t-t_0), \qquad (3)$$

where the constant α is certainly greater than 1/2 and is probably about unity, and $t_0(=\alpha_1)$ is a lower limit of fragment size below which the metal becomes brittle.

A formula of the same general type as (2) is given by G. I. Taylor (*loc. cit.*, p. 379) for the condition that two 'dislocations' should be able to pass one another. The critical shearing force to affect this is given by

$$S = \frac{\mu\lambda}{2\pi h},$$

where μ is the coefficient of rigidity, λ the interatomic distance, h the nearest distance of the slip planes on which the dislocations are situated. I prefer the present way of regarding the problem, because it makes no postulates about the arrangement of the dislocations, but is based on the average fragment size for which there is direct X-ray evidence.

One point may be noted briefly. The yield of one fragment imposes an extra strain on its neighbours, as has been seen above. If they are already strained nearly to the limit, they will yield in their turn. Thus an avalanche of yielding will run right across an individual crystal grain along the mean direction of the glide planes as shown by the arrows in Fig. 1. It may be many fragments in breadth and so of macroscopic size. The explanation of the slipband in some such way has often been proposed, but the above picture perhaps explains it rather more realistically.

To sum up, the point of view adopted here is that it is possible to calculate the limiting stress a metal will stand elastically without making any assumptions about the way glide is initiated or travels in a single crystal, or about the forces required to produce it, beyond assuming they are very small, which is known to be the case. If a mosaic fragment is strained beyond the point at which a glide of one interatomic distance will reduce the strain energy, it is unstable and the glide is certain to take place. This condition by itself suffices to determine the elastic limit. Much emphasis has been laid in the past on the necessity of studying the gliding process and strength of a single crystal before the poly-crystalline metal can be understood. It would appear that, paradoxically, the reverse is the case. The strain hardening of a single crystal is a complex process depending on the progressive deterioration of its perfection, whereas the cold-worked metal has attained a constant statistical average as regards the size of its mosaic fragments, and thus attains the constant strength calculated here.

Physical Nature of the 'Mosaic Fragments' or 'Crystallites'

The cold-worked crystal grain is pictured above as a mosaic of fragments meeting at well-defined interfaces, each having a perfect crystalline pattern throughout its own domain. It is not intended to convey the idea that this is necessarily the true picture. It has certain attractive features which I outlined in a note on "The Structure of a Cold-worked Metal"[5]. The structure was there described as resembling a foam, with movable boundaries able to take up positions of equilibrium. It was shown that such a structure, if momentarily broken down into a very fine scale, would rapidly recrystallize at first up to a certain characteristic size, whereupon the process would become so slow as practically to cease.

Some such effect must exist, in order to account for the constant mechanical strength of the cold-worked metal which is characteristic of it and persists, but other models may give an equally good explanation. What is observed is a broadening of the X-ray line, which may be caused by small crystal size, or by some distortion of the lattice with its consequent strains. The formula (3) for the stress which the metal will withstand is independent of the precise picture of the nature of the fragmentation. Let us suppose, for example, that the cold work produces, not a mass of perfect fragments differing in orientation, but a crimping or waving of the lattice planes so that successive small regions make an angle with each other, but all crystalline coherence of one with the next is not destroyed. The constant t, interpreted above as the dimensions of a fragment, would then become the repetition interval of the crimping. Such a modulation of the perfect crystal spreads the sharp X-ray reflexion into side-bands. By optical principles, the spread of these side-bands due to this modulation at intervals of t is the same as the broadening of an X-ray line produced by independent perfect crystals of width t, although there are certain rather subtle differences in the X-ray diffraction effects which may throw light on the true nature of the fragmentation. The point to be emphasized, however, is that if we suppose the crimping to limit the elementary gliding process to regions of dimensions t, the same dimension t will also determine the broadening of the X-ray lines, and the formula (3) above will hold.

In conclusion, I wish to express my warm thanks to Dr. E. Orowan for helpful discussion and criticism. Dr. Orowan's note on slip-bands in NATURE of April 12, 1941, p. 452, suggested the fundamental idea on which the above explanation of the strength of metals is based.

[1] Wood, W. A., *Proc. Roy. Soc.*, A, 172, 231 (1939).
[2] Taylor, G. I., *Proc. Roy. Soc.*, A, 145, 362 (1934).
[3] Wood, W. A., and Smith, S. L., *J. Inst. Met.*, 67, 315 (1941).
[4] Smith, S. L., and Wood, W. A., *Proc. Roy. Soc.*, A, 178, 93 (1941).
[5] Bragg, W. L., *Proc. Phys. Soc.*, 52, 105 (1940).

THE HAND OF THE APE-MAN, *PARANTHROPUS ROBUSTUS*

By DR. R. BROOM, F.R.S.
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THE block of bone breccia in which the beautiful skull of Paranthropus was found has already yielded us the distal end of a humerus, the proximal end of an ulna and two toe bones. The matrix on which the maxilla rested has remained until recently untouched, as it retains the excellent impressions of

FINGERS OF PARANTHROPUS. NATURAL SIZE.

1. Bones in relative position as found.
2. 2nd left metacarpal and proximal phalanx of Paranthropus.
3. Distal end of 2nd left metacarpal of Paranthropus.
4. Distal end of 2nd left metacarpal of Bushman.
5. Distal end of 2nd left metacarpal of baboon.
6. Palmar side of distal end of 2nd metacarpal of Paranthropus.
7. Palmar side of distal end of 2nd metacarpal of baboon.
8. Side view of proximal phalanx of 2nd left finger of Paranthropus.
9. Proximal end of proximal phalanx of 2nd left finger of Paranthropus.
10. Probably proximal phalanx of 4th finger of Paranthropus.

the premolars and the first and second molars. In this matrix there was exposed a little piece of bone which I thought might prove interesting. On following it in, I found it was part of the well-preserved second metacarpal of the left hand. Close to it I also found two phalangeal bones, and in another piece of matrix much of another phalangeal bone. The distal end of the metacarpal lay within a millimetre of the maxilla.

The metacarpal bone is perfect, except for the loss of the proximal end. It is long and slender, and not like the metacarpals of any of the living anthropoids.

It is more like the metacarpal of the Bushman, but longer and more slender. It is quite certainly not a human metacarpal. In a number of respects it resembles the baboon metacarpal, but it is about a quarter larger than the corresponding metacarpal in a large male *Papio comatus*. The distal end of the metacarpal is essentially cercopithecid in character, and there can be little doubt that there must have been as in the baboon a pair of sesamoids.

We know that in man a pair of sesamoids is present at the distal end of the first metacarpal, and one is frequently present at the distal ends of the second and fifth metacarpals. But radiologists have recently found that other sesamoids are also not infrequently present. There may be one or a pair of sesamoids present at the distal ends of all the metacarpals. It thus seems probable that the ancestor of man had a pair of sesamoids at the distal ends of all the metacarpals, as in the baboons.

The large phalangeal bone is almost certainly the proximal phalanx of the same finger as the metacarpal. It is almost typically cercopithecid in structure, but deeper proximally than in the baboon.

There will doubtless be those who will argue that these skeletal remains do not belong to the skull. I understand that opinions have been expressed that the humerus may be that of a chimpanzee, or even that it is human; and possibly it will be held by some that the hand bones I have discovered are those of a giant baboon. All these skeletal remains were found in the same piece of bone breccia, which is less than a cubic foot in size and which gave us the Paranthropus skull; and as the metacarpal is certainly that of a large Primate, it seems to me probable that the hand, the skull, the humerus, the ulna and the toe bones are all the bones of the skeleton of one individual. If this is so, we get a few interesting facts about the structure of this remarkable ape-man.

A giant Pleistocene baboon, *Dinopithecus ingens*, has, however, been found in the Transvaal, but it is not known to occur at Kromdraai; the only large baboon at Kromdraai being *Parapapio major*, which is not larger than the living baboon. If ever teeth of Dinopithecus are discovered at Kromdraai, the question will of course arise as to whether these hand bones, though closely associated with the Paranthropus skull, are not really bones of the hand of Dinopithecus.

At Sterkfontein there has been discovered a large baboon-like pelvis, with a femur and three vertebræ. These may be parts of the skeleton of Dinopithecus. The femur is considerably smaller than the supposed Plesianthropus femur, and more baboon-like. It is thus possible that Dinopithecus may have been contemporary with Paranthropus, and it may be argued that the finger bones are those of Dinopithecus.

It may be many years before we get a hand of Dinopithecus in association with a skull or teeth, and even if we do I do not see how we shall be able to prove that it is not a hand of Paranthropus in association with a Dinopithecus skull or teeth, unless we also get an associated humerus.

From the shape of the distal end the metacarpal is manifestly a metacarpal of the left hand, and the only point that might be debated is whether it is a 2nd or a 5th metacarpal. The shape of the distal end seems to leave no doubt that we are dealing with a 2nd metacarpal; and if it is a 2nd metacarpal the posterior part of the bone is quite differently shaped from that in the baboon. If we are dealing with a 5th metacarpal, whereas the shaft is like that of the baboon, the distal end is very different. If we compare the bone with that of the Bushman, we find a considerable agreement except that the bone is longer and more slender, and the distal end has clear evidences of there having been two sesamoids in association. All the available evidence points to a closer affinity with the Bushman metacarpal than with that of the baboon, except that as there have been two well-developed sesamoids the distal end resembles considerably that of the baboon. The sesamoids have also led to the proximal end of the phalanx being more baboon-like than man-like.

The little phalangeal bone found beside the metacarpal is manifestly a first phalanx. It cannot be a thumb-phalanx. It might perhaps be the first phalanx of the 5th finger of Paranthropus. If so, the 5th digit would be remarkably small and short. There is, however, another possibility, and even a probability. In the same block of matrix is a fragment of the frontal bone of a small 'baboon'—probably *Parapapio angusticeps*—a small 'baboon' which is fairly common at Kromdraai; and it seems that the most natural determination of this small phalangeal bone is that it is a phalanx of *Parapapio angusticeps*.

This hand is closely associated with the skull of Paranthropus, and it seems to me so much more probable that the hand belongs to the same individual as the skull that I believe that this is the hand of Paranthropus, even though it has some cercopithecid characters. In any event it seems but right to figure the specimens and place the facts before the world that others can consider the matter.

We know that the milk teeth of Paranthropus and Australopithecus have retained many cercopithecid characters lost in the living anthropoids, and we need not be surprised to find cercopithecid characters in the metacarpal and phalangeal bones.

If the hand is that of Paranthropus, then we have a type that has no close resemblance to that of the living anthropoids, but a type somewhat intermediate between that of the baboon and man. This does not mean that Paranthropus is descended from a baboon, but only that the ancestor had retained some cercopithecid characters.

Until recently I inclined to follow Gregory in believing that man has been derived from a primitive Dryopithecid; but as the living anthropoids and most of the fossil Pliocene forms have teeth characters not found in man and the Australopithecines, I now think it more likely that man and the Australopithecines came from a pre-Dryopithecid, a view which is favoured by Weidenreich, and a little like the views of Osborn and Wood-Jones. If the hand is that of Paranthropus, we have additional evidence in favour of this view.

If we compare these hand bones with the large bones of the gorilla, chimpanzee and the orang, we might readily conclude that they are too small for the hand of an animal about as large as a large chimpanzee. But we know that Plesianthropus, which is allied to Paranthropus, had an os magnum even smaller than that of the Bushman, and had thus almost certainly a small, rather delicate, hand. We know that the supposed Plesianthropus os magnum cannot possibly be the os magnum of a baboon; and we are thus apparently justified in holding that the large finger bones very closely associated with the Paranthropus skull really belong to Paranthropus.

SCIENCE AND SOCIETY

By DR. F. SHERWOOD TAYLOR
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At the twenty-first annual general meeting of the University Catholic Federation of Great Britain, which took place at Birmingham during April 10–12, three conferences were held on the theme of "Science and Society". The first conference was concerned with the question, "What is Science ?", and under the chairmanship of Prof. Thomas Bodkin, professor of fine arts in the University of Birmingham, was opened by a paper from Dr. F. Sherwood Taylor, curator of the Museum of the History of Science of the University of Oxford, entitled "An Historical Survey of the Rise of Science".

Dr. Sherwood Taylor pointed out that the rise of science was contemporary with that of civilization. Its first stage was the rational treatment of crafts and the study of phenomena which had religious significance. The Egyptians and Chaldeans were the chief originators of science in its practical aspect, but theoretical science, the philosophy of Nature and natural causes, had to await the genius of Greece, which excelled in the abstraction of general principles, yet was defective in its rash assumption of a universal correspondence between that which the mind conceived as fitting and that which in fact existed. The Greeks, and the immediate heirs of their achievement, excelled in all which could be investigated geometrically, but were comparatively deficient in those sciences which could be acquired only through the discipline of the laboratory, which began to have importance only when the wave of ancient science was fast receding. In the period A.D. 300–1100 Europe was barren of scientific achievement, because wholly preoccupied with political reconstruction, and with the enormous implications of the central fact of human history, the Incarnation. The attitude of this period towards natural science was that speculation with regard to it in no way furthered a blessed life, and so was a culpable waste of time and talents. Meanwhile, the philosophy of Greece blossomed again in Islam, and when it came to Western Europe and was assimilated with Catholic doctrine, Greek science came with it. In the thirteenth century such men as Albertus Magnus, Roger Bacon, Peter Peregrine, Mondino, and the numerous alchemists gave good hope of an age of experimental science. But it was not to be, and the wave of modern science which is yet gathering force took rise from a different source, the Platonic speculations of such men as Marsilio Ficino.

