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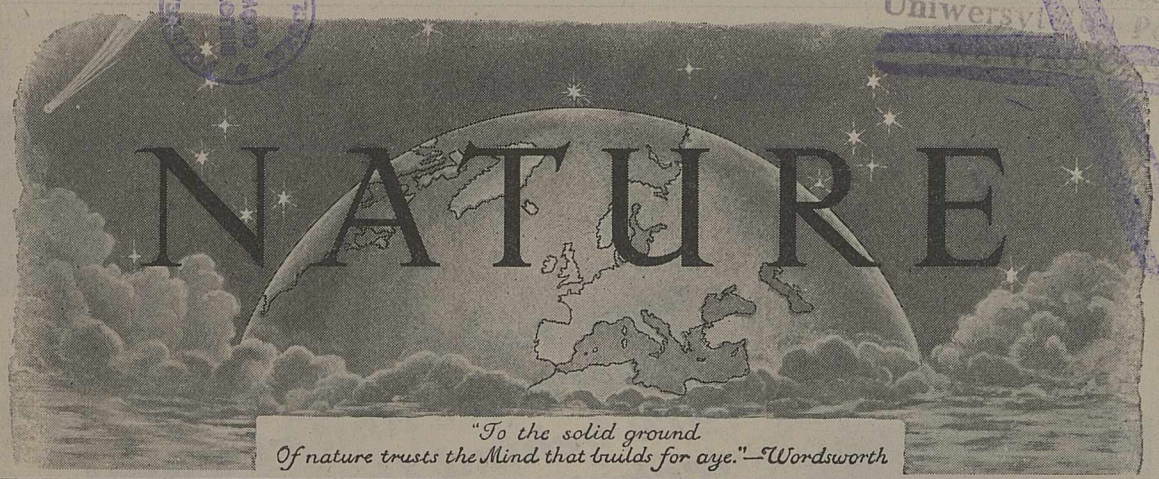

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EDUCATION OF THE CHEMIST

THOUGH the outlines of the post-war world are still nebulous, it will certainly be an impoverished world, and a world in which Britain will confront immense opportunities but with sadly straitened resources. Times cannot fail to be hard. Even were we to resign ourselves ignobly to the selfish minimum, life would be no pleasant routine of short hours, bread, and circuses. It will be very much more rigorous if, following the deeper aspirations of the national conscience, we accept—and act upon—the belief that Britain has a mission of leadership.

So much is common ground. If we then assume, as we are justified in assuming, that Britain will shoulder whatever tasks are indicated by the finger of duty, we must ask ourselves how best to prepare for what lies ahead. The air resounds with words, but the ideas to be associated with them are often tenuous and elusive. 'Reconstruction' and 'rehabilitation' arouse different images and different reactions in different minds ; even 'planning', to some minds, carries a tang of bureaucratic meddlesomeness which excites a 'never-shall-be-slaves' antagonism. Where we can scarcely be at variance with one another is in postulating that the first necessity at the present time is forethought.

No government, especially amid the exigencies of mortal war, would be capable of taking all the forethought demanded by so critical and so unfathomable a future. It follows that the problem must be partly delegated to, or spontaneously attacked by, individual national bodies capable of dealing usefully with particular aspects of it. A start has already been made in this direction in more than one quarter, and it is very satisfactory to note that, at the initiative of the Royal Institute of Chemistry, serious consideration has been given to the question of the education desirable for young chemists*. It is very satisfactory for the plain reasons that ingenious and economic exploitation of natural wealth will be an indispensable condition of our future existence, and that in this exploitation chemists will be key men. The recruitment of an adequate number of chemists and also their quality and their training are therefore of vital importance. Quality is not wholly controllable. It depends on a complex interplay of biological, sociological, and other factors ; but there is no reason to suppose that coming generations will be any less fertile in chemical ability than those of the past. Training, on the other hand, may be shaped at will, and thus of any proposed scheme of chemical education it is legitimate to ask two questions, namely, whether it is likely to produce a sufficient supply of skilled chemists of various kinds, and whether it affords encouragement for the development of administrative and similar abilities—that is, whether it looks forward to a state of affairs in which the chemist and his fellow men of science will exert in public, industrial and social matters an influence

* The Education and Training of Chemists : Report of the Chemistry Education Advisory Board. Pp. 16. (London : Royal Institute of Chemistry.)

proportionate to their intellectual capacities and to the natural forces they control.

We thus turn with interest to the report of the Chemistry Education Advisory Board set up in 1943 under the auspices of the Association of University Teachers, the Chemical Society, the Royal Institute of Chemistry, the Science Masters' Association, and the Society of Chemical Industry, two nominees of the Association of British Chemical Manufacturers having been later co-opted as members of the Board in order to represent employers. One may note with some surprise that, although two of its fellows were on the Board, the Royal Society was not officially represented; neither was the British Association.

The report deals with its thesis under the following main heads: chemistry in schools, chemistry in the universities, the education and training of industrial chemists and chemical technicians above the minimum school-leaving age, part-time education up to the age of eighteen, the training of chemists in the professional grade, and the supply and training of teachers. It will be observed that while the terms of reference are reasonably wide, they do not embrace, except incidentally, the second of the two questions posed above. Though this may cause disappointment, the omission is understandable, but we hope that the Board—which is probably to remain in being—will repair it as soon as opportunity offers. No feeling of diffidence should hinder full expression of informed opinion upon a matter of such consequence. It is, of course, a sound principle to consolidate each position before assaulting the next, but caution may be carried too far. The present report could well have been the vehicle of a bolder pronouncement upon the part that should be played in the community by the chemist in particular and the scientific man in general.

This criticism must not be taken to imply dissatisfaction with what the report does in fact provide. The contrary is true. The composition of the Board shows it to be widely representative, and the report contains observations and recommendations worthy of the closest possible attention. We may consider some of them here. Since we have referred to the merely incidental treatment in the report of the broader aspect of chemical education, we take first a point in which this aspect is touched upon, so to speak, in reverse. The Board expresses the opinion —in which we fully concur—that it is a matter of great importance "that those, more especially, who will afterwards become leaders in industry and commerce, civil servants and administrators, should become more fully imbued with the spirit of science and should gain both a fuller appreciation of the scientific method and a greater understanding of the power of scientific knowledge and research". The sentiment is unexceptionable; but what we miss is any sufficient suggestion as to how the education of chemists (whom we may regard as typical of scientific workers as a whole) should be modified so that they too might, if they chose, become leaders in industry and commerce, Civil servants and administrators. It is, indeed, a remarkable fact, and we think a deplorable fact, that while many choices of career are open to the man who reads one of the humanities at the university, there is a very much more restricted choice for the science graduate. How far this is due to the structure of society and how far to a remediable defect in university courses may be difficult to determine; but, in spite of such notable exceptions as Sir Stafford Cripps, the rule remains. It is a rule which men of science should exert themselves to eliminate.

Before proceeding to discuss other points of the report, we may make passing reference to the astonishing, and we believe retrograde, opinion of the Board that "for those [post-School Certificate school] pupils who are studying Natural Science as a part of general culture rather than as a part of technical training, practical work in the laboratory need not be required". This may be a majority opinion; there are schoolmasters on the Board, and we find it difficult to conceive that they, who must have witnessed at first hand, and on countless occasions, the all-vivifying effect of laboratory work upon their classes, should have concurred in it. Unless, indeed, we are to look for a clue in a subsequent sentence: "it has to be borne in mind that the time consumed in practical work, if insisted on, may lead, in the case of the pupils under consideration, to the abandonment of instruction in Natural Science altogether". This would provide another example of the Board's apparent diffidence, and one would be tempted to invoke the shade of Danton: "De l'audace, et encore de l'audace, et toujours de l'audace!"