After a century or more, when science was regarded, with natural magic, as an arcanum, the genius of Galileo demonstrated the practice of modern science, while Francis Bacon enunciated its theory. Here came perhaps the most portentous step in world history, the separation of natural knowledge from philosophy and religion. Natural knowledge, by limiting its objective, became cumulative, and ever more swiftly grew to its present bulk. The economic application of science, previously unimportant, became finally predominant. Industrial civilization led to the horrors of exploitation in the nineteenth century, and each succeeding half-century has brought to mankind a more numerous crop of revolutionary inventions. The next half-century is likely to transform the world even more profoundly than the last, for good and evil: Are we to let it proceed without rational direction or control ?

The second paper in this conference was given by the Rev. J. Leycester King, S.J., professor of psychology at Heythrop College, who took for his subject "Science and Reason". He emphasized that a large part of the world's troubles can be traced to a desertion of scientific ideals, the substitution of illusion for fact. Science is alive to the discord and irrationality of the modern world, and to the implications of the policy of tampering with truth, which policy is the antithesis of science. Yet most of those who seek a remedy in science are themselves, consciously or unconsciously, subject to the illusion, long discarded by philosophy, that only what is mediately or immediately observable is real. Science must realize that there are unobservables which are real, and which are within the competence of human thought to study and systematize. These matters are now reserved to philosophy and theology. Science, divorced from these, has made rapid progress, it is true, but this progress has only been possible because science and its workers are embedded in a civilization based upon Christian principles. The knocking away of the Christian foundations of our civilization has already resulted in self-deception, illusion, wishful thinking and unreason, and though we may point in priggish horror at the deliberate distortion of truth practised by our enemies, we are not to forget that we are ourselves already far down the slope of disintegration.

We have been living on our spiritual capital. Our need is not of more science, or of less science, but of formulating an end and meaning of life, perceiving a unity in which the harmony of the manifold appears. Our knowledge of this unity will but increase the purity and vigour of science, for the truth inherent in the whole must subsist in the sub-wholes which form our field of investigation. Science must be re-married to philosophy, which alone can provide a datum-line of immutable principles, about which oscillate the dogmas of science, of which so many have been proclaimed as infallible, then modified, and at last abandoned. Separated, philosophy and science must fade and pine: united they have the grandest of futures.

The second conference, under the chairmanship of Dr. Hugh O'Neill, chief metallurgist of the London, Midland and Scottish Railway, was concerned with the social impacts of science, and was opened by Prof. Louis Renouf, professor of biology at University College, Cork, with a paper entitled "The Influence of Modern Biology". Modern biology, he indicated, begins with Darwin, and since its inception has exerted the most conspicuous influence on human thought. Darwin's notion of organic evolution was intended to be, and in fact proved, a most valuable working hypothesis for science, but in the able hands of T. H. Huxley, and later as "travestied by Haeckel", it became the foundation of the materialistic biology which has vastly influenced the popular beliefs of the modern world. Biology and physiology have entered the field of human behaviour; the attempts made to account for moral codes in terms of endocrine glands are good examples of their more extreme methods. To-day social biologists have enormous prestige and popularity, and problems of human society have come to be thought of in biological terms. It is of the greatest importance, then, that the biologist should be fitted for his present responsibilities. But, in fact, the greatest part are reared in a materialistic atmosphere, and acquire a philosophy which is manifest in the first-class research work which is to-day being presented in an irrelevant matrix of Marxian philosophy. Catholics, and indeed Christians in general, are at fault in looking upon all forms of science with a timidity that is a relic of a past defensive attitude. There is a great need for more Christian men of science, especially biologists, who may oppose a truly personalist attitude to the decadent views falsely put forward as the answers of science to the human problems of marriage, education and family relationships. One of the most important steps to be taken is the proper education of medical men. The medical course is long, and commonly admits of few but professional studies, whereas it is most desirable that medical men should have some knowledge of sociology, the arts and the elements of philosophy. A preliminary year's course of humanistic studies would be of great value to men who will have so important a position in the social structure.

There followed a paper on "Science and Man" by Dr. H. P. Newsholme, professor of hygiene in the University of Birmingham. The most important effect of science on the community was its example of single-minded search for truth, and discarding of emotional and personal feelings ; but this setting aside of all but the material aspect of things, though it arise from a recognition of the incapacity of science, may lead to the implicit assumption that the material aspect alone is worthy of consideration. This limitation of outlook has led to correspondingly defective results. Thus Freud did good service in opening up the subconscious, but failed to recognize in it an avenue of God's approach to man. In the region of the physical life and of social environment the debt of humanity to science has been incalculable. But though the health and comfort of man has been increased, the troubles of his spirit are left untreated.

The great prestige of science has led society to respect the opinions of its workers, and their implicit materialism has contributed to the formation of a materialistic society, which in turn rears more materialistic scientific workers. Not only science, but also almost every human activity, has become dissociated from religion, and the immediate consequence has been their exploitation by the selfish. Scientific agriculture has led to denudation and sterility ; family limitation is depleting the population and degrading it by separating the pleasures of sex from its responsibilities. Furthermore, the exaltation of the physically fit as alone worthy of survival threatens the world with the arrangement of mating on physical grounds, with sterilization of the so-called unfit, and with euthanasia, which leads by a short step to the deliberate 'elimination' of the aged, mentally deficient or incurable. In the realm of ideas the effect has been even to extend natural law beyond its function, which is the summation of past events. Such events as find no place in the records of science, for example, miracles, such as the Resurrection, the greatest of them, are sometimes denied ; and theories, such as that of organic evolution, are extended from body to mind. If science had retained its association with religion, it might have grown more slowly, but the product would have been richer and more significant, and the world would have been protected against the worst types of exploitation of the powers of science.

The final conference was presided over by the Right Rev. Bernard Griffin, Bishop Auxiliary of Birmingham. The Rev. Philip de Ternant contributed a paper on "The Place of Science in Education". His title, he said, was not science in the school, which is another subject. At the time of Alcuin the concept of a scholar was primitive but comprehensive. The old Trivium and Quadrivium contained the germ of scholasticism and of *universities* : it involved recognition of the *unity* of the *universe* and of the spirit of man. One idea may be seen to underlie these three forms of a single word. As material knowledge increased, specialization became necessary, but to-day's is much overdone in response to the utilitarian age. Our task is to create a reversion to the older type of scholar and to re-integrate the scattered elements of knowledge, now known only collectively as science. The great specialists are noteworthy for the breadth of their basic knowledge, but men of science generally lack philosophy to-day. The true purpose of a university has been disnatured by fetishes, popular and scholastic. The width of outlook and general interest formerly displayed in the older "Academes", from the Royal Society down to local field clubs, and in the followers of nature hobbies in the family circle itself, is much needed to-day.

The Rev. Philip de Ternant advocated the 'perennial' philosophy of St. Thomas Aquinas and his modern followers, such as Maritain, in opposition to the widespread aberrations of to-day, and asked for a primer or handbook on the subject adapted to the use of science students. He regretted the obscurantism of the public and of certain pious people. St. Thomas had established that the study of natural science is a religious duty, as leading us, first to consideration and admiration of the Divine Wisdom, thence to reverence, fear and especially love, when the goodness and beauty of created things attracts the souls of men and leads to a comparison of the same things in a higher form in God ; finally it sets up in men a certain similitude of the Divine perfection and wisdom. So, also, a wrong notion of the nature of creatures leads us to think they are all that exists, and that men are subject to laws which do not exist. So, argues St. Thomas, that opinion is false which says that it matters nothing to religious faith what anyone thinks of creatures, so long as he is right with God ; for error concerning creatures leads to a false idea of God, and so leads minds away from Him. Therefore scripture threatens with penalties, as if they were pagans, those who have a false idea of natural facts : "Because they have not understood the works of the Lord, and the operations of his hands : thou shalt destroy them and shalt not build them up" (Ps. xxvii, 5).

QUANTITATIVE AND QUALITATIVE METHOD IN SOCIOLOGICAL RESEARCH

THE principal item on the Saturday (April 11) meeting of the British Psychological Society at Brighton was the open discussion in the evening between Mr. Henry Durant of the British Institute of Public Opinion, and Mr. Tom Harrisson of Mass-Observation. Mr. Durant opened the discussion by supporting the proposition "that Empirical Methods in the Social Sciences should be Predominantly Quantitative".

Social scientists should, in their empirical work, endeavour to employ methods and concepts producing quantitative results. In Mr. Durant's view, organized science in the physical world is based upon measurement. These measurements can be tested and verified because they are based upon units of measurement which are objective and can be handled by any investigator. By insisting upon the quantitative method and developing its use in every direction possible, more and more phenomena are being reduced to quantitative terms. Biology took an immense step forward when genetics with its statistical basis was developed. Sound has been provided with its unit of measurement and is but the last in a list of qualities which can now be handled quantitatively. It is true that some physical sciences, for example, physiology, are not, at the present time, predominantly statistical in character. It is also true that the work of the biochemist and the crystallographer is rapidly providing a quantitative, mathematical basis for sciences such as physiology.

In the social sciences, Mr. Durant said, it is possible to point to quantitative elements in a discipline so 'qualitative' as psycho-analysis. Freud develops the concept of displaceable energy which can attach itself to either the ego or the id. If there is reality in this concept, units of measurement will inevitably be developed, and actually work along these lines is being done at the present time. Prof. J. D. Bernal, in a recent paper read before the British Association, discussed the importance of obtaining statistical data by means of social surveys. "It is true that we have not got accuracy to seven figures, but without a snap survey action has to be taken with no figures at all, and even one figure arrived at roughly marks an enormous improvement, mathematically an infinite gain."

Mr. Durant thinks no one should hope that social science can be reduced solely to statistical data. In every investigation the man of science, whether or not he is aware of it, is employing a social theory. The problems he investigates, the concepts he adopts, are in all cases part of a much larger whole which, when consistently extended, temper of the physical scientist. He must try to test his hypotheses by observation, since experiment is largely denied to him. It is no argument that the social sciences are still young and must, therefore, be content with the qualitative methods which formerly characterized all sciences. The history of science indicates that progress is most rapid when there is the most vigorous insistence upon exact statistical measurement. Often the unit of measurement is difficult to develop and the technique of measurement presents even greater problems. It is the task of the social scientist to overcome these difficulties in his own field, for only by these means will he be able to eliminate the subjective bias which characterizes so much work which is being done at the present time in the social sciences.

Mr. Tom Harrisson, opposing Mr. Durant's arguments, stressed first of all the scope of disagreement and discussion. He agreed, of course, that quantitative methods are essential in all empirical studies. The difference of opinion here was not on the method but the emphasis; he rejected the conception that such research *must* be predominantly quantitative. It should be secondarily quantitative. Parallels with the physical sciences can be misleading, because they have already a living tradition of procedure, accepted research standards, a great body of proved and agreed basic theory and theses. The social sciences, unfortunately, developed much later, and there is still no common outlook or interchange within the whole field of social research. Empirical work has been scrappy and diffuse; much of it has been quantitative and the proportion has increased very much lately. The War has given a big fillip to the social sciences, for in the present periods of vast social and psychological change, new problems present themselves to Government departments and others, which urgently require attention from the psychologist, the sociologist and the student of public opinion.

Social science has not been well enough based and organized to respond to this call equally at all levels. It has tended to answer largely with quantitative studies, often without adequate appreciation of the background facts; there has been a tendency to assume that because some human factor can apparently be measured in percentage terms, the study is, therefore, necessarily 'scientific'. The useful device known as the 'random sample' has provided an easy method for studying what people *say*. A few thousand interviews give a picture which will not be appreciably altered by interviewing the whole population. This quantitative method has, therefore, attracted much of recent social science. But because results are statistically consistent, it does not follow that they do not give a 'false' picture. By themselves they may be misleading, especially because we are still completely ignorant of the relationship between what people say to a stranger (the interviewer) and what they say to a friend; or between what people say, think and do. We are not yet in a position to know what weight can be attached to verbal behaviour; and at present we use interviews indiscriminately at our peril.

Mr. Harrisson feels that increased emphasis on this crude quantitative approach through the interview, without corresponding developments along other lines, such as observational technique, individual analysis, and penetration study of institutions, is unsatisfactory. In our present state of limited knowledge in social science, particular importance is attached to the full qualitative understanding of human phenomena, and at this stage the main function of quantitative methods, important as they are, is to act as a check, corrective and extension of the qualitative approach.