Turning next to the question of university entrance scholarships, we are glad to find that the Board wholeheartedly supports the views expressed by the Norwood Committee regarding the urgent need for a remodelling of these examinations. If the whole basis of the education of the science pupil "is to be broadened, the requirements of the scholarship examination must similarly be broadened", and the examination must give proper credit not only for the special scientific ability but also for the general education of the candidate. In the words of the report, "merely to include subjects of general culture in the school curriculum without giving due weight to them in the scholarship examination, would not prove effective".

In themselves, however, the university scholarship examinations are not solely responsible for the excessive specialization in the post-School Certificate years at school. Part of the blame must be borne by the Higher School Certificate, and the Board recommends that this examination, too, should be suitably modified by the inclusion of non-scientific subjects for the science specialist. This would necessarily mean a somewhat lower standard of attainment in individual science subjects, and therefore ties up neatly with the further opinion of the Board that exemption from attendance at a first-year course at a university is undesirable. Here again we are in full agreement with the Board.

As to the university courses for the intending chemist, the Board recommends that they should be so adjusted as to make possible participation in the general intellectual, social, and recreational life of the university or college. "The student of chemistry should

have time not only to read and think about his specialist studies, but also to mix with men studying other subjects than his own and thereby broaden his general intellectual interests and enlarge his outlook". It is an arresting reflection upon present conditions that such a recommendation should be necessary.

The Board further believes that it is of importance to emphasize that industry requires, and can make use of, for administration, research, laboratory and process operations, etc., not one type alone but many types of chemists, chemical assistants, and chemical technicians, whose education and training may vary greatly and proceed along diverse lines. Opportunity and suitable educational facilities should be provided to enable a worker beginning his career in any one of the lower grades to pass to a higher grade and to attain the highest qualification and professional position to which he may aspire, and for which he shows himself fitted. For these reasons, the Board welcomes the Government's intention to establish compulsory part-time education up to the age of eighteen, and suggests that the special requirements of young chemists should, at the minimum school-leaving age, be reviewed and care taken in assessing their abilities and in giving guidance with regard to their further education and training. This might be done in the larger centres by setting up advisory committees consisting of representatives of the schools, of universities, of technical colleges, of chemists in industry, and of the Royal Institute of Chemistry. Power might also be given to such advisory committees to recommend suitable part-time students for the award of scholarships or bursaries to enable them to continue their education at a university or technical college.

These are sound and practicable suggestions, which clearly ought to be put into operation at the earliest opportunity. The same may be said about the Board's views on the technical education of chemical technicians and chemical works operatives, that is, young employees and skilled or semi-skilled craftsmen who require a knowledge of chemistry and chemical technique but in whom no high standard of academic attainment is needed or expected. Even with such men, however, the Board feels quite properly that the standard of education—general, scientific, and technical—should be raised as much as possible, and that this is one of the main reasons, so far as chemical industry is concerned, why the minimum school-leaving age should be raised and compulsory part-time education introduced.

Two concluding topics treated by the report are the training of chemists in the professional grade, and the supply and training of teachers. On the first, the Board feels that the first three years of a university or higher technical college course should be comparatively free of technology, and that only in the fourth year should technological subjects take first place. On the other hand, during his undergraduate years, the student of chemistry should be encouraged to visit as many industrial works as possible, in order to acquire some insight into the large-scale applications of chemistry and the conversion of laboratory operations into industrial processes. Before the War, vacation courses for undergraduate chemists were arranged by certain manufacturing firms, and the Board hopes that similar facilities, on an increased scale, may be offered by chemical manufacturers after hostilities cease. The Board is also of opinion that it is important to develop much more fully than hitherto the establishment of graduate schools of technological study on lines such as those followed at the Massachusetts Institute of Technology.

Finally, on the supply and training of teachers, the gist of the report is that—particularly in technical colleges—scales of payment are not at present adequate, and that the only way to ensure sufficient teachers of the desired character and calibre is to make the conditions of service sufficiently attractive. That it should be easier to make this recommendation than to implement it is unfortunate, for the provision of the requisite number of competent teachers is patently one of the linchpins of the whole educational vehicle. But experience of the last four or five years has shown that money can always be found when hard necessity calls; and it is for the Chemistry Education Advisory Board and other chemical and scientific bodies to convince the country of the urgent necessity of mobilizing and arming the total strength of Britain's chemical forces.

INDUSTRIAL POLICY AND EMPLOYMENT IN GREAT BRITAIN

THERE is much that is of real interest to scientific workers in the report, "Work: the Future of British Industry", which has recently been prepared by the Sub-Committee on Industry and issued by the Conservative Central Committee on Post-War Problems. In origin and trend, the report is avowedly a party document, but it attempts in the first place—and succeeds in so doing—to show the measure of agreement that already exists on industry and economic policy between the chief political parties in Great Britain. Largely it is a statement of principles, and it clearly owes much to such previous documents as the Unilever paper, "The Problem of Unemployment", the Nuffield College papers on "Employment Policy and Organization of Industry after the War" and "Industry and Education", and sundry others on reconstruction and industrial policy.

The extent to which there is common ground as to the approach to post-war problems and our attitude to them, rather than on the measures by which they are to be solved—for, as will be noted later, the report gives little hint as to a policy—may be illustrated by a few examples. Once again we find emphasized the interdependence of industry and agriculture, the importance of the growth of industrial management as a salaried profession, and of the new educational reforms in widening the sphere of recruitment for such positions as well as in raising the standard of skill. The necessity of developments in technical education is specially stressed; and in welcoming closer collaboration between industry and commerce and the education service, there is a pointed reference to the need to include the universities.

What is said here on the purpose of industry, not merely as producer of the goods required to raise continuously the standard of living for all, to earn the means of paying for the necessaries we must import from abroad, and as a means of livelihood, but also on its being for millions a large part of life itself, implies an attitude which is the real starting point for all human developments in industry and the creation of the right atmosphere for true efficiency. Recognition that the nature of the work, the mental atmosphere, the material environment, the contacts with fellows, with seniors and with subordinates must necessarily enrich or impoverish the lives and outlook of the workers, and through them the life and outlook of the nation as a whole, is the true starting point for developing co-operation whether through joint production committees or in other ways. Once again, we find a welcome for the 'staff college' idea; and the observations on training for management, health services and welfare, hours of work, status and responsibility should be endorsed by all shades of opinion. Moreover, while emphasizing the place of trade unionism and its value as a training for democracy, there is a timely reminder that trade unions were not established to be the preserve of any one political party.

Again, the report faces the future with emphasis on opportunities rather than on difficulties. The prime need is readiness to pioneer and face risks. It is essential to encourage the spirit of initiative, of adventure, of hope, not to go slow and play for safety. In keeping with this, we find that the report not only recognizes the importance of overthrowing all sectional obstacles to human efficiency and restrictive practices, but also, in keeping with other recent reports, urges the need in many branches of industry for a new awakening to the importance of organized research and to the scale on which British industry must further and utilize the advances of science. A major factor in determining the future prosperity of Great Britain will be the full use of our inventiveness and technical skill. More trained scientific workers, a strong development of scientific research in universities and far greater encouragement and scope for scientific men in industry—all these are urged in the report. Once again it is argued that the manner in which experimental and development work is treated for taxation purposes is restrictive and tends to impede application of results of research to the factory, but the need for change in taxation policy comes second to that for an awakening among those who determine financial policy in industry to the part which science has to play in the future of British industry.

On the question of the relations between government and industry the report recognizes the need for building up a practical system of government, but on the broad question of the structure of industry the report is scarcely as open-minded as, for example, Mr. S. Courtauld in some of his recent utterances, and is inclined to prejudge the issue. In accordance with suggestions in Parliamentary debates and in the Nuffield College paper, it regards new measures for training the staffs of Government departments concerned with industry, and especially export problems, as essential, so that they can instinctively appreciate those problems from inside. It calls for dynamic co-operation between industry and Government departments, and looks for a Ministry of Industry and Commerce inspired by a more positive and constructive conception of its duty to help British industry to grow healthily, make good any weaknesses, sell its goods and provide employment. Among its suggestions are a panel of advisers to a Ministry of Industry, chosen from among the best men available in the industrial field, as well as a highly qualified research staff, attached to the Ministry if not to the Cabinet offices, so that, when Government policy is being shaped, expert advice on any relevant aspect can be taken into account.

These suggestions are independent of the general character of industrial enterprise; but there are other comments, for example, on the future of controls and on the location of industry, which represent a large measure of agreement among progressive opinion. The reasons for continuing controls after the War are well formulated, and taken with Sir Stafford Cripps's recent statement and Mr. Bevin's speech to the cotton trade on January 7, should do something to take this question out of the field of faction and place it in its true perspective. In regard to the location of industry, many of the proposals of the Barlow Report are clearly supported. The imperative necessity of ensuring that the national interest is paramount in all decisions in this field, and that it is not obstructed or thwarted by sectional interests, is the crux of the case for the National Industrial Board recommended in that report; although the necessity for central machinery and powers is admitted in veiled terms which do not distinguish between the majority and the minority proposals.

After discussing monopolies, trade associations, etc., the report makes the essential point that is often overlooked in such discussions: technical progress, skilled administration, and good workmanship—these, and not a new political system, can raise the standard of living. A new political system might, of course, contribute to raise the standard in any one of these three directions. The real question is what forms of organization are most conducive to efficient and successful management in any and in every field of industry.

A welcome feature of the report is the support accorded to international co-operation. In the Committee's view, the greatest single cause of the severe unemployment which afflicted practically every industrial country at some time or other between the two wars was the failure of the nations to diagnose unemployment rightly as a world problem, and to collaborate confidently with each other in policies correctly designed to remedy its deep-seated causes. It should be a prime aim of British policy to ease the way to economic collaboration among all the United Nations in accordance with the fifth point of the Atlantic Charter.

The necessity for new developments of international economic machinery is recognized, as well as the expansion and strengthening of existing institu-

tions such as the International Labour Office. Further, a new international currency agency is suggested, whatever differences of view exist about the manner and rules of its operation. General stability of exchange-rates is a prime necessity in laying firm foundations for the recovery and continued growth of world trade, and the provision of massive credits for rehabilitation is given strong support.

The report expresses the hope that the United Nations will also put boldly in hand long-term constructive plans for world prosperity. Stable and reasonable prices for primary producers are necessary, not only for the sake of farmers, but also as an insurance against the shocks which widely fluctuating prices of agricultural products cause to trade and unemployment. As the Hot Springs Conference recommended, a body of broad principles should be reached, through international discussion, regarding the planning and structure of international commodity agreements. The emphasis is laid on regulation, not restriction.

Support is also forthcoming for proposals to raise the economic standards of backward peoples. The awareness of the possibilities in raising standards of living and welfare, undertaken on sound economic and scientific lines, is a welcome feature of the report, which recognizes that the increase in world purchasing power thus created would flow back to become a further safeguard against under-employment in the industrial countries. The report appears to favour entrusting these tasks to international reconstruction and development agencies as visualized by Political and Economic Planning. Here again we find the need for accurate data emphasized, and it is urged that an essential step in stabilizing employment is an international statistical service.

An important section of the report is devoted to export policy in relation to employment. Here, pleading for further government support, the Committee advocates not subsidies but the removal of any handicaps on export business which it is in the power of the government to remove, and the fullest co-operation between industry and government in the examination of acute export problems. The dependence of social security on a policy of employment is recognized, as is the value of public works, though here the report is much more guarded than the Unilever statement. Public works should be treated as a buffer against depression, not as a cure for it; but priority should be given to projects making for efficiency, whether of industry, agriculture or transport, or the quality of our people—a Severn bridge, a road bridge over the Forth, port facilities, and school buildings are indicated.

The report, taken as a whole, is characteristic of progressive thought, independent of party, and the measure of agreement thus indicated as to the direction, if not necessarily of the tempo and methods, of advance should help to eliminate faction and facilitate the initiation of some of the large measures immediately required. Moreover, such agreement should at least facilitate the scientific approach to the problems of reconstruction, and help to secure that, whatever action is taken or policies formulated, they are at least in keeping with the demands of the facts which scientific inquiry has brought to light. The Labour Party's adoption of a memorandum on food prepared by Sir John Orr as its own official policy may well be regarded not merely as a sign of a non-partisan approach to this vitally important problem, but also as an indication of the possibility that party programmes and policies may at least start from common ground in the results of impartial scientific investigation of the technical aspects of the problems concerned.

While in this way the scientific method may help to eliminate the demagogue, it must be remembered that the scientific and technical issues, important as they may be, are, as a rule, only a part of the problem. As to the means of dealing with the social and political aspects, there may well be, and usually are, alternative solutions. Accordingly it is not sufficient, as the Conservative Sub-Committee on Industry has done in this report, to make clear the measure of agreement on objectives. It is necessary for policy also to be formulated, and for the differences between the practical measures proposed by different political parties to be made equally clear. This present report fails to do this, but unless and until it is done (whether for or by the electorate), a democratic system cannot function effectively.

THE BORDERLAND BETWEEN PHYSICS AND MUSIC

The Physics of Music

By Dr. Alexander Wood. Pp. xii+256+14 plates. (London: Methuen and Co., Ltd., 1944.) 21*s*. net.

DR. WOOD is known to many generations of Cambridge physicists as an excellent teacher of acoustics, and to an even wider circle as a writer of text-books on the same subject. In his latest book he is equally successful in "the very interesting borderland between physics and music" in which so much new knowledge has been gained in recent years. He has written a most useful and valuable book, from which both physicists and musicians can learn a great deal.

The first five chapters expound the general theory of sound, with no very marked emphasis on music, and lead up to a good chapter on the ear and the mechanism of hearing. The next three chapters deal fairly exhaustively with the production of sound by musical instruments—strings, organ pipes, the human voice and orchestral instruments, both wind and percussion. Then come four varied chapters on dissonance and consonance, on scales and temperament, on the mechanical and electrical reproduction of sound, and on the acoustics of halls and concert rooms. This last is a most valuable chapter—or would be if everyone would read it who ought to. For, although the situation has greatly improved of late, many of our auditoria form standing monuments to a want of co-operation between scientific men, musicians and architects. Here Dr. Wood tells us what can be done and what ought to be done. "Probably," he says, "there is no direction in which co-operation between the musician and the scientist is likely to be more fruitful than that of designing auditoria for music," and the same might have been said of rooms for speaking.