The social sciences have been slow to develop in Britain largely because the most educated and intelligent sections of the community are removed from the life of the mass of people who left school at or before the age of fourteen. It is difficult for the university professor to get down into the homes and hearts and minds of these people; few have done it objectively and over any length of time. Sociologists have long been conscious of this dilemma, and the sample method offered a way out—you ask people about themselves on a set questionnaire, or you pay others to go and ask for you, then tabulate the results in statistical detail. These results are important, in Mr. Harrisson's view, and there is room for many more of these studies, especially on the lines of the careful work done by the Wartime Social Survey; but to suppose that social science is thereby scientific, and that it can in fact progress far along primarily quantitative lines before the fundamental premises of method are proved (for example, the validity of social class, the distribution of temperamental types, geographical factors in outlook) is an abuse of the word 'science'. This word is too loosely used in the social sciences, where many of those concerned have not been trained in scientific method but on philosophical lines, so that they too easily accept decimal points as objective data.

Mr. Harrisson urged that we need less partisanship in social science, which is still embryonic. Every method, every study at this stage should be encouraged. But the primary and vital acts of empirical social study must always be qualitative. Mr. Harrisson welcomes the increase in quantitative methods, but deplores the growth of the idea that *only* such methods are socially scientific, an idea which is reflected in the wording of Mr. Durant's submission on this occasion.

In the discussion that followed, a wide divergence of view was expressed.

Dr. Gertrude Wagner spoke of the combined qualitative and quantitative method, and the need for social scientists to observe their own problems, to think them out qualitatively, then confirm their hypotheses by means of the quantitative method. She expressed the view that the only difference between Mr. Durant and Mr. Harrisson was as to whether there should be two hundred or two thousand interviews. Mr. Harrisson did not agree with Dr. Wagner on this, stating that there are sides of social science where no interviews are required, and current engrossment in the interview method was one of the things he was criticizing.

Dr. L. P. Richardson pointed out that the qualitative process is an essential initial step even in elaborate quantitative studies, as in the minutely accurate measurement work he had done in earlier days at the National Physical Laboratory. In comparing the weight of two bars of metal with the exactness required, it is still necessary to select the right bars for comparison by a qualitative act.

Dr. P. Senft discussed, in some detail, the philosophical relationship between quantitative and qualitative methods. Novelists like Proust and Stendhal have generally shown a far greater insight into human nature than psychologists and others approaching the same phenomena by quantitative methods.

Dr. Millais Culpin outlined some of his experiences during the work of the Industrial Health Research Board; he found the debate very like those he had heard long ago in medicine. It all boiled down to the old argument between those who were content to ask: What ? and those who were also concerned to know: Why ? The quantitative method is likely, if handled thoughtlessly, to lead into an interminable pursuit of the What, though the social sciences must be concerned very much with the Why.

Prof. M. Ginsberg expressed himself in favour of Mr. Harrisson's views. The idea that social research methods could be predominatingly quantitative, and that qualitative methods must merge into quantitative, is absurd. The suggestion that there is no real distinction between the two approaches is unsound. Quality does not pass imperceptibly into quantity. The two are distinct, and there are, in addition, many sorts of quality. The quantitative and qualitative approaches in themselves involve different concepts.

Dr. G. H. Miles's experiences in the field of market research have disillusioned him about crude quantitative methods in social study. He has seen elaborate statistical investigations which were built up on unsound methodological assumptions, such as a survey in which people were interviewed on certain food habits. They claimed to eat more butter than they could conceivably have consumed. For people often do not know what they really do, and more often give answers which show them as respectable citizens; people always want 'to show up well' in the interview.

Mr. Harrisson said that the discussion had cleared the air in a useful way. So long as social scientists were ready to interchange views and argue things out in a friendly atmosphere, so long would this be a vital and growing subject. There has been too much sociological over-sensitiveness to criticism in the past. Elasticity of outlook is necessary for the advance of any science; the development of science is largely the process of correcting somebody else's error.

Mr. Durant expressed the view that there had been a substantial body of agreement, and for his part he could not see any real difference of opinion, for he felt that in the end everything became quantitative.

PRODUCTION OF OPTICAL GLASS IN AUSTRALIA

By PROF. E. J. HARTUNG
University of Melbourne

THE manufacture of optical instruments of many kinds for the Armed Forces has become an important section of the extensive programme of munitions production undertaken by Australia in the present emergency. Of necessity, a new and complex industry of this type had to cope with many initial problems, among which the supply of suitable optical glass soon began to cause anxiety. Some glass was obtained from Great Britain and the United States, but in the dark months following the capitulation of France optical glass of good quality and in sufficient quantity was not obtainable. In certain directions, the need became so great that spectacle lenses were used, and blocks of glass for the prisms of tank periscopes had to be made by welding together many sheets of plate glass.

The decision to undertake the production of optical glass in Australia was made in the latter half of 1940, and subsequent events have shown most thoroughly the wisdom of this policy. About fourteen months after the first experimental work was initiated, full-scale production of glass of admirable quality commenced and has continued uninterruptedly, so that Australia is now not only completely independent of external supplies but is even exporting optical glass to other countries. This achievement has been due to close co-operation between the Chemistry Department of the University of Melbourne and the technical staff and facilities of Messrs. Australian Consolidated Industries Ltd., to which organization the actual production of the glass was entrusted. It is also a pleasure to record the very willing assistance received from the staff of the National Bureau of Standards, Washington, who placed freely at our disposal their extensive knowledge of technical details, thereby saving us much valuable time.

The original programme called for the production of six standard types of optical glass; this number was afterwards reduced to four which are now in production, but all six were made successfully in the

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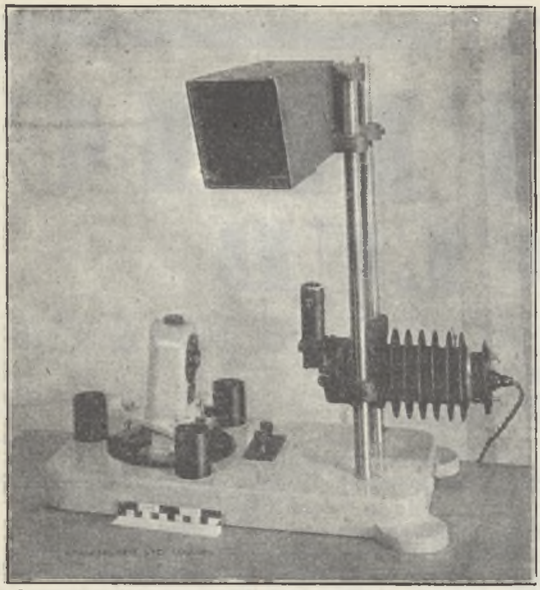

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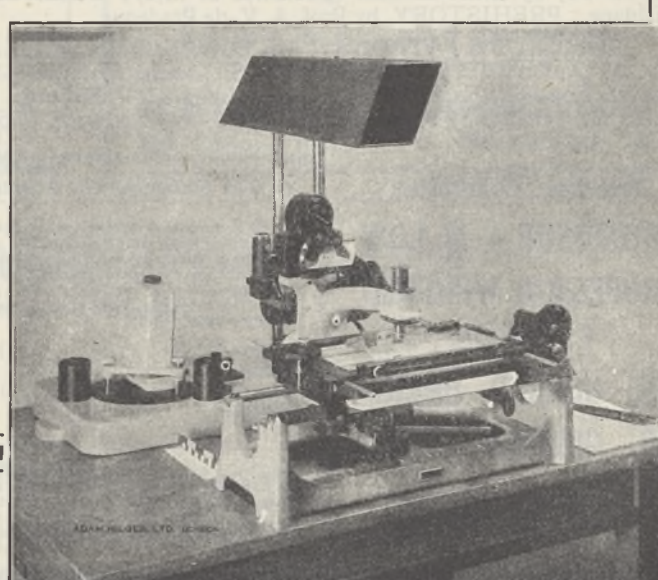

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laboratory. There were two main problems: (a) suitable raw materials for the glasses; and (b) suitable fire-clays for the pots. Fortunately, excellent sand was available in quantity, being in regular use for making flint glass for table ware. This sand contains less than 0·01 per cent iron oxides and the optical glasses made from it have proved to be almost ideal in regard to freedom from colour and turbidity. Other raw materials of high purity were soon located and removed further anxiety in this respect. The main experimental investigation was therefore directed to the selection of suitable pot-clays. About eighty specimens from various parts of Australia were examined as to refractoriness under load, shrinkage, chemical composition, especially iron and titanium content, texture and workability. From these about ten clays were selected for further trial; these were suitably blended and fashioned into small open pots holding about 2 lb. of glass each. These pots were fired in a small gas furnace and the glass batch introduced through a silica tube into the pot at 1,400° C. until the glass was in quiet fusion. After stirring with a silica rod, the pot was heated at a steady temperature (usually 1,450° C.) for 12 hours, cooled down, cracked open and the glass examined for pot contamination.

In such small pots, it was, of course, impossible to make optically homogeneous glass, but the resistance of the clays to glass attack and their general quality under the severe test conditions could be readily ascertained. It was felt that the results of these tests could be applied to the construction of suitable large pots with safety, owing to the better volume-surface ratio in the latter and the lower and more controllable temperature to which they would be exposed. These expectations were realized, and it was also found possible to slip-cast the large pots and dry them ready for the pot arch in about six weeks. As these pots can be raised to the temperature of the melting furnace in 4½ days, a great saving in time is thereby accomplished.

The pot-making and optical glass annexes have been very simply constructed to facilitate handling and reduce labour to a minimum. The capacity of the former is amply sufficient to maintain a supply of pots for a one-day melting schedule for the glass, which in turn reduces shift problems and operating costs, while the pot-handling and the stirring equipment is simple and efficient. After inspection of the chunks of glass from the pot, they are softened and moulded into the required blanks in special steel moulds which produce a very clean product, thus requiring only small tolerances. These blanks are then annealed in electric annealers before being finally inspected.

A most satisfactory feature of the production has been the high yield per pot (55–60 per cent) of usable glass, most of it of very high quality. For example, measurements by the National Standards Laboratory of Australia have shown quite remarkable constancy in optical properties of the glass from various parts of an individual pot, combined with very satisfactory freedom from striation or other blemish. Tests on eight consecutive melts of borosilicate crown yielded a mean refractive index (Na) of $1 \cdot 5100 \pm 0 \cdot 00023$ and barely detectable differences in dispersion. Indeed, the glasses now being produced fall in properties well within the tolerances set by the Australian Optical Munitions Panel, and ensure, therefore, an abundant supply of excellent material for munitions purposes.

OBITUARIES

The Very Rev. Sir George Adam Smith, F.B.A.

THE VERY REV. SIR GEORGE ADAM SMITH died on March 3 at his residence, Sweethillocks, Balerno, Midlothian, in his eighty-sixth year. A native of Calcutta, he was son of George Smith, who had a high reputation not only as a journalist but also as a biographer of missionaries. The young George was brought to Edinburgh, where he was educated at the Royal High School and the University. His university period does not seem to have been marked by any special distinction in examinations, though I fancy he must have taken a high place in the English class, if we are to judge by his writings. But he made valuable friendships there with such men as Henry Drummond, R. W. Barbour, Thomas Shaw (afterwards Lord Craigmyle) and R. B. Haldane, the great philosopher and war minister. His attachment to Edinburgh remained deep to the last. As a member of the Free Church of Scotland, he naturally proceeded to New College for his divinity course, when he had decided on the ministry as his life's work.

These were days of high tension in ecclesiastical circles. Smith must long have felt a strong attraction to the Old Testament, which contact with the celebrated teacher, 'Rabbi' A. B. Davidson, could only tend to accentuate. At that time the name of William Robertson Smith was on every lip in Scotland. He had imbibed in Germany what were then advanced views on the sources of the Pentateuch and on other Old Testament problems, and had set them forth in notable articles in the *Encyclopædia Britannica*. As a result he was tried for heresy by the General Assembly, and was ejected from his chair at the Aberdeen College.

George Smith, who had studied at two German universities after his Edinburgh courses were finished, and had afterwards travelled in Egypt and Syria, became an assistant minister at Brechin, but was soon appointed to carry on the work of Robertson Smith's chair, and thus had his introduction to Aberdeen, where he was destined to spend a large portion of his life. The extension of the city westwards had led to the erection of a very handsome church at the point known as Queen's Cross. The Aberdonians of those days were famous as church-goers and sermon tasters, and the members of this church were early convinced that Smith, who had been heard in various pulpits, must become their minister. He remained in this position for ten years, 1882–92, and built up a lasting reputation as a brilliant preacher and faithful minister.

Smith was able in the course of that period again to travel in Syria and east of Jordan, and subsequent visits served to confirm a knowledge of that region such as very few Hebraists in our time have attained. Not only was he the best interpreter of the Old Testament prophets to his generation, but also he had a very keen eye for the influence of geography on history. His "The Book of Isaiah" (1888–90), which grew in part out of his sermons at Aberdeen, made him known throughout English-speaking lands. The year 1896 was marked by the first of a number of visits to the United States, where as lecturer, preacher and public speaker he gained a high reputation. Perhaps the most notable of his works is his "Historical Geography of the Holy Land" which, originally published in 1894, reached a twenty-sixth edition in 1935. He set an example to other scholars by issuing revised editions of several of his works, including this, some years before his death.