The general reader will find much to interest him as he browses through the pages. He may, for example, be surprised to learn how very sensitive a physical instrument the ear is. A softly played violin gives out only 0·0000038 watts of energy, and yet will fill a good-sized room with audible sound. At a pitch of about 3,500 cycles, the ear can hear waves of sound with an amplitude of motion of less than a hundredth part of the radius of the atom. There is, of course, an obverse to this picture, and we read that all the shouting and cheering at a cup-tie match generates just about enough energy to warm a cup of tea.

The flexibility of the ear is equally striking. A full orchestra emits about 20 million times as much energy as the solo violin just mentioned, yet the ear can register both sounds in comfort and with judgment and discrimination. In technical language, it can deal with sounds of from 0 to 130 phons, where each phon represents an energy-increase of about 26 per cent. Dr. Wood brings home to us the vastness of this range by remarking that one twin crying may give a loudness of 60 phons, while the addition of his brother twin will only raise this to 63 phons. Yet the ear works efficiently up to a loudness of 130 phons—10 million babies crying in unison. After this it is not surprising that we come to the "threshold of pain".

In so far as it is concerned with music, the book necessarily treats sound in a somewhat subjective way. Sometimes we may perhaps wonder if this tendency does not go too far, both in the book and outside it. For example, we read on p. 44 that "pitch is not simply dependent on frequency, but depends also on loudness". By way of confirmation, we are told of experiments by Stevens and Snow in which pitch was found to vary with loudness to a maximum extent of 2½ full tones—a fourth. "The pitch of high tones rises with increased loudness, while the pitch of low tones falls with increased loudness." All this seems to make nonsense until we discover that Dr. Wood defines pitch as a "subjective quality of a sound"; it is "the characteristic of a sound in virtue of which we describe it as high or low". When the *A* of a violin is tuned to the *A* of a piano, a musician will say that the two tones are of the same pitch but of different timbre, meaning that the fundamental and its various harmonics enter into the two sounds in different pr portions. But a non-musical listener may describe the violin note as being of higher pitch, because he hears more of the higher harmonics than in the piano note (actually Seashore finds that when the open G is sounded on the violin, the amazingly small fraction of 0·1 per cent of the energy resides in the fundamental, as compared with perhaps 20 per cent for the piano). Now Dr. Wood apparently bases his definition of pitch on this kind of non-musical judgment. The results might well have been disastrous, but happily are not. For within five pages the author has forgotten his own definition of pitch, and is telling us of the new international standard of pitch, "440 cycles per second for the note *A* in the treble clef", with no mention of the loudness with which the note *A* is to be sounded. The matter is not wholly unimportant, in view of recent attempts to use the experiments just mentioned as proof that musical theory cannot be based on scientific principles. If pitch varied with loudness in the way claimed, every chord of music, as it died away into silence, would resolve itself into a succession of ghastly discords, in direct contradiction to the experience of every musician who has ever listened to music.

On this particular question, true music and true science are probably in full agreement; but there are a number of other questions on which they are inclined to give different verdicts. In particular, there is the question of whether distinctive emotional characteristics are associated with the various keys in which music can be written: Is the emotional quality of a piece changed when it is transposed from *C* to *D*—or even from *C*♯ to *D*♭? Many musicians say yes; they can recognize an emotional change, even when the music is performed in equal temperament (in which case the various keys differ in nothing physical except pitch, and *C*♯ and *D*♭ do not even differ in this). Most scientific men think this is a pure illusion, or at best a carry-over of associations from a time when equal temperament was unknown. Dr. Wood discusses all such problems very judicially and fairly. If any criticism is to be made, it is that he stands too modestly aloof; his summing-up gives but little guidance to the jury.

The book gives an adequate account of the large amount of acoustical research carried out in recent years, especially in the United States; in general it is well-written and readable, interesting, authoritative and accurate. Thus it can be warmly recommended, and especially to those musicians who wish to know more of the science in which their art has its roots.

J. H. JEANS.

THE NEW ORDER IN INORGANIC CHEMISTRY

Inorganic Chemistry

By Fritz Ephraim. English edition by Dr. P. C. L. Thorne and Dr. E. R. Roberts. Fourth edition, revised. Pp. xii+922. (London and Edinburgh: Gurney and Jackson, Ltd., 1943.) 28*s*. net.

THE standard text-books in advanced inorganic chemistry at the service of past generations presented the reader with a gigantic jumble of disconnected data. One great unifying principle—the periodic classification of the elements—was indeed recognized; but it was admittedly riddled with exceptions. Small wonder that the majority of students, on reaching the research stage, preferred the severely systematic field of organic chemistry; order is always more attractive than chaos.

To-day the state of affairs is different. Our detailed knowledge of atomic structure, founded on the work of Rutherford, Moseley and Bohr, and our disentanglement of the vexed topic of valency into distinct types, dependent upon the extent to which electrons are transferred or shared between combining atoms, render it possible to develop inorganic chemistry as a coherent whole. The volume under review affords an outstanding, though not a unique, example of the success that can be achieved in this direction. It is true that it is not suitable for the beginner—a very solid basis of elementary facts must still be accumulated before any general theories can be built upon them—but it will undoubtedly appeal to the more advanced student, provided he is not deterred by the first few chapters. These are, perhaps necessarily, very heavy going, but the tension eases as the book proceeds, and the last chapters in particular are packed with material that cannot fail to fascinate and instruct even the expert.

The success of the volume, first issued in English in 1926, is proved by the present attainment of its fourth edition. Each revision has introduced marked improvements. The original text, although good in general, contained a number of almost unbelievable 'howlers'; these have now been carefully eliminated and only a few minor defects remain. For example, the simultaneous presentation of the old idea that a positive charge on an ion is something tangible that can be handed around, and of the newer conception that a positive ion is produced by the loss of an electron (pp. 151, 155, 163), is bound to cause confusion. The fact that the reaction $2Cl_2 + 2H_2O \rightleftharpoons 4HCl + O_2$ is effectively reversible, while the reaction $Cl + HBr = HCl + Br$ (presumably Cl_2 and Br_2 are intended here) is not, cannot be explainable by the statement (p. 218) that the electro-affinities of the elements competing for the hydrogen are more similar in the former case, since exactly the opposite is true (see the table on p. 151). A similar inconsistency is the inclusion of nitrous acid in the list of substances illustrating Luther's rule (p. 376), according to which nitrous acid must be a more powerful oxidizing agent than nitric acid, followed later (p. 691) by the remark "nitrous acid is a somewhat weaker oxidant than nitric acid". The "change in volume" factor cited as the primary influence in determining the heats of solution of gases, liquids and solids (p. 401) is generally insignificant compared with the "change in state" factor, which is not even mentioned.

Direct references to original investigations are numerous, and useful instructions to the student on how to look up the literature before commencing a research are furnished in a special appendix. Unfortunately, the editors have not always followed their own precepts, and several inaccuracies in the text-matter are directly attributable to the antiquity of the accompanying references. Instances are the polyammines of the hydrogen halides (p. 616) and the acid sulphates of the alkali metals (pp. 581–2).

These, however, are merely subsidiary blemishes in a volume which, on the whole, reaches a very high standard and merits the most cordial recommendation.

JAMES KENDALL.

THE END OF THE NATIONAL STATE

The Crisis of the National State

By Dr. W. Friedmann. Pp. ix+198. (London: Macmillan and Co., Ltd., 1943.) 12*s*. 6*d*. net.

DR. FRIEDMANN has developed in this book a striking theme that demands attention. This is that the National State, by a species of historical dialectic, has reached the end of its development and now passes over into neo-imperialist forms. There is no book on political theory that I have seen during the past year to compare with it in brilliancy or one that I would more readily put into the hands of statesmen and politicians.

It is relevant to Lord Halifax's recent proposals that Dr. Friedmann regards the British Empire as not one of the world's *Grossraum-ordnungen*. "It lacks the essential features of *Grossraum*: unity of space and communications, and consequently economic self-sufficiency in the face of modern war. The British Empire is, indeed, the expression of a past phase of Empire". Like the Habsburgs, the British monarchy and Government have concerned themselves with building up higgledy-piggledy a heterogeneous collection of estates, without cultural or any other unity, all over the map. To put Dr. Friedmann's contention in a more brusque form, the British Commonwealth, in abstraction from the West, including the United States, has no future. A brief inspection of geography and population factors should show us this truth, but, for obvious reasons of prestige, politicians will not attend to these considerations until the time comes when it is too late to unify the West, too early to unify the world, and world direction must necessarily pass into more vigorous Eastern hands. Having won the War we shall have effectively ended in the humiliating position of France in 1918, which explains her obeisance to the inevitable and her fall in 1940.

Dr. Friedmann's major theme, however, is based on a study of German nationalism. This, reaching a paroxysmic intensity in Nazi racial theory, then undergoes transformation (comparable to Roman imperial transformation from the close corporation of *cives Romani*, claiming patrician descent from Romulus) into a new imperial form, where Hitler is frank to admit that there is little opportunity for German nationalism as distinct from membership of an international ruling order of administrators and secret police. The logic of nationalism, as group appetite for power, is that it moves from being power for my nation into being my nation's power supra-national over other nations, that is, national imperialism, and then into being power for all bureaucrats, of any nationality, who can functionally contribute to maintain the supra-national imperial power.

The weakness of most contemporary theorists is either that they under-estimate the factor of power, and believe in some kind of liberal pre-established harmony where every country keeps its own army solely to distribute U.N.R.A.'s food supply, or that they seriously believe that any accumulation of power can solve the essentially mental problems of human psychology, ambition and discontent, to-day idealized as 'dynamism'. We suffer from an absence of police which we have never had since Rome fell; and from a breakdown of humanistic education in civilized corporate living which is quite recent—and is expressed by the nihilism of Sorel. Dr. Friedmann fully appreciates the first point, but (unlike Dr. Mannheim) does not dwell on the second.

Dr. Friedmann concludes by favouring regional federal associations or multi-national associations within the framework of a world institution of the United Nations. As touching the orthodox theories of technico-economic organization—the form of 'functionalism' criticized by the present writer elsewhere (*Contemporary Review*, Sept. 1943)—Dr. Friedmann points out that, far from economic necessity compelling internationalism, to-day new developments permit, to some countries (for example, the United States and the U.S.S.R.), regional autarky as never before. Further, "the various political philosophies which dominate international politics in our time are at one in subordinating economic and technical developments to political will. It depends more and more on the latter whether economic conditions will be developed on a national or international scale". The Roosevelt-Eden school of economic-technical collaboration, vestigial from the epoch of economic man, shirks the major issue of a common political will, because it wishes to do so, and is already out of date in the politics of power.

GEORGE CATLIN.

BRAIN RHYTHMS*

By PROF. E. D. ADRIAN, O.M., F.R.S.
University of Cambridge

IN 1929 Prof. Hans Berger, of the Psychiatric Institute at Jena, published the results of some work on which he had been engaged for many years. He had set out to record the electric currents developed in the human brain, and had shown that if metal electrodes were fixed to the scalp, it was possible to detect a regular oscillation of electrical potential which was not due to muscles or skin glands or any other source outside the skull, and could only have come from the nerve cells of the cerebral cortex. The oscillation had a frequency of 9–10 a second. It only appeared when the subject was at rest with attention relaxed and eyes closed; but it obviously represented some kind of continuous activity in the brain covering a fairly large area. What he discovered was then quite unexpected. It has made us revise many of our ideas about the brain and has brought us a little nearer to understanding what goes on in it.

The oscillation, Berger's α rhythm, represents a very small change of potential, about 50 microvolts, and a very small ebb and flow of current in the cerebral cortex. There is nothing unexpected in the fact that brain cells develop small currents when they are active, for all active cells do so. The unexpected thing is the regularity of the rhythm. It is true that if it were not so regular, it might never have been detected, but the regularity means that large numbers of brain cells must be working in unison at the same rate. We should have expected something much more complex and variable—activity varying from moment to moment and from place to place—and not the uniform pulsation shown in a typical record of the electroencephalogram.

We should have expected this because the brain is a great sheet of nerve cells and interlacing nerve fibres, and its working must depend on the spatial distribution of activity in it. This is determined by the particular pathways which must be taken by the incoming and outgoing messages, for the messages are all in the same form wherever they come from, and it is because they arrive in different regions that we interpret one as sight and another as sound. We know, for example, that if one looks at a bright cross, the initial event in the brain will be the activation of a more or less cross-shaped area at the back of the occipital lobe, and that if one hears a sound a pattern will be reproduced in the temporal lobe corresponding to the areas of vibration in the cochlea. All the external events of which we are aware are recorded as spatial and temporal patterns of excitation in the sense organs. These patterns are reproduced in the brain with a good deal of editing, omission of details and heightening of contrasts, and it is from them that we reconstruct our external world.

Now the α rhythm of the electroencephalogram comes from large areas in the occipital region and to some extent from the frontal area as well. At first sight this seems to leave little room for all these diverse patterns of electrical activity. But actually the regions where the potential change is at a maximum are not those where the messages from the sense organs are received in the brain, but are the neighbouring 'silent' or 'association' areas. Also, to make the rhythm appear, the eyes must be closed and the attention relaxed, so that the brain is relatively inactive, at least so far as vision is concerned. Thus the regular wave sequence is derived from certain parts of the cerebral cortex when these have little to do. The cells there are not concerned with the incoming signals and so will be free to beat in unison, and if fairly large areas are so beating our records from the head will show the α waves and will not show the small local irregularities which are probably going on all the time so long as we are conscious.

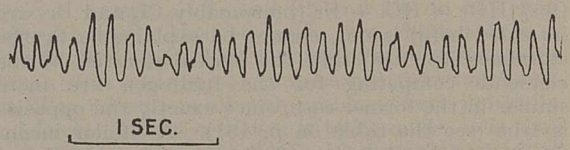

Fig. 1. NORMAL ELECTROENCEPHALOGRAM SHOWING THE α RHYTHM. THE MAXIMUM POTENTIAL CHANGE IS 45 MICROVOLTS.