On appointment to the chair of Old Testament languages, literature and theology in the United Free Church College at Glasgow, Smith had left Aberdeen in 1892. In Glasgow he found time to take an interest in social problems, such as the life of the very poor in that vast city. When in 1909 the Crown appointed him to succeed Dr. John Marshall Lang as principal of the University of Aberdeen, there was a good deal of ill-feeling in Church of Scotland circles, but this was soon lived down, especially as no one on the United Free Church side rejoiced more in the re-united Church of Scotland than Smith did. (He had been Moderator of the United Free Church Assembly in 1916–17.) It is perhaps too soon to sum up his twenty-eight years principalship, but two things may, I think, be said, that the relations between University and City were cemented as never before, and that the power of the University Court was increased at the expense of the Senatus.

If Smith was a brilliantly successful man, he did not escape sorrow. The first and second of his three sons were killed in the War of 1914–18, and his second daughter died a few weeks before her father. He was a man of deep feeling and ceaseless activity. His life was as full perhaps as that of any academic person of his time. It merits and will no doubt receive an adequate biography. His portrait was painted at least three times, by Aiken, Orpen and Souter: the second is at King's College, Aberdeen, the third at Trinity Hall, Aberdeen. A. SOUTER.

Lieut.-Commander L. C. Bernacchi

LIEUT.-COMMANDER LOUIS CHARLES BERNACCHI was born in 1876 in Tasmania, and spent his early years in Melbourne, where his father was astronomer to the State Government. The call of physics, and especially of magnetism, therefore came naturally to him, and at the age of twenty-two he went as physicist to the first expedition which ever wintered on the Antarctic continent. This was the Newnes Expedition of 1898–99, led by Borchgrevink, which wintered at Cape Adare, within two hundred miles of the south magnetic pole.

Bernacchi had only just returned from that journey when he joined the National Antarctic Expedition of 1901–4 under Captain Scott, and he was the author of several physical reports after its return. Magnetism is often thought to be one of the more sedentary sciences, but it took Bernacchi on a thirty-day sledge trip on very short rations out over the featureless Ross Barrier with a Barrow dip circle with which he took observations each night after man-hauling all day. Scott's narrative in fact nearly always associates the word "energy" with Bernacchi's name. Two magnetic huts which he built at Hut Point were, ten years later, to prove a godsend to a marooned party of men who found building material from them, bricks for blubber stoves, lamps and copper sheets and brass tubes, so that his name became a household word for anyone seeking such things. There was even cement in not too desperate a condition.

Returned from the south, Bernacchi travelled again, this time in tropical regions, but a few years later found him forsaking physics and the wilds for a life in the City of London. But his interest in polar work never diminished, and in one way or another he was associated with most of the later expeditions.

His energy and almost restless interests took him into many fields—economics, civics and politics—as well as leading him to serve on many committees and councils.

After the War of 1914–18, in which he served in a special branch of the R.N.V.R., his polar interests crystallized in a very practical form by his taking a leading part in the formation of the Antarctic Club, of which he was the senior member. It is the pleasant custom of that Club at its annual dinner for the president to take wine in turn with the representatives of each successive expedition to the south. No member of the Club is likely to forget the sturdy figure with its genial smile which year after year rose to the first call of the evening: "The President wishes to take wine with the member of the Southern Cross Expedition of 1899, Commander Bernacchi".

FRANK DEBENHAM.

Dr. Adrien Loir, M.B.E.

A DIRECT link with the life and work of Louis Pasteur was severed by the death in Paris of his nephew, Dr. Adrien Loir, on December 16, soon after he had entered his eightieth year. His father, who was professor of chemistry at the University of Lyons, trained him in laboratory technique so that he might help Pasteur in his experimental work. The youth was fortunate in having been chosen by his uncle to accompany him in September 1882 to Bollene in the Department of Vaucluse, where Pasteur and Thuillier, during the next two and a half months, investigated an outbreak of *rouget* (swine erysipelas). During 1882–88 Adrien Loir assisted Pasteur in the little laboratory in the Rue d'Ulm. This was a notable period in the active life of Pasteur, for it included his researches into the treatment of hydrophobia in man and the prevention of anthrax in domesticated animals.

Dr. Loir helped to establish a number of Pasteur institutes in various parts of the world: in St. Petersburg in 1886; in Sydney in 1889; and in 1893 in Tunis, where he remained as director for nine years. He held a chair in the University of Montreal during a two-year stay in Canada, and he then returned to France on his appointment in 1909 as medical officer of health of Havre; he continued in this post until his retirement in 1939.

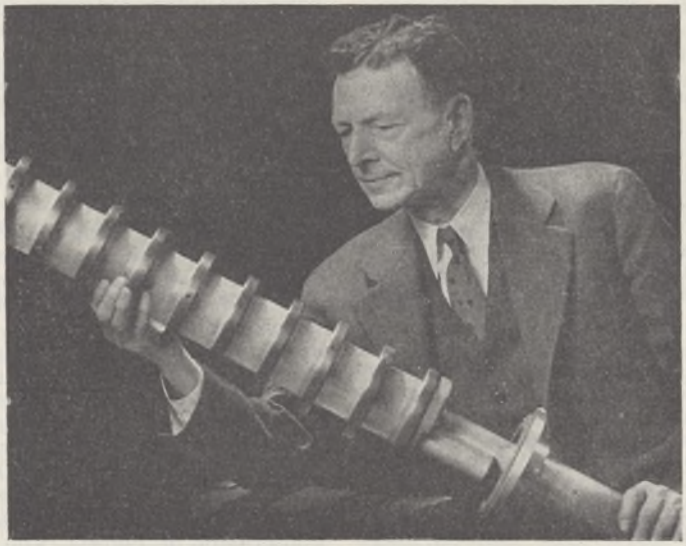
Loir published papers on public health problems such as infant mortality and the prevention of typhoid fever; and he had an international reputation for his knowledge of methods for reducing the rat population in seaports. He was hopeful that good results might be obtained by the use of special breeds of rat-catching cats, but later he realized that the prevention of rat infestation and indirectly of the spread of plague infection consists essentially in applying general hygienic measures and, in particular, in making it impossible for rats to find food and shelter.

Dr. Loir proved to be so helpful to the British authorities in the War of 1914–18, when Havre was an important base for British troops, that he received the award of the M.B.E. for his services. Many honours and distinctions, including the degree of doctor of laws of the University of Glasgow, were bestowed upon him during his varied and useful career.

NEWS and VIEWS

Dr. W. D. Coolidge: Duddell Medallist

THE eighteenth Duddell Medal of the Physical Society has been awarded to Dr. William David Coolidge in recognition of his pioneer work in the production of ductile tungsten and, more especially, of his invention and subsequent development of the hot-cathode high-vacuum X-ray tube which is everywhere known by his name. The medal was formally presented to him on May 1 by Viscount Halifax, H.M. Ambassador in Washington, at a dinner of the American Physical Society at Baltimore. Born in 1873, Coolidge began life on a farm in Massachusetts. He found means of entering the Massachusetts Institute of Technology, where he graduated in 1896 and remained until 1905, except for a short period at Leipzig. He then joined the staff of the Research Laboratory of the G.E.C., Schenectady, N.Y., becoming assistant director in 1908, associate director in 1932, and finally director of research and vice-president of the Company in 1940. He has been widely honoured both in his own country and in Europe: of several universities he has received honorary degrees, and of many learned societies he is an honorary member or a medallist; in Great Britain he has received the Hughes Medal (1927) of the Royal Society and the Faraday Medal (1939) of the Institution of Electrical Engineers.



DR. W. D. COOLIDGE

The Coolidge tube is described in his original paper as "an X-ray tube with pure electron discharge." Unlike the older cold-cathode gas tubes, it affords exact control of both intensity and 'hardness' of the radiation through the adjustments of the filament current and the accelerating potential difference, and operates continuously without change in either respect. During the War of 1914–18, Dr. Coolidge produced complete X-ray field installations including specially designed tubes of large thermal capacity, and later he developed self-contained oil-immersed outfits, which became widely applied in dentistry and in industrial laboratories on account of their easy manipulation. For high voltages he developed a multi-section tube with intermediate tubular electrodes for step-by-step acceleration of the electrons; in the accompanying photograph Dr. Coolidge is holding a million-volt tube of this type. Such tubes have been used for deep therapy under closely controlled conditions, and for the examination of materials in industry. In other tubes of this type the electron beam is made to emerge through a 'window' in the tube, and its effects have been investigated.

Ministry of Works and Planning

THE Ministry of Works and Planning Bill, which received its second reading in the House of Commons on April 29, while recognizing the principle that private profit must not be allowed to regulate the surroundings and conditions of our life after the War, is, as the Paymaster-General admitted in his speech, a very small step towards the solution of problems of planning. The purpose of the Bill is to provide for the transfer to the Minister of Works and Planning of all the existing functions of the Commissioners of Works and the Commissioners of Public Works in Ireland, and of the existing town and country planning functions of the Ministry of Health (but not its housing powers). The precise relations of the Minister of Works and Planning and the Paymaster-General are obscure, nor is it clear how far the transfer of powers goes. The Bill is, however, a step forward towards the creation of the central authority for planning in Great Britain, put forward by the Uthwatt Committee in its first recommendations.

British Reconstruction Associations

A BROADSHEET entitled "British Reconstruction Agencies" recently issued by P E P (Political and Economic Planning) affords a valuable supplement to the summary of research activities in this field included in the "Destruction and Reconstruction" issue of the *Architectural Review* of last July. Apart from its handier form for reference, the broadsheet includes, in addition to particulars of official agencies for physical reconstruction and of committees and voluntary organizations concerned with particular aspects, notes on the Inter-Allied Relief Bureau groups working for the Allied Governments, and organizations for the study of international reconstruction. An introductory note stresses the importance of a bold reconstruction policy as an essential part of the War effort. This was emphasized by Sir Stafford Cripps early in March and is one of the keynotes of an admirable report "The Old World and the New Society", issued by the Labour Party last month. The greatest weakness of British studies on reconstruction at present, says the broadsheet, is that they are not clearly enough linked with the War effort, and while many regard 1942 as the decisive year of this War, fewer seem aware that it may equally be the decisive year for the peace. Both may be lost if we cannot now convert the fight of the United Nations into a genuine crusade for a supreme moral principle and for the building of a people's civilization out of the civilization of a privileged few. Great Britain in particular needs to grasp this relationship of reconstruction policy to the War effort, and to recognize that the vision of a new order at home and abroad is an indispensable weapon both in the waging of a war and in the winning of a peace.

The United States and the War

WRITTEN before the United States entered the War "The Arsenal of Democracy" (Oxford Pamphlets on World Affairs, No. 53. London: Oxford University Press. 4*d*. net) still gives a pertinent account of the economic contribution of the United States towards the defeat of the Axis powers. After describing the movement of American opinion towards aid to Britain and her Allies, and the successive stages of American action before and after the passage of the Lease-Lend Act, Mr. A. J. Brown discusses the war-potential of the United States and its mobilization. His pamphlet gives a lucid account of the problems of the transfer of a peace-time economy to a war-footing and, if supplemented by current articles of the type appearing in recent issues of *Fortune*, should enable the reader to assess reasonably the significance of the bottlenecks of machine tools, skilled labour and raw materials. The labour and administrative problems are clearly displayed and the American contribution in shipbuilding, aircraft production and other supplies is fairly indicated; there is a useful appraisal of the relative strength of Great Britain, the United States and the U.S.S.R. in comparison with the Axis powers and with special reference to the time factor.

Academy of Sciences of the U.S.S.R.

A GENERAL meeting of members and corresponding members of the Soviet Academy of Sciences was held in Sverdlovsk, in the Urals, during May 2–7, to discuss the plan of scientific research work for 1942. The following papers were read: "Urgent Tasks of Science in Mobilizing the Resources of the Eastern Districts of the U.S.S.R. for the Needs of Defence", by Profs. Komarov and Bardin; "The Tasks of Social Science in the War", by Prof. Alexandrov; "Some Fundamental Problems of Agricultural Science", by Prof. Lyssenko; "Physics and the War", by Prof. Joffe; "Biology and War", by Prof. Orbeli; "The Teutonic Order, its Early Successes and Final Defeat", by Prof. Tarle; "Historic Documents of the Red Patriotic War", by Minsky. The meeting also discussed the adjustment of the Academy's work in accordance with the needs of the War.

Medical Progress in China

IN a recent lecture published in the *Asiatic Review* of April, Dr. W. H. Woo gives an interesting survey of medical progress in China from the earliest times. The origin of native medicine can be traced back to the earliest Chinese emperors, who flourished three or four thousand years ago. So early as the Chou dynasty, about 700 B.C., medicine had reached a high degree of development, and four kinds of medical man—physician, surgeon, dietician and veterinary surgeon—were distinguished. Afterwards, one of the most notable events in the history of Chinese medicine was the publication by Li Shee Chin about A.D. 1578 of a materia medica consisting of fifty-two volumes and containing not only herbs but also drugs of animal and mineral origin as well. A new medicine was introduced in 1835, being due chiefly to Dr. Parker, who founded the first hospital in China, but it was not until three quarters of a century later that Sun Yat Sen, the founder of the Chinese Republic and himself a medical man, placed medical services on a proper footing.

In 1927 a Ministry of Health was founded in China to reorganize public health centres and reform medical education. In spite of an energetic campaign against disease, the death-rate from various causes in China is still very high. According to the latest annual statistics, the infantile mortality in China is 200 per thousand, and the maternal mortality 15 per 1,000, as compared with 53 per 1,000 and 4 per 1,000 respectively in Great Britain, and tuberculosis kills 5 out of every 1,000 Chinese, while in Great Britain the proportion is ten times lower. An active campaign has been undertaken against opium smoking, and this evil would doubtless have been eradicated but for the Japanese, who encouraged the habit and distributed opium free in occupied territory. In pre-war days, medical schools in China numbered about thirty-six, but many of them have since suffered from depletion of staff and loss of laboratory equipment, to remedy which the present policy of the Ministry of Education is to confine medical education to centres in Free China.

Gold Coast Timbers

ALL over the Empire, wherever forests at all accessible exist, the same formula is heard expressed: "War-time conditions have brought about an increased demand for timber both locally and for export"; and the demands of the fighting forces are to a large extent responsible for this increased demand. On several occasions allusion has been made to this factor in NATURE. There may occasionally be an asset to set against these often unsupervised extra fellings, one of which is mentioned in a publication of the Forestry Department of the Gold Coast entitled "Gold Coast Timbers" (Govt. Printers, Accra, 1941), issued under the name of the Chief Conservator of Forests, who had the assistance of officers of the Department in its compilation. As was the case during the War of 1914–18, especially in India and Burma, the great demands by the Army and, in the present War, largely increased demands for commercial war production, have necessitated a larger call on the tropical forests and the bringing into utilization of timbers for which there was no commercial demand in peace-time. As the author says of the Gold Coast, timber is required for many and varied purposes, and species formerly but little used have come into prominence.

It was in view of this extra demand that the present small monograph was prepared. It only purports to give a summary of existing information about some of the more important Gold Coast timbers, forty-four in number; other species in the forests not mentioned may prove as useful, it is said, in the future, even if not more useful, than some of those here dealt with. There are some 20,000 square miles of high forest and double that number of savannah forest. Some 1–1½ million acres of the high forest are classed as at present accessible. On the subject of distribution and frequency of species, enumeration surveys have been carried out to a certain degree, but it is emphasized that average figures only have been obtainable from them. This is, however, quite in keeping with the ordinary first attempts to obtain some knowledge of the stocking in the tropical forest. The suggested classification of durability and impregnation susceptibility appear to be somewhat clumsy and capable of simplification. A summary of the uses of local timbers is given. The little monograph should prove of use both to forest officer and timber buyer; and may even ensure some measure of control over the all too common unsupervised fellings in tropical forests, which have been taking place on an increased scale.

The Imperial Forestry Institute

IN the seventeenth annual report, for 1940–41, of the Imperial Forestry Institute (Oxford, The Holywell Press, Ltd., 1941) it is stated that the year was the first under the new organization, one result of which is to amalgamate the Oxford School of Forestry with the Institute. The interruptions of leave and so forth naturally interfered with Colonial forest officers taking refresher courses at the Institute. As has been the case with other forestry schools, practical forestry courses had to be confined to Great Britain. The professor of forestry, Prof. H. G. Champion, was fortunate in being able to retain a certain staff at the Institute. As a consequence some degree of investigation and experimental research work was continued in sylviculture, mensuration and management, soil science (in which the valuable co-operation of Dr. M. C. Rayner of Bedford College, London, was afforded), tropical forest botany and fruit pathology.

Economy of Tin in Bearings

SINCE the change to Japanese control of the tin-producing regions in south-eastern Asia, the sources of about two-thirds of their supplies have been lost to the Allies. In an attempt to make this good, the Ministry of Supply has just issued a pamphlet on modifications recommended in bearing-metal practice. More than 2,000 tons of tin are used annually in Great Britain in bearing-metals, and the new suggestions, if loyally adopted, would, it is estimated, ensure a saving of 65 per cent, equal to the entire output of the Cornish mines last year. This pamphlet is available from the Non-Ferrous Metals Control, Grand Hotel, Rugby, or the Tin Research Institute, Fraser Road, Greenford, Middlesex. The white bearing-metals have been divided into four groups with 80–92, 68–75, 7–12 and 0–5 per cent of tin respectively. Alloys with 12–68 per cent of tin have very rightly been omitted entirely, as suitable alloys for practically any purpose can be found in the compositions still retained, modified, if necessary, by other additions. A long list of typical bearings is given with the class of alloy suitable for each. Alloys falling outside these groups may be used only with the approval of the Non-Ferrous Metals Control.

A further appreciable saving may be made by reducing the thickness of white metal linings, a practice which has been steadily growing for some years. As a result, especially in the automobile industry, it has been found that the thinner linings can often carry heavier loads with an increased factor of safety. Other suggestions for economy include careful segregation and collection of scrap, the use of steel bushes lined with bronze instead of solid bronze ones, and the substitution, for most purposes, of an alloy containing 85 copper, 5 tin, 5 lead, and 5 zinc for Admiralty gunmetal.

The U.S. National Academy and Calendar Reform

A POLL of the U.S. National Academy of Sciences indicates a three-to-one preponderance of opinion in favour of a calendar reform which would 'even up' the lengths of the months, giving each twenty-six working days and having each month begin on a Sunday. The ballot was conducted by Prof. W. E. Castle, of the University of California, Berkeley. He received responses from 168 of them, or more than half the membership of the Academy. Of those answering, 76 per cent favoured the change, 10 per cent opposed, and 14 per cent were undecided. Of those who favoured the change, 58 per cent wanted it initiated in 1945, which is the next year that begins on a Sunday; 42 per cent were against this unless the War ends soon enough.

Earthquakes in the Pacific

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association has found the epicentres of two recent earthquakes. The first, on March 1, 1942, took place at 9h. 52·0 m. U.T. The tentative epicentre, calculated from instrumental recordings at eight observatories, was latitude 13° N., longitude 91° W., which is in the Pacific Ocean, south of San José in Guatemala (Central America).

The second shock, on March 5, 1942, at 19h. 48·2 m. U.T., had its provisional epicentre at latitude 48° S., longitude 98° W., which is in the Pacific Ocean to the west of southern Chile. The focus of this latter shock is estimated to have been at a depth of some 250–300 km., so that it might be termed an 'intermediate' shock. Earthquake shocks have been known to occur down to depths of 700 km. Both the above earthquakes occurred in regions known to be liable to earthquakes.

Demographic Census of Rio de Janeiro

THE last census of Brazil showed that on September 1, 1940, Rio de Janeiro had 1,781,567 inhabitants (*J. Amer. Med. Assoc.*, Feb. 14). The decline of births was illustrated by the fact that whereas in the period 1921–1930 the births numbered 344,921, in the period 1931–1940 only 321,976 births were registered, although there was an increase in the population. In the first period there were 248,964 deaths, and in the second period 274,233. This increase, however, was not in proportion to the growth of the population. In the same periods the marriages numbered 80,545 and 106,112 respectively, though there was a decrease in the birth-rate. The population of the capitals of the Brazilian States was 5,661,091 in 1940, or 13·6 per cent of the population of the whole country. In 1920 the figure was only 8·6 per cent of the whole nation.

Institute of Fuel: Melchett Medallist

THE Melchett Medal for 1942 of the Institute of Fuel has been awarded to Dr. Arno Carl Fieldner, the head of the Technologic Branch of the Bureau of Mines, Washington, for outstanding work carried out by him and under his supervision in connexion with fuel. The Melchett Medal was founded in 1930 by the first Lord Melchett, and has been presented to seven Englishmen, one American, one Frenchman, and three Germans.

LETTERS TO THE EDITORS

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

The Social Sciences

An editorial appeared in *The Times* of March 28 under the heading "Social Surveys", accompanied on the same day by a special article entitled "War-time Social Surveys". It was there suggested that a Social Science Research Council might be set up as a guide to the Government.

In view of recent discussions that have taken place about the establishment of such a Council, certain suggestions there put forward by the writer of the special article seem to call for comment.

Some of the most fruitful experiments in social life as well as in the practice of government spring out of the needs of war-time. No one more than myself will praise the "utilitarian objective" in science. (Incidentally, I note that the word 'science' has dropped out of "Social Science Research Council" and the word "National" has been inserted ; surely a significant change.) No one will despise £40,000 annually coming from the Government "for the Advancement of Science". But I do sincerely trust that any Social Science Research Council that may be set up after or during this War will not be a Government-controlled body, but an academic body. The Economic Advisory Council or its successor is appropriate to meet, under Cabinet control, the Cabinet's need. Politicians and Civil Servants are not generically inspired by the pure desire to know ; and the sharp distinction between science and 'business of State', menaced in every direction of modern life, is far more basic in the social than in the physical or medical sciences. This does not mean that an academic Social Science Research Council, enjoying the same independence as the Royal Society, cannot be of immense aid to a Government that refers problems to it for research, in just the same fashion as its counterpart, the American Social Science Research Council has been.

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The Solar Corona

The difficulties which have so far been experienced in working out a physical theory of the solar corona (*vide* Rosseland, "Theoretical Astrophysics", Chap. 14) have apparently been increased by the discovery of Grotrian and Edlén that many of these lines are due to forbidden transitions of highly stripped atoms of iron and nickel having the constitution $3\,p^x$ ($x = 1$ to 5), and to calcium atoms having the constitution $2\,p^x$; thus the line 5303 is produced by an iron ion which has lost as many as thirteen electrons. After learning of this extraordinary discovery from an article by Prof. H. N. Russell in the *Scientific American* of August, 1941, I undertook a critical examination of the available spectroscopic data, and can confirm that the claim is a sound one.

Prof. Russell has pointed out that the solar corona apparently shows a predominance of the very same elements which are found prominently in iron-meteors, but to me the coincidence appears to be only fortuitous. From extant observations we can draw a fairly safe conclusion that the lines cannot be due to large-scale meteor flashes ; but the stripped atoms responsible for the lines are streaming outwards with high velocities. This conclusion follows (1) from the work of Lyot[1] (1937) that the breadth of the coronal lines, which is unusually large for a temperature of 6,000°, *increases* as we approach the solar limb ; (2) from the work of Waldemeier[2] (1938), in which it is shown that the great breadth of the coronal lines may be explained as being due to radial streaming of particles, and the greater the breadth, the greater is the velocity. In the inner corona, the velocity is reduced to nearly 60 km./sec., but it must be much larger in the chromosphere, and in the reversing layer, where as will be shown presently, the particles originate.

If these conclusions are granted, we have next to find out what physical processes give rise to such highly stripped atoms and send them through the solar envelope with such tremendous velocities. It is obvious that we have to exclude thermal or photo-electric ionization and generally all extra-nuclear processes.

The only plausible hypothesis appears to be that these highly stripped atoms are produced in a nuclear reaction, analogous to uranium fission, occurring somewhere inside the reversing layer. It is known from investigations on uranium fission that the fission fragments separate from each other with energies of the order of 80 Mev. corresponding to a velocity of 6–8 cf, where c is the velocity of light, f is the Sommerfeld fine-structure constant (cf is the velocity of the electron in the first H-orbit). These fission fragments are known from experiments by Bøggild, Lauritsen and others[3] (1942) at Prof. Bohr's laboratory at Copenhagen to be endowed with a high net positive charge at the moment of their production ; in fact, they are found to have lost all those outer electrons the orbital velocities of which are inferior to their own velocity of separation (6–8 cf). An iron atom which retains only 10 electrons, namely, $Fe^{+}\,1s^2.\,2s^2.\,2p^6, \ldots$ should have a velocityof $6{\cdot}5\,cf$ at the moment of its production and hence its energy should be 60 Mev. There is one difficulty in this hypothesis. So far only ^{238}U, ^{235}U, ^{232}Th and ^{231}Pa have been shown to be capable of fission (Bohr and Wheeler[4], 1939), and experimentally fission into two fragments only has so far been demonstrated. But this difficulty is not insuperable ; on energetic grounds, fission into a larger number of fractions, say three or four, is possible. As for the presence of the fission elements in the sun, their spectra is so complex that no serious attempt at identification has yet been undertaken.

In any event, the presence of Fe^{+13} or Ni^{+15} moving through the solar envelope with large velocities is a demonstrated fact, and one can calculate the range and electron exchange of these particles. If we make the reasonable hypothesis that the iron ions start at the moment of their production as $Fe^{+16}\,1s^2.2s^2.2p^6$, they would have an initial velocity of $6{\cdot}5\ cf$. Their career through the solar atmosphere is analogous to that of α-particles, or better of fission fragments, through the cloud chamber. They would be losing energy all the way because they ionize the solar atoms with which they come into contact according to the process known as ionization by collision. The solar atoms from which α-rays are expelled may be supposed to be mostly hydrogen atoms, and on reasonable assumptions, the range comes to about 10^{21} hydrogen atoms. The particles must, therefore, originate inside the reversing layer.