The cells of the cortex might beat like this when they are left alone because this is how they are made; because like heart muscle or ciliated cells they cannot remain alive and inactive; or the beat might be imposed on them by rhythmically active cells in some other part of the brain which can act as pacemaker to the association areas. Wherever the pacemaking region may be, the important fact is that the rhythm is much the same from one person to another. For clinical purposes, therefore, an electroencephalographic recording can be used as an index to show whether the brain is working normally or not, and for this reason it has become an important technique of clinical neurology. Apart, however, from the value of these records as a means of diagnosis, there is the problem of their significance in relation to the normal mechanism of the brain and of the mind. Do they tell us anything about the neural accompaniment of perception and thought?

The statement that one can record the electrical activity of the brain through the skull raises the hope that one should be able to detect all sorts of brain events connected with consciousness. The hope begins to fade when it is realized that the main feature of our records is a rhythm from nerve cells which are relatively inactive. But there is something of interest to be learnt from them. It is true that we cannot yet record the detailed activities of different parts, but only the gross changes when a whole area goes into action; yet these do give us some novel information about the physical accompaniments of thought and in particular about the process of attention.

To begin with, it seemed that the α rhythm was much less interesting. It might have been merely a spontaneous beat of the nerve cells in parts of the cortex, particularly those concerned with vision—a beat developing whenever the cells were not stimulated by messages from the eyes. Opening the eyes would break up such a rhythm in the receiving area, because the visual pattern there would mean that different groups of nerve cells would be discharging at different frequencies. Something of this kind can certainly happen in the regions where a message enters the cerebral cortex, for in records from the exposed brain (in anæsthetized animals) the arrival of a message in the receiving area produces small, rapid waves in place of the slower and larger α

* Friday Evening Discourse at the Royal Institution delivered on February 4.

rhythm. But the α waves are not confined to the receiving areas of the brain, and it can be shown that in fact the presence or absence of messages from the eyes is not the essential condition for the disappearance or return of the α rhythm.

As far as vision is concerned, what really determines the presence or absence of these waves is not whether visual messages are or are not coming into the brain, but whether we are or are not attending to them—whether we are looking at anything. Man is a visually controlled animal, and if our eyes are open there is usually something in the visual field which catches our attention or some part of it. This is not true for all mammals; the rat and the cat seem to rely more on other senses and can be quite inattentive to sights. But with us the only sure method of shutting out sights from the mind is to close the eyes. Normally, therefore, opening the eyes means that we start looking, or that we become attentive to the visual field. The α waves then disappear, and they return when we close our eyes and cease looking. But shutting the eyes does not cut out all light from the retina, and the α rhythm appears in the brain however much or little light may be falling on the closed lids. Even in a pitch-black room, if we open our eyes and start trying to see something, the rhythm goes, although opening the eyes cannot have altered the illumination of the retina. Sooner or later, when we have given up the attempt to see, the waves will return although the eyes are still open.

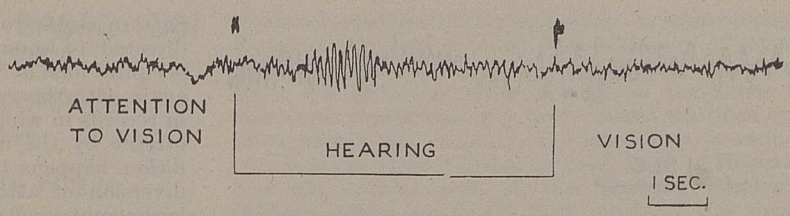

Fig. 2. THE α RHYTHM APPEARS WHEN THE ATTENTION IS TRANSFERRED FROM VISION TO HEARING. THE VISUAL FIELD HAS BEEN MADE UNATTRACTIVE BY + 10 *D* SPECTACLES. DURING THE MIDDLE SECTION OF THE RECORD THE ATTENTION IS CONCENTRATED ON THE TICK OF A WATCH.

What matters, therefore, is not the excitation of the retina but the turning of attention to the visual field or away from it. This can be shown even more clearly in another way. In daylight and with the eyes open, the attention can rarely be abstracted completely from vision except for short periods; something keeps on 'catching the eye' and coming into the mind, even though we have most of our attention fixed on other things, a sound or a smell, for example. The reason why the visual field cannot be completely ignored is that the picture of it in our brain has patterns and sequences which arouse interest by recalling memories or starting some new train of activity. But if we can make the visual field convey less meaning, it will cease to be so attractive and our attention can leave it more easily. A simple way of securing this is to wear spectacles which will throw everything out of focus. When this is done, although the eyes remain open, the α rhythm will appear much more readily than when the visual field is in its proper focus. With the field blurred, we have only to listen intently to a sound and the α waves will begin, to cease again if we transfer our attention back to vision. Here, too, there has been no change in the illumination of the retina but only the shift of attention. It may be noted that it is not only the intellectual interest of the field which holds our attention. Any movement in it or any sudden change of illumination will do so; and there is a great variation in the ability of different persons to detach the attention from vision, and in the same person at different times.

All this shows that the α rhythm is an activity which appears in the cerebral cortex when the attention is not directed to vision, and disappears when it is. The mental act of looking somehow prevents the α waves from developing in certain parts of the brain, parts which are likely to be concerned in analysing the visual pattern. The α rhythm is therefore a rhythm of inattention, a positive activity which fills those parts of the cortex which are for the moment unemployed. It is not the basic rhythm of unstimulated nerve cells, and there must be some kind of competition between the message from the eyes and from the source of the α rhythm to decide which shall control the cortical areas.

To examine this competition in more detail, we must have some way of recording the sensory activity of the brain as well as the α activity. All the messages which reach the cortex will produce their own electrical accompaniment, and this can be recorded well enough if electrodes can be placed on the surface of the brain. But if we can get no nearer than the scalp, the potential changes generated in any group of nerve cells will usually be obscured by those of other groups near by, and the record will then show us nothing. Fortunately this difficulty can be overcome, in part at least, by making all the cells work in unison. This can be done, as far as vision is concerned, by making the field more or less uniform and lighting it with a flickering light. The nerve cells are then forced to work in unison at the frequency of the flicker, and we can record their electrical activity through the skull up to frequencies of about 30 a second. This gives us a method of tracing the visual messages in the brain, for by means of the flicker rhythm they can be made easy to recognize.

Provided that the flickering area is in the centre of the visual field, it need not subtend more than a few degrees at the eye to give a potential oscillation at the same frequency in the occipital region. The waves are more or less where one would expect them to be, in the right occipital region if the left half of the field flickers, and vice versa. But the flicker waves are not confined to the visual receiving area: they are found also in the neighbouring areas, those from which the α waves come when the eyes are closed. The flicker area is not so large as the α area, but on occasion as much as a quarter of the brain surface seems to pulsate with the flicker rhythm. The retinal messages must then have spread widely and impressed their rhythm on some of the association areas of the cortex.