Further, there will be a lively interchange of electrons between the stripped ions and the solar atoms according to the processes described by Jacobsen[5] (1930), and Kramers and Brinkmann[6] (1930). As the velocity decreases, more and more electrons will be acquired, in the normal or metastable states, and ultimately, the ion emerges in the inner corona where alone it has a chance of being observed as an ion with a $3p^x$-structure, with much-reduced velocities (60 km. per sec.).

It is interesting in this connexion to recall the following intuitive remarks of the late Lord Rutherford : "In the furnace of the Sun and other hot stars, the electrons, protons. neutrons, and atoms present must be endowed with high average velocities owing to thermal agitation. It is thus to be expected that the processes both of disintegration and aggregation of nuclei, such as are observed in the laboratory, should be operative on a vast scale for all nuclei, and that a kind of equilibrium should be set up between these two opposing agencies of dissociation and association for each type of atomic nucleus."

The nuclear reaction envisaged here is of a type which was not suspected when Lord Rutherford wrote the above passage. But it is quite possible that nuclear reactions of the type contemplated by Lord Rutherford are also constantly taking place, even on the surface of stars. The occurrence of the He^+-line, 4686, in the lower chromosphere, and of He-lines in the upper chromosphere, and the vanishing of the He-lines in the reversing layer have long remained unexplained puzzles (Perepelkin and Melnekov[7], 1935). For this case probably some kind of nuclear reaction which gives rise to α-particles is responsible ; the α-particle in its passage through the solar envelope will first capture an electron, becoming He^+ in the normal or some excited state, then capture another electron, and become He in the normal or excited state. The process was first discovered in the cloud-chamber studies of α-rays by Henderson and Rutherford[8], who showed experimentally that during the last centimetre of its path, the α-particle may gain an electron and then again lose it nearly a thousand times. During the last few millimetres, He^+ may gain and lose electrons a large number of times.

The outer corona is now believed to consist entirely of electrons, but difficulty has been found in tracing the origin of these electrons. They are probably the δ-rays expelled from solar atoms by the highly-stripped iron or nickel ions in the upper chromosphere.

A complete physical theory of the solar corona on the above lines has been worked out and is in process of publication in the *Proceedings of the National Institute of Sciences of India*.

If the consideration presented here prove to be correct, the occurrence of coronal lines is a fingerpost showing that nuclear reactions are taking place even in the gaseous envelope of the sun, and possibly also of stars, and may in some cases influence observable stellar phenomena to a not inconsiderable extent.

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University College of Science,
Calcutta. Feb. 27.

[1] Lyot, *L'Astronomie*, **51**, 203 (1937).
[2] Waldemeier, *Z. ast. Phys.*, **15**, 44 (1938).
[3] Bøggild, *Phys. Rev.*, **60**, 827 (1942).
[4] Bohr and Wheeler, *Phys. Rev.*, **56**, 426 (1939).
[5] Jacobsen, *Phil. Mag.*, **10**, 401 (1930).
[6] Kramers and Brinkmann, *Proc. Kon. Akad. Amsterdam*, **30**, 973 (1930).
[7] Perepelkin and Melnekov, *Pulkovo Bull.* No. 122, 14 (1935).
[8] Henderson, *Proc. Roy. Soc.*, A, **102**, 496 (1923).

History of the British Thermal Unit

A CERTAIN amount of interest appears to have arisen of late as to the history and definition of the British thermal unit. The position so far as we have been able to ascertain it is set out below, and it would seem that the British thermal unit under that name does not appear to have any very definite origin or legal definition.

In the early literature of Great Britain on the equivalence of work and heat, the unit of heat used was that which has since become known as the British thermal unit, but by Joule, Thomson, Rankine and others of that time it was simply referred to as a "heat unit". The Oxford Dictionary gives 1876 as the earliest date of use of the term British thermal unit. This occurs in "Catalogue of the Special Loan Collection of Scientific Apparatus at the South Kensington Museum, 1876" under item 1056. The complete entry (p. 273 of 3rd Edit.) is :

"*Hargreaves's Thermo-radiometer*, for measuring loss of heat by radiation from walls of furnaces, sides of steam boilers, etc.

"James Hargreaves.

"The silver-plated copper vessel is filled with water and enclosed in the case, the blackened face then being exposed for a given time (say, five minutes) to the radiating surface, a thermometer inserted in the neck of the vessel shows the elevation of temperature due to radiation. The heat is calculated as follows, either in calories or British thermal units, $\frac{Ws(T-t)}{am} = x$, where Ws = weight and average specific heat of vessel and contents, t = temperature of same before exposure, T, temperature of same after exposure, a = area of blackened face of vessel and m, time of exposure, whence may be calculated the amount of fuel necessary to replace the heat lost by radiation."

It would seem that this may have been a chance use of the term *British* thermal unit, as a means of distinction from the calorie, for reference to other works of about that time has shown that Lardner and Loewy's "Heat" (1877), p. 97, gives the unit, but no name, Cotterell in "The Steam Engine considered as a Heat Engine" (1878), p. 8, speaks of the quantity of heat being measured in thermal units. Prof. Everett in his "Units and Physical Constants" (1879) makes no mention of the British thermal unit, nor does it figure in the article on "Heat" contributed by Sir William Thomson to the 1880 edition of the "Encyclopædia Britannica". Furthermore, William Anderson, in his Howard lecture on "The Conversion of Heat into Useful Work" delivered on December 5, 1884, said : "I shall now explain that the quantity of heat or energy of molecular vibration which raises one pound of water 1° F. is called the British unit of heat" (*J. Soc. Arts*, 33, 565 ; 1885) ; on p. 576 he uses the abbreviation u for this unit.

In Prof. Jamieson's "Text Book of Steam and Steam Engines", 10th Edit. (1895), p. 32, however, one finds the definite statement : "The standard unit now adopted in this country is called the British Thermal Unit and is the quantity of heat required to raise 1 lb. of water by 1° F. when at its maximum density, i.e., from 39·1° to 40·1° F." (The temperature used by Joule when defining his "heat unit".)

Access to earlier editions of this work has not been possible, but it certainly appears that the British thermal unit as we know it to-day had become recognized by 1895. Writing on December 5 of that year, Prof. H. L. Callendar stated (British Association Report 1896, p. 159): "For steam engine work undoubtedly one of the most important units at present in use is the British thermal unit, or pound degree Fahrenheit."

The precise temperature at which the rise of 1° F. is to be measured does not appear to have been specified in any legal definition. The Gas Regulation Act, 1920, merely states: "The calorific value of gas means, for the purposes of this Act, the number of British thermal units (gross) produced by the combustion of one cubic foot of the gas measured at sixty degrees Fahrenheit under a pressure of thirty inches of mercury and saturated with water vapour."

The Act mentioned was based on recommendations of the Fuel Research Board, and the relevant reports have been published by the Department of Scientific and Industrial Research in a pamphlet entitled "The Therm" (H.M. Stationery Office, 1922). The therm is defined in the Act as 100,000 British Thermal Units.

Hyde and Mills in the introduction to their book "Gas Calorimetry" (1932), after referring to the Gas Regulation Act, 1920, go on to state: "The definition of a British Thermal Unit presents some difficulty since opinion differs as to the temperature at which it should be defined. For the purposes of this book, however, it is desirable that the values of a British Thermal Unit and a kilo-calorie should be easily convertible one to another. . . . The British Thermal Unit is therefore defined as the amount of heat required to raise the temperature of 1 lb. of water at 59° F. by 1° F."

In addition to this definition and that of Prof. Jamieson quoted earlier, other workers including Sir Alfred Ewing, "Dictionary of Applied Physics", 1, 922, and "Thermodynamics for Engineers", have defined the British Thermal Unit as 1/180 of the quantity of heat required to warm 1 pound of water from the melting point to the boiling point. This last is the definition given by the British Standards Institution for the mean British Thermal Unit in *B.S.* 205 (1926 and 1936), where the British Thermal Unit is defined as the quantity of heat required to raise the temperature of 1 lb. of water from 60° F. to 61° F.

The similar effect of variations in the specific heat of water on the value of the calorie was brought to the notice of the British Association in 1895 in a paper reproduced in the *Phil. Mag.* (40, 431; 1895). The suggestions made in this paper received considerable publicity and the correspondence was reproduced in the Report of the British Association for the following year.

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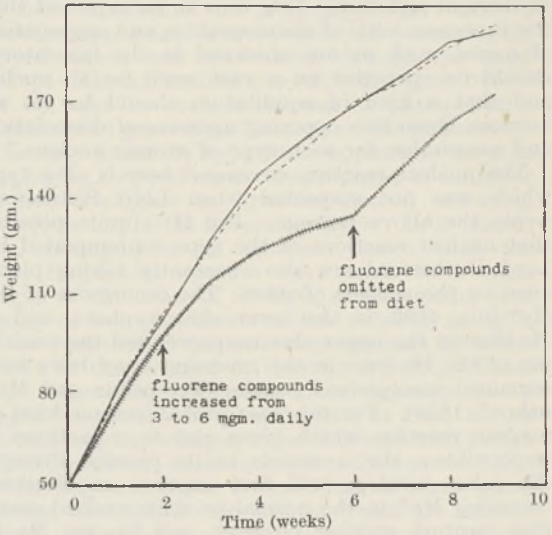
2-Aminofluorene as Growth Inhibitor for Bacteria and Rats

IN an effort to discover common mechanisms responsible for growth-inhibition of both tissue cells and bacteria, colloidal solutions of carcinogenic compounds (including 1-2-5-6 dibenzanthracene, 3-4 benzpyrene, methylcholanthrene, dimethyl yellow) have been tested systematically by us for possible bacteriostatic action. No very significant results have been obtained.

Recently, Wilson, DeEds and Cox[1] discovered the carcinogenic action of the insecticide, 2-acetyl aminofluorene. Its action is of peculiar interest since, when given orally, multiple tumours of different histological types developed in some rats. We found that 2-aminofluorene dissolved in nutrient broth had a bactericidal or strong bacteriostatic effect on certain bacteria and of these *Staphylococcus aureus* was chosen as the standard test organism. Since the corresponding acetyl compound has a considerable inhibitory effect on the growth-rate of rats, we decided to investigate related fluorene compounds in order to determine the effect of alterations in the chemical configuration on both the growth-rate of rats and that of the staphylococcus. We synthesized the



EFFECT OF FEEDING 2-ACETYL AMINOFLUORENE AND 2-ACETYL AMINOFLUORENONE ON GROWTH-RATE OF RATS.

Diet: whole milk powder (30 per cent) and bread; cod liver oil (0·2 ml. daily) and cabbage once a week. Full line, controls; broken line, feeding on 2-acetyl aminofluorene; crossed line, 2-acetyl aminofluorenone.

following compounds: 2-aminofluorenone, 2-aminofluorenol, 9-aminofluorene and the corresponding acetyl compounds. The latter were used in rat-feeding tests and the compounds with a free amino group in the *in vitro* bacterial tests. 2-acetyl aminofluorene is unsuitable for *in vitro* work owing to its poor solubility in nutrient broth. Since, however, there is no reason to think that the acetyl group plays any part in its specific *in vivo* action, it seemed justifiable to compare the action of the free amino compounds *in vitro* with that of the acetylated compounds *in vivo*. None of the compounds mentioned, with the exception of 2-acetyl aminofluorene, had any significant growth-inhibiting action on rats (see accompanying graph). The effect of the related compounds on bacterial growth was similar except that 2-aminofluorenone had a definite bacteriostatic action, which was, however, feeble compared with that of 2-aminofluorene (see accompanying table).

THE EFFECT OF 2-AMINOFLUORENE (1/10,000) AND 2-AMINOFLUORENONE (1/10,000) ON THE GROWTH OF *Staphylococcus aureus*. INOCULUM: 10^6 COCCI/ML. MEDIUM

	Appearance of turbidity (hr.)	Degree of turbidity. Incident light absorbed (per cent) after (hr.) 13	16
Control culture	8	75	85
2-aminofluorenone	13	25	78
2-aminofluorene	45	0	0

The results indicate the importance of the presence of the two reacting hydrogen atoms in the 9-position, in combination with the amino group in the 2-position, in determining the growth-inhibiting and possibly the carcinogenic activity of 2-aminofluorene.

The possibility of studying the action of a chemical carcinogen by its effect on bacterial metabolism has obvious advantages in the analysis of the mechanism involved.

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[1] Wilson, R. H., DeEds, Floyd, Cox, A. J., *Cancer Research*, 1, 595 (1941).

Time of Collapse of a Soap Bubble

A SPHERICAL soap bubble of radius R blown at the end of a uniform glass tube of radius a and length l will gradually deflate itself and disappear. Its time of collapse τ can be computed on the assumption that the gas inside the bubble of viscosity η passes out of the tube in streamline flow under the pressure excess in the bubble. In a spherical soap bubble of radius r, this pressure excess is $4T/r$, where T is the surface tension of the soap solution. Hence from a consideration of the viscous flow of a gas in a tube under a small pressure difference between its ends, it follows that,

$$-d\left(\frac{4}{3}\pi r^3\right) = \frac{\pi a^4}{8\eta l}\frac{4T}{r}\,dt:$$

whence

$$-\int_R^0 r^3 dr = \int_0^\tau \frac{Ta^4}{8\eta l}\,dt.$$

Hence $\dfrac{R^4}{\tau} = \dfrac{Ta^4}{2\eta l}$.

It has been found experimentally possible to blow spherical soap bubbles of more than 5 cm. diameter, the shape of which, in spite of gravity, can be considered to be spherical to a good approximation. When the bubbles are suitably blown, the vertical and horizontal diameters do not differ by more than a quarter per cent even in large bubbles of about 8 cm. diameter. The experimental results have confirmed the above relation, which therefore opens up a new method of estimating the surface tension of different soap solutions. Under suitable experimental conditions, a determination of the viscosities of certain gases *or* their effect on the surface tension of soap films is also rendered possible.

Experimental results will soon be published elsewhere.

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Jan. 12.

Enzymatic Synthesis of Levan

STUDY of the formation of micro-organisms of polysaccharides from sucrose has been hampered by the absence of a satisfactory technique for the cell-free isolation of the enzyme catalysts concerned[1]. This obstacle has now been removed. The separation of a dextran-synthesizing enzyme from *Leuconostoc mesenteroides* has been reported recently by Hehre[2]. It is the purpose of the present note to report the isolation from *Bacillus subtilis* and Aerobacter of an enzyme or enzymes which act on sucrose with formation of levan.

In sucrose-agar, colonies of *Bacillus subtilis* induce formation of levan to some distance from their site of growth[3]. When cell-free agar pieces from the vicinity of such *B. subtilis* colonies are aseptically removed to sterile sucrose solutions, they cause the gradual appearance in the fluid of a pronounced opalescence accompanying the formation of a polysaccharide which is identical in chemical and physical properties with levan. After 24 hours incubation, the amount of polysaccharide formed was considerable (300 mgm./per cent). When ground up in sucrose solution, a partial extraction of synthesizing enzyme from its agar matrix was obtained. This technique proved ill-suited, however, to the isolation of the synthesizing enzyme on a considerable scale.

A further and more convenient source of a levan-synthesizing enzyme was found in a levan-forming strain of Aerobacter. This organism, unlike most of the aerobic spore formers, is easily killed by narcotics. Cell-free autolysates prepared from an aqueous suspension of the cells by incubation with a little thymol in chloroform and subsequent centrifugation actively synthesized levan from sucrose (393 mgm. per cent in 40 hr.). On drying over Drierite in vacuum a stable water-soluble powder of considerable synthetic activity was obtained.

Control tests showed definitely that synthesis by the different enzyme preparations which have been described had occurred in the complete absence of living bacterial cells.

It seems reasonable to hope that with the aid of these enzyme preparations, new insight will be obtained into the sequence of reactions leading to levan formation. A full report on the properties and activity of the levan-synthesizing enzyme preparations will be presented elsewhere.

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Feb. 15.

[1] Harrison, Tarr and Hibbert, *Can. J. Res.*, 3, 499 (1930).
[2] Hehre, *Science*, 93, 237 (1941).
[3] Beijerinck, *Folia Microbiologica*, 1, 377 (1912).

Meiosis in Drosophila

UP to now students of Drosophila have regarded meiosis in the male as almost inaccessible, and have, therefore, confined themselves to the genetical investigation of essentially cytological problems. This is due to the belief that meiosis was completed in the pupa and that only the actual spermiogenesis takes place in the adult.

I have worked principally with aceto-orcein smear preparations of testes of *D. subobscura*. Meiosis in this species starts in the fully grown larva and continues in waves throughout the whole of pupal and adult life at least up to a fortnight after eclosion. It subsides during periods of differentiation, for example, when the vasa deferentia begin to grow, and during periods of great stress, for example, on emergence, so that no divisions occur in young males up to two days of age.

In view of these facts Huettner's statement[1] that "adult males of *D. melanogaster* are useless for the study of meiosis" seemed improbable. I, therefore, made preparations from males of our Oregon line more than two days old. The testes exhibited all stages of spermatogenesis.

In the course of various experiments, I have been able to study mitosis and meiosis in *XY*, *XO*, and *XYY* adult males of *D. subobscura* and in *XY* males of *D. melanogaster*. Primary non-disjunction of the sex chromosomes was observed in both species.

It is hoped that by using adult Drosophila males, problems which demand the simultaneous classification of phenotype and chromosome type may now be tackled with greater ease.

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April 10.

[1] Huettner, A. F., *Z. Zellf. u. mikr. Anat.*, 2, 615 (1930).

Proteins Susceptible to Cold in Pathological Sera

IN the blood of dogs infected with kala-azar, proteins are precipitated on cooling to room temperature (20° C.), or better still when allowed to stand in the ice-box (5° C.) overnight. This protein belongs to the pathologically increased euglobulin fraction. In twenty-one sera investigated (six cases) the cold fraction test was positive. In typical specimens, turbidity soon followed by precipitation sets in within a quarter of an hour of standing in the ice-box. The protein precipitated from kala-azar serum on cooling (cold fraction) is defined as the centrifugable protein fraction which precipitates after 24 hr. at 5° C., and is redissolved by warming to 37°–50° C. This cold fraction ranged between traces of turbidity which could not be determined quantitatively to maximal 3 gm. per 100 c.c. of serum. Typical cases gave tests as shown in the accompanying table:

Case	Total Prot.	Alb.	Glob.	Eu-glob.	Fibrin-ogen	Cold fract.	Dilution fract.*	Formol-gel
Dog 1	10·22	2·39	7·83	4·59	1·1	0·28	9·96	+
Dog 2	10·25	1·87	8·38	3·90	1·0	0·63	0·19	+
Dog 5	11·30	2·75	8·55	4·49	0·94	0·40	0·43	+
Dog 6	10·31	3·25	7·06	1·91	—	0·70	turbid	+
Human	6·06	1·72	4·34	1·81	—	+	+	+

* Dilution fraction: Dilution 1 : 30 with distilled water, centrifugable precipitate determined after 5 minutes standing at 20° C.

No clear-cut parallelism could be established between cold fraction Brahmachari and formol-gel tests. In Dog 1, identical cold fraction values were found simultaneously in serum (1·23 per cent) and exudate from artificial pleuritis (1·4 per cent).

The cold fraction is completely redissolved by warming to 37° C. In samples obtained from animals with particularly heavy infections, a relatively small fraction precipitates which is insoluble even at 60° C. If freshly drawn serum is allowed to stand at 37° C. for 24 hr. or at 60° C. for 30 minutes, precipitation in the cold occurs no longer. If the cold fraction is allowed to stand in its serum at 5° C. for a prolonged time, an increase or a decrease is observed; constant cold fraction values are scarcely ever obtained. A portion of this fraction does not redissolve on warming to temperatures up to 60° C. The cold fraction proved to be markedly labile.

In 0·9 per cent saline the cold fraction dissolves readily, and in this medium it is especially sensitive to temperature. At 70° C., irreversible heat precipitation occurs. The optimum *p*H, both of cold and heat precipitation, is at *p*H 5·7–6·2 (phosphate buffer). This fraction is particularly susceptible to diminution of salt concentration of the solvent.

Although the serum contained cold fraction, none was found in saline extracts obtained from tissues (lymph nodes, bone marrow, spleen, liver) of a dog suffering from kala-azar.

Hamsters infected with kala-azar showed no hyperproteinæmia and no abnormal proteins in the serum. The euglobulin values were normal. In dogs, visceral leishmaniasis is markedly chronic and is accompanied by a marked stimulation of the reticulo-endothelial cells; in hamsters infected with the strain of *L. donovani* used in these experiments, no such stimulation of the reticulo-endothelial system is produced.

We investigated five treated cases and one untreated case of human kala-azar. In all sera (eleven investigations) the cold fraction test was positive, but far less than in canine cases.

A large number of other pathological human sera was investigated as to the occurrence of the cold fraction. Only in a few cases of chronic infections (tuberculosis, malaria, osteomyelitis) was a weakly positive cold fraction test encountered. However, out of seven cases (twenty sera investigated) of endocarditis lenta, five cases gave positive cold fraction tests.

Precipitations which occur in plasma at low temperature are being investigated.

We are indebted for this material to Prof. S. Adler and Dr. J. Tchernomoretz, who kindly provided us with a steady supply of kala-azar dog serum.

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Jerusalem.

Reversible Quenching by Oxygen of the Fluorescence of Polycyclic Hydrocarbons

IN their recent letter in NATURE[1], Drs. H. Weil-Malherbe and J. Weiss have overlooked the work of Bowen and Williams[2], in which the reversible quenching by oxygen of the fluorescence of solutions of fifteen aromatic hydrocarbons was measured. The fluorescence of naphthalene was found to be quenched at least as powerfully as the 3 : 4 benzpyrene to which attention is directed. The absolute fluorescence efficiencies of the hydrocarbon solutions were compared with the absolute rates of oxidation, and it was found that for naphthalene, anthracene, rubrene, etc., the permanent oxidation was much less than corresponded to the quenching effect, proving that a reversible dissociation of the quenching complex hydrocarbon - oxygen into the original molecules must occur. The general relations between fluorescence quenching and actual photo-oxidation by oxygen appeared to be of a very complex nature.

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[1] NATURE, 149, 471 (1942).
[2] *Trans. Faraday Soc.*, 35, 765 (1939).

INFLUENCE OF SNOBBERY ON THE PRACTICE OF MEDICINE

THE lecture entitled "The Hand in Healing: a Study in Greek Medicine from Hippocrates to Ramazzini", delivered before the Royal Institution on December 4 by Prof. B. Farrington, professor of classics at University College, Swansea, has now been published by the Institution. In it Prof. Farrington discusses three topics: (1) the decline of anatomy and surgery after Galen; (2) the limitation of ancient medicine to the rich and the professional classes; (3) the invasion of medical science by *a priori* philosophical concepts. His object is to show that the decline in social status of the manual labourer (*a*) prevented the development of physics and chemistry, and (*b*) caused a gradual deterioration of anatomy and surgery. That chemistry and physics, in the modern sense, were practically unknown, that surgery after Galen was separated from medicine and rapidly declined, are admitted truths; the novelty in Farrington's paper is his finding the cause of these phenomena in the Greek dislike of what were called "banausic" occupations. This is a most ingenious suggestion, almost certainly containing an element of truth. The evidence, however, should be closely examined before the hypothesis is accepted; in a few places Prof. Farrington appears to have misunderstood it.

The meaning of "banausic occupations" raises a thorny question. "Banausia" seems to have been an Athenian conception, appreciated perhaps throughout Greece but to a less degree than at Athens. It signifies not so much a prejudice against manual work in itself—for full honour was given to painters, sculptors, soldiers and farmers—but only against wearying trades involving long hours in conditions that ruin the worker's physique and dull his intellect. Moderns feel a similar prejudice against certain monotonous operations in factories. Such pursuits *are* harmful; we are learning that "banausic" work should be done by machines rather than by men and women. The dislike of the Greeks was the result of a healthy instinct, but they are to be blamed because while accepting the facts they relegated "banausic" labour so far as possible to slaves, in order to have the leisure to live full lives as citizens. The first man to interest himself in occupational disease was apparently Paracelsus, who wrote a treatise on the ailments of miners. Be all this as it may, it would be difficult to show that medicine or even surgery was ever ranked among the "banausic" arts; by the time surgery came to be despised, the Greek ideals that gave rise to "banausia" had ceased to exist.

On p. 15 Prof. Farrington states that "the Hippocratic medicine was already (fifth century B.C.) limited in its application to a section of the people", that is, to the idle rich. Yet medical historians such as Rossignol (in 1858), Littré and Couch (in 1934) have pointed out that the patients of the Hippocratic clinical histories are for the most part humble folk, being indeed often slaves. This fact has to be reconciled with Plato's statement that for slaves there were slave doctors.

Prof. Farrington also takes the view that the long treatise "Regimen" was a medical text-book written by a typical Hippocratic physician for general use. This is extremely doubtful. It was probably the work of a professional trainer, who with a special purpose wrote for a special public—those who, fearing lest their work should be interrupted by a threatened illness, wished to 'nip it in the bud'. To call such people valetudinarians (p. 17) is perhaps unfair.