Now if the eyes are open, the flicker will keep the visual attention engaged and the α rhythm at bay. But if the eyes are closed and the flickering light is thrown on the closed lids, the subject will be conscious of the flicker but the conditions will favour the α rhythm, since closure of the eyes is usually coupled with the withdrawal of attention from vision. In these conditions the two rhythms can be seen to compete for the cortex, and sometimes to co-operate if their frequencies allow of it. The flicker-rate will sometimes appear in patches with the α-rate in between, and if a rapid flicker is turned on suddenly

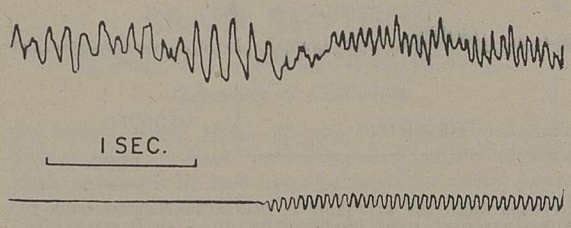

Fig. 3. ELECTROENCEPHALOGRAM FROM THE OCCIPITAL REGION, SHOWING THE CHANGE FROM THE α RHYTHM TO THE FLICKER RHYTHM WHEN THE EYES ARE OPENED AND THE SUBJECT LOOKS AT A SCREEN LIT BY A FLICKERING LIGHT. THE RATE OF FLICKER (17 A SECOND) IS SHOWN BY THE PHOTO-ELECTRIC CELL RECORD BELOW.

the area of the brain giving the flicker rhythm may be large at first and may then shrink rapidly, giving place to the α waves but persisting longer in regions nearer the visual area. If the flicker is made equal to or twice the α-rate, we may find the two summing up to give very large regular waves. Such a combined rhythm usually takes some time to build up as the two sets of waves have to be synchronized, but there is evidently an interaction between them and a tendency to remain synchronized as long as their frequencies are not too far apart. These wave effects vary from one subject to another and there are variations according to mood, time of day, etc.; in general, the sleepier the subject the more the α rhythm will predominate, and the brighter the flicker the more persistent will be the flicker rhythm.

The interaction and interference of these rhythms shows how the cortex, or certain parts of it, may be put at the disposal of our attention. If we decide to look, or if it is decided for us by something 'catching our eye', a change occurs which prevents the α rhythm from occupying the regions surrounding the visual receiving area. If we can turn our whole attention to a watch ticking, the α rhythm comes back. What brings this change about?

The evidence is still rather scanty. It is likely that the whole of the cerebral cortex is concerned, in that it is the balance of activity in every part which determines where the attention will turn and how long it will be held in one field; but the executive act, the direction of the attention to the particular field, is probably carried out by a relatively small central region in the neighbourhood of the thalamus and near the main incoming pathways. It is from there that the α rhythm seems to be controlled, and it is at least probable that it is the sudden disturbance of this region which causes the loss of consciousness after a blow on the head. This central directing region must act on information received from the cortex, for it will be all the memories and associations stirred up by a stimulus which will determine its interest, and these are presumably not aroused until the message has reached the cortex. But the central region must balance up the conflicting claims of different stimuli and must then decide which should have the main share of the attention, its function resembling that of a central university committee which has to decide which branch of learning should be supported by the next benefaction.

The visual stimuli always get the lion's share. If they are at all interesting, the central region will suppress the α rhythm over the occipital area, so that the visual pattern has a considerable part of the cortex set free for its analysis. When the visual pattern ceases to be interesting and the attention is directed to sounds or other sensory messages, the occipital lobe is not turned over to those but is filled again with the α rhythm. This is shown very clearly in records in which the visual waves are made recognizable by the use of a flickering light, and if the flicker happens to be at twice the α rate a partial diversion of attention will be enough to give the large compound waves at the α frequency.

Apparently the occipital part of the brain is used to analyse sights, and sights only. What parts deal with the patterns aroused by sound and touch we cannot yet say. The areas seem too small to be easily detected, and must certainly be much smaller than the areas which deal with vision. On the other hand, a concentrated mental effort may sometimes abolish the α rhythm although the eyes remain shut. Presumably in this case the whole of the α area may be turned over to non-visual activities.

There are still many gaps in the evidence, but there is much to support the view here put forward, namely, that there is a deep-seated part of the brain which contains the mechanism by which attention is directed one way or the other, and that the α rhythm is under the control of this region, if it is not directly produced by it. If this is so, it is not difficult to understand that abnormalities in the α rhythm are often associated with abnormal kinds of behaviour. The most valuable application of the electroencephalogram in medicine is in the localizing of diseased regions and tumours of the brain by the change in the character of the waves. Another is its use in detecting the sudden explosive discharges of the nerve cells which occur in the brains of epileptics. But quite apart from such obvious disorder of the brain cells, the electroencephalogram may show an α rhythm which is definitely abnormal, irregular, faster or slower than usual or with odd-shaped waves, and in a significant proportion of the subjects who give such records there are abnormalities in the mental or emotional sphere which may be a serious handicap. There are, of course, many factors besides the constitution of the brain which determine whether we react like our fellows or not, but the brain is a not unimportant factor and the electroencephalogram seems to offer a means of assessing some of its deviations from the normal. It remains to be seen whether its use for this purpose will have much practical value: at present the most that can be said is that if we had to appoint someone to a responsible post and had an unlimited field of candidates, it would be safer to exclude the five per cent whose electroencephalogram showed the most unusual features.

That is a very long way from saying that the electroencephalogram can tell us how the subject will think and act. In fact the information which it gives relates to a very limited field. But the limitation arises mainly from the fact that we can only record the gross effects and not the detailed patterns in the brain. With present methods the skull and the scalp are too much in the way, and we need some new physical method to read through them. We need the "patent double million magnifying gas microscopes of hextra power" with which Sam Weller thought he might be able to see through "a flight o' stairs and a deal door". In these days we may look with some confidence to the physicists to produce such an instrument, for it is just the sort of thing they can do; but until it is available we have to confess, with Sam Weller, that "our wision's limited".

A SOCIAL MEDICINE BASED ON SOCIAL STATISTICS

By PROF. P. SARGANT FLORENCE
University of Birmingham

1. Experience in Industrial Fatigue

THIRTY years ago I was appointed investigator to a committee set up by the British Association, meeting at Birmingham, to study "Fatigue from the Economic Standpoint". I took 'economic' as a clue pointing me *toward* the external behaviour of men at work and pointing *away* from studies of the physiology of fatigue internal to a man. The data at my disposal were thus confined to the external conditions likely to influence a man's work and the external tests of a man's efficiency at work. The findings which I first reported[1] about the effect of such conditions as long hours or different types of work upon such tests of efficiency as output and accidents gradually developed into a scheme of study, published in 1924[2], which I have found a useful framework for co-ordinating the results of subsequent inquiries. The scheme is here presented in bare outline.

Special Scheme of Study for Industrial Fatigue

VARIATIONS IN INDUSTRIAL CONDITIONS

Conditions of the workplace	*Conditions of the workers*
Hours and intensity of work	Type of worker employed
Type and method of work	Vocational selection
Physical environment: air, light, noise, etc.	Training and experience of workers
Social and psychological environment:	Wages and living conditions
Supervision and relations within working groups.	
Methods of wage payment, etc.	

↓

CAUSE

VARIATIONS IN THE 'HUMAN FACTOR' INDICATED BY

Output	*Accidents*	*Lost time*	*Labour*	*Efficiency*
Quantity		(Absenteeism)	Turnover	(Performance tests)
Quality				
Economy				

The typical unit investigation consists in keeping a group of workers under observation and determining the form and degree of correlation (or 'co-variation') between measured variations in any one condition, and measured variations in an index test of their efficiency, for example, the law of co-variation between a group's hours of labour and their quantity of output or between temperature of the air and a group's accidents. In any actual situation many variable but uncontrollable circumstances arise, of course, during the period of observation. For this reason these studies were social not only in observing a society such as a factory, but also in depending for the reliability of their conclusions upon a statistical norm for a *whole social group* in which individual deviations cancelled out. They were social not only by choice of subject but also by sheer methodological necessity.