The intrusion of speculative philosophy into medicine, vigorously attacked by the author of "Ancient Medicine", appears, if we may judge from the subsequent literature, never to have had much effect on actual medical practice. Every art, in addition to the practical theory that explains and reinforces it, has beyond this a speculative background of theory pure and simple. This speculation has a useful part to play, the classic example being Manson's guess that mosquitoes are connected with malaria, a guess that led to the discoveries of Ross. In the infancy of science it tended to encroach upon practical theory, so that the author of "Ancient Medicine" felt bound to protest. Greek thought, in fact, was over-rich in this intelligent guesswork, throwing out suggestion after suggestion in wild profusion. We moderns on the other hand are prone to undervalue it, although every now and then a Jeans or an Eddington inspires us with restrained and beautiful speculation. On the whole, however, we confine such thought to fiction. We should not like to read H. G. Wells's fascinating theories in a textbook.

On p. 28 of Prof. Farrington's lecture we read: "almost two thousand years after Aristotle . . . was explicitly formulated . . . the belief in the existence of definite bodies capable of being isolated . . . and recombined into new compounds". The latter half of this sentence would surely be a good description of the atomistic hypothesis of Democritus!

Even if these criticisms be justified, Prof. Farrington's lecture is of great value, and must certainly be taken into account by historians of Greek thought.

W. H. S. JONES.

THE GAS RESEARCH BOARD

THE Gas Research Board, which is supported by the Institution of Gas Engineers, the Society of British Gas Industries, and other bodies and individuals in the British gas industry, has recently issued its second report*. War-time conditions have prevented publication of some of the research done under its auspices and also the holding of the normal autumn research meeting.

The thirty-second report of the Refractory Materials Joint Committee*, which is also published, records, among other subjects, experiments on the materials used in the manufacture of firebacks for open coke fire-grates. Reference is made to the advantages in heating efficiency and performance of the use of the insulating refractory firebricks which have been so extensively developed in recent years.

Two reports, issued by the Gas Research Fellows for the year 1939–40 and 1941, deal with properties of Bunsen flames—in particular with flame ignition and propagation. There are two methods of measuring flame velocity: (*a*) the static method whereby propagation through a stationary explosive mixture is measured photographically; and (*b*) when the velocity is calculated from the form and size of the stationary inner cone of a Bunsen flame and the known rate of gas mixture fed to the burner. Hitherto results have shown great discordance, which has

* (1) Communication G.R.B. No. 4. Pp. 16. (2) Communication G.R.B. No. 5. Pp. 92. (London: Gas Research Board, 1941.)

now been traced to the unjustified assumption that the inner 'cone' of a Bunsen flame is a true cone. It has now been shown that if the true area of the inner cone is measured and used in the calculation, then ignition velocities are obtained by this method which are independent of rate of mixture feed and burner size, depending only on working temperature and pressure. In other words, the ignition velocity so determined is a characteristic of the composition of the gas-air mixture. This should greatly facilitate the study of flame combustion.

It is often overlooked that the inner cone of a Bunsen flame does not touch the burner, from which it is separated by a 'gap' or 'dead space' in which the mixture is preheated to the temperature at which inflammation occurs. It appears that the size of the 'dead space' determines the possibility of 'lighting back', for when the diameter of the burner is reduced to twice the 'dead space', then the flame cannot pass down the tube. The influence of size of tube and hole in stopping the travel of flame is well known and usually ascribed to the cooling, but it now appears to be essentially a characteristic of the gas.

FORTHCOMING EVENTS

(*Meetings marked with an asterisk are open to the public*)

Tuesday, May 12

CHADWICK PUBLIC LECTURE (at the Royal Society of Tropical Medicine and Hygiene, 26 Portland Place, London, W.1), at 2.30 p.m.—Dr. J. Alison Glover: "The School Medical Service in War-time".*

ILLUMINATING ENGINEERING SOCIETY (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. G. H. Wilson: "Street Lighting: Past, Present and Future".

Wednesday, May 13

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2). at 1.45 p.m.—Miss Helen Masters: "The Post-War Home", 11: "Domestic Offices, Equipment and Maintenance".

PHARMACEUTICAL SOCIETY OF GREAT BRITAIN (in the Small Hall of Friends House, Euston Road, London, N.W.1), at 2.30 p.m.—Dr. Philip Hamill: "Prescribing in War-time."

INSTITUTE OF METALS (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 6 p.m.—Mr. William Thomson Halcrow: "Water Power and its Application to the Production of Metals" (Thirty-second Annual May Lecture).

Friday, May 15

ROYAL INSTITUTION OF GREAT BRITAIN (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. C. Plummer, F.R.S.: "Galileo and the Springtime of Science".*

Sunday, May 17

ASSOCIATION OF SCIENTIFIC WORKERS (SOUTHERN AREA) (in the Refectory, University College, Southampton, at 2.30 p.m. Conference on "Science for Victory" *

APPOINTMENTS VACANT

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

DEPUTY BOROUGH ELECTRICAL ENGINEER in the Electricity Undertaking of the Woolwich Metropolitan Borough Council—The Town Clerk, Town Hall, Woolwich, London, S.E.18 (May 15).

PRINCIPAL OF THE WALKER TECHNICAL COLLEGE, OAKENGATES—The Secretary for Education, County Buildings, Shrewsbury (May 16).

CIVIL ENGINEERING ASSISTANT—The Clerk to the River Ouse (Yorks) Catchment Board, 7 Langcliffe Avenue, Harrogate (May 20).

INSPECTOR OF AGRICULTURE to serve during his early years as Lecturer in the School of Agriculture near Khartoum—The Controller, Sudan Government London Office, Wellington House, Buckingham Gate, London, S.W.1 (endorsed "Inspector of Agriculture") (May 25).

UNIVERSITY CHAIR OF RADIOLOGY (THERAPEUTIC) tenable at Middlesex Hospital Medical School—The Academic Registrar, University of London, Richmond College, Richmond, Surrey (May 26).

HEAD OF THE CHEMISTRY DEPARTMENT—The Secretary, Robert Gordon's Technical College, Aberdeen (May 30).

LECTURER IN BIOLOGY (PART-TIME)—The Principal, Bishop Otter College, Chichester.

LECTURER (WOMAN) IN BIOLOGY AND HORTICULTURE—The Principal, The Training College, Lincoln.

LECTURER IN GEOGRAPHY (PART-TIME) at the Brighton Municipal Training College—The Education Officer, 54 Old Steine, Brighton.

ASSISTANT (MALE) to the Public Analyst—The Secretary, Health Department, Grey Friars, Leicester.

REPORTS and other PUBLICATIONS

(*not included in the monthly Books Supplement*)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 15: The Molecular Weights of Rubber and related Materials, 3: A Correction of Part 2; 4: The Micellar Theory of the Structure of Rubber. By G. Gee. Pp. 8. (London: British Rubber Producers' Research Association.) [204

Other Countries

U.S. Department of the Interior: Geological Survey. Bulletin 890–B: Spirit Leveling in South Carolina, Part 2: Southern South Carolina, 1896–1938. Pp. ii+457–766+plates 1–2. 40 cents. Bulletin 900–D: Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma, Part 4: Townships 24 and 25 North, Ranges 10 and 11 East. By L. E. Kennedy, J. D. McClure, H. D. Jenkins and N. W. Bass. Pp. iv+131–172+plate 4. 35 cents. Bulletin 900–E: Subsurface Geology and Oil and Gas Resources of Osage County, Oklahoma, Part 5: Townships 26 and 27 North, Ranges 10 and 11 East. By L. E. Kennedy, W. E. Shamblin, Otto Leatherock and N. W. Bass. Pp. iv+173–208+plate 5. 40 cents. Bulletin 901: Clay Investigations in the South States, 1934–35. Reports by W. B. Lang, P. B. King, M. N. Bramlette, T. N. McVay, H. X. Bay and A. C. Munyan. Pp. x+346+8 plates. 1 dollar. Bulletin 907: Geology of the Alaska Railroad Region. By Stephen R. Capps. Pp. vi+202+9 plates. 1.25 dollars. Bulletin 913: Triangulation in Utah, 1871–1934. Pp. iv+170+1 plate. 20 cents. Bulletin 914: Microscopic Determination of the Ore Minerals. By M. N. Short. Second edition. Pp. viii+314+14 plates. 1 dollar. Bulletin 915–A: Geophysical Abstracts 96, January—March 1939. Compiled by W. Ayvazoglou. Pp. ii+48. 10 cents. Bulletin 915–B: Geophysical Abstracts 97, April—June 1939. Compiled by W. Ayvazoglou. Pp. ii+49–86. 10 cents. Bulletin 915–C: Geophysical Abstracts 98, July—September 1939. Compiled by W. Ayvazoglou. Pp. ii+87–132. 10 cents. Bulletin 916–D: Transit Traverse in Missouri, Part 4: Northwestern Missouri, 1911–37. Pp. xx+441–564+1 plate. 20 cents. Bulletin 916–E: Transit Traverse in Missouri, Part 5: Southwestern Missouri, 1900–37. Pp. xiv+565–732+1 plate. 25 cents. Bulletin 916–F: Transit Traverse in Missouri, Part 6: Northeastern Missouri, 1900–37. Pp. xiii+733–868+1 plate. 20 cents. Bulletin 916–G: Transit Traverse in Missouri, Part 7: Central Missouri, 1902–37. Pp. xiv+860–1024+1 plate. 25 cents. Bulletin 922–A: Quicksilver Deposits of the Bottle Creek District, Humboldt County, Nevada. A Preliminary Report by Ralph J. Roberts. (Strategic Minerals Investigations, 1940.) Pp. iii+29+plates 1–5. 35 cents. Bulletin 922–B: Quicksilver Deposits of the Mount Diablo District, Contra Costa County, California. By Clyde P. Ross. (Strategic Minerals Investigations, 1940.) Pp. iii+31–54+plates 6–8. 10 cents. Bulletin 922–C: Manganese Deposits in the Little Florida Mountains, Luna County, New Mexico. A Preliminary Report by S. G. Lasky. (Strategic Minerals Investigations, 1940.) Pp. iii+55–74+plates 9–11. 25 cents. Bulletin 922–D: Chromite Deposits of Grant County, Oregon. A Preliminary Report by T. P. Thayer. (Strategic Minerals Investigations, 1940.) Pp. iv+75–114+plates 12–20. 45 cents. Bulletin 922–E: Quicksilver Deposits at Buckskin Peak, National Mining District, Humboldt County, Nevada. A Preliminary Report by R. J. Roberts. (Strategic Minerals Investigations, 1940.) Pp. iii+115–134+plates 21–23. 15 cents. Bulletin 922–F: Tungsten Deposits of Boulder County, Colorado. By T. S. Lovering. (Strategic Minerals Investigations, 1940.) Pp. iii+135–156+plates 24–25. 20 cents. Bulletin 922–G: Manganese Deposits at Philipsburg, Granite County, Montana. A Preliminary Report by E. N. Goddard. (Strategic Minerals Investigations, 1940.) Pp. iv+157–204 +plates 26–34. 40 cents. Bulletin 922–H: Tungsten Deposits of the Atolia District, San Bernardino and Kern Counties, California. By Dwight M. Lemmon and John V. N. Dorr, 2d. (Strategic Minerals Investigations, 1940.) Pp. iv+205–246+plates 35–37. 25 cents. Bulletin 922–I: Antimony Deposits of a part of the Yellow Pine District, Valley County, Idaho. A Preliminary Report by Donald E. White. (Strategic Minerals Investigations, 1940.) Pp. iii+247–280+ plates 38–39. 30 cents. Bulletin 922–K: Antimony Deposits of the Wildrose Canyon Area, Inyo County, California. By Donald E. White. (Strategic Minerals Investigations, 1940.) Pp. iii+307–326+plates 45–46. 25 cents. Bulletin 922–M: Tin Deposits of the Black Range, Catron and Sierra Counties, New Mexico. A Preliminary Report by Carl Fries, Jr. (Strategic Minerals Investigations, 1940.) Pp. iii+355–370+plates 54–62. 50 cents. (Washington, D.C.: Government Printing Office.) [144

U.S. Department of Agriculture. Farmers' Bulletin No. 1893: Control of Grape Diseases and Insects in Eastern United States. By J. B. Demaree and G. A. Runner. Pp. ii+28. (Washington, D.C.: Government Printing Office.) 10 cents. [154

Publications of the Dominion Observatory, Ottawa. Vol. 13: Bibliography of Seismology, No. 10: Items 5135–5279, July to December 1941. By Ernest A. Hodgson. Pp. 157–188. (Ottawa: King's Printer.) [204

Transactions of the San Diego Society of Natural History. Vol. 9, No. 32: A Vertebrate Faunal Survey of the Organ Pipe Cactus National Monument, Arizona. By Laurence M. Huey. Pp. 353–376. Vol. 9, No. 33: Notes on some Mexican and Californian Birds, with Descriptions of Six Undescribed Races. By A. J. van Rossum. Pp. 377–384. (San Diego, Calif.: San Diego Society of Natural History.) [204

The South African Journal of Science. Vol. 38: Being the Report of the Thirty-ninth Annual Meeting of the South African Association for the Advancement of Science, Johannesburg, 1941, 30th June and 1st July. Pp. xx+399. (Johannesburg: South African Association for the Advancement of Science.) 30s. net. [204

Department of Science and Agriculture, Jamaica. Report for the Year ending 31st March 1941. Pp. 6. (Kingston: Government Printing Office.) [224