To obtain exact statistical norms both conditions and tests of efficiency had to be numerically measurable, and much of the methodology involved consisted in establishing quantitative indexes. Most of the tests of human efficiency are now standard ratios; even quality and economy of output can be reduced in many cases to percentages of spoilage and wastage. But many of the industrial conditions are harder to measure. Type of occupation, for example, did not at first sight appear capable of statistical assessment. But a preliminary qualitative analysis disclosed quantitatively measurable variables such as length of required training, the frequency of repetitions, regularity of repetition (or rhythm) measured by a low deviation from average in the times of successive repetitions of a job[3]. Social relations and environment are obviously the least easy to reduce to a measure. But the work of Prof. Mayo of Harvard and his collaborators at the Western Electric's Chicago works has shown how much of the overt behaviour of groups of workers can be objectively observed and numerically recorded[4]. Clearly, further research using quantitative methods is urgently needed in the social psychology and anthropology of industrial groups.

Once a statistical co-variation is established, it remains to interpret the precise chain of causation. In my industrial studies I used as a working hypothesis a 'human factor', variations in which were taken (1) to cause variations in the tests of efficiency, (2) to be caused by variations in the industrial conditions[5]. The precise psycho-physiological processes such as fatigue that may be manifested by this human factor, intermediate between conditions and tests, is largely a matter for clinical and laboratory study. This was the point in the scheme where external observations, accurately measured and summarized statistically, gave place to 'internal' experiment and analysis. Such experiment often artificially reproduced the industrial situation in a laboratory. It attempted to test some particular variation in the human factor under conditions deliberately selected and controlled.

2. Application to Social Medicine

The study of industrial fatigue, defined broadly as a study of the variation in human efficiency associated with variations in industrial conditions, is unquestionably a special branch of social medicine, and it is possible that the technique specially developed there may prove useful to social medicine in general. Tentatively I suggest the following enlarged general scheme, which would make the definition of social medicine *the study of the variations in human health and efficiency associated with variations in social conditions.*

General Scheme of Study for Social Medicine

VARIATIONS IN SOCIAL CONDITIONS

(*A*) OCCUPATIONS	(*B*) LIVING CONDITIONS HOME LIFE	(*C*) PERSONS AFFECTED
School or work, if any	(determined largely by income)	
Hours and intensity of occupation	Food	Sex, age, condition (e.g., motherhood)
Physical conditions	Housing	Heredity (physical and mental)
Social and psychological environment	Distance from work	Acquired characters
Type of occupation	Degree of urbanization	Education
Unemployment	Medical attention	Vocational training
	Family relations	Background and experience
	Recreation	
	COMMUNITY SERVICES (determined largely by central and local government expenditure)	
	Public hygiene, hospitals, insurance, etc.	

CAUSE

VARIATIONS IN PSYCHO-PHYSIOLOGICAL MECHANISM ('*Deviations from Positive Health*')

INDICATED BY

Fertility and reproduction-rates	Measurement of physique	Morbidity (various diseases)	Mortality (various diseases)	Efficiency records (output, accidents, etc.) and tests
1	2	3	4	5

All the working conditions on the left-hand side of the special industrial fatigue scheme are here grouped under occupation, which may apply to *school* or *work*, either in industry or in the Forces. The effect of unemployment must also be considered. Living condi-

tions take on an increased importance and are given a column to themselves. They may be divided into home life, including the food still customarily taken there, and community services. These services may be preventive, such as are rendered by local medical health officers, curative such as the hospital services, or palliative such as insurance benefits.

In the investigation of industrial fatigue, type and training of workers and their selection to fit their job were found to be important conditions of efficiency (and happiness). It was found to make a difference in the results of, say, hours upon accidents if the workers were men or women, or were experienced or 'green'. Similarly, in any investigation of social conditions it will make a difference on what persons or group of persons the impact of the purely environmental condition falls. As an expansion of 'type' and 'training' of workers a third column is therefore added to the general scheme of study, headed "Persons Affected". Here the influence of nature and nurture (sex, age, heredity, education, experience) upon differences and variations in human health and efficiency and their importance in recruitment of personnel is taken into account. This is the special field of social biology, and its importance suggests that a fully developed school of social medicine should have a special lecturer or readership in social biology attached to the chair.

The indexes and tests of efficiency in the original scheme may be enlarged by the addition of standardized tests of health and survival such as marriage, reproduction and fertility-rates, morbidity and mortality-rates from various causes, and in general. There will, of course, be the same need for laboratory and clinical research into the intermediate psycho-physiological mechanism to interpret how the variable social conditions are associated with variations in these statistically measured external events. One approach, already mooted, is to assume psycho-physiological variations or deviations from some standard of *positive health*.

Many of the social conditions are now directly measurable in statistics already recorded or easily reckoned: under the heading occupation, hours worked and physical conditions; under the heading home life, physical housing conditions, distance from work, degree of urbanization (by population density), family income (largely determining food consumption); under community services, per capita expenditure of central and local authorities; under persons affected, age, period spent at school or in training. The possibilities and limits of such exact information both about social conditions and tests of health and efficiency require a lecturer or readership in demography and social statistics for their elucidation.

Where statistical records are not yet available in sufficient detail or do not answer the relevant question, *ad hoc* inquiries should be made in the field. For example, the constituents of food purchased or eaten by families, the actual extent of specific types of social services performed, the stop watch measurement of the intensity of work, social relations both at the place of occupation and in the home and community. The need mentioned above for exact psychological and anthropological study extends from industrial to all other social groups. Social medicine would indeed be greatly helped by the establishment of lecturers or readerships enabling fieldwork observations to be undertaken in the social psychology or anthropology of factories, schools or indeed typical households. The hospital almoner, for example, constantly comes up against 'case work' problems arising from psychological reactions to work or to family relationships, and needs expert advice. Much of the research work here would be preparatory to statistical measurement. The quality of types of social relationships must be understood before quantitative assessment of each type can be undertaken.

Classical and recent research in social medicine may be briefly reviewed (giving references in brackets) to show how far the lines actually developed fit into the scheme of study outlined above. If occupation (at work or school) and living conditions be lettered *A* and *B*, and the five tests of health and efficiency numbered 1, 2, 3, 4 and 5, we can find examples of all possible combinations of variation in one sort of condition *A* or *B* with variation in tests 1 to 5. Besides these 'couplings' there are 'triplings', 'quadruplings', and so on, where variations in two or more sorts of condition are related to a test. It is here that the persons affected (column *C*) come into the picture as influencing the effects of the purely environmental conditions.

Couplings	*All possible combinations*
A and 1	Differential Fertility of Different Occupations (Dr. Enid Charles)
A and 2	Measurements of Height, Weight, Muscular Strength, etc., of Unemployed. (Industrial Health Research Board)
A and 3	Relation of Type of Work to Sickness Absence. (Medical Research Council)
A and 4	Occupational Mortality-Rates. (Registrar-General)
A and 5	Hours of Work and Output, Absenteeism, Accidents, etc. (Health of Munitions Workers Committee) (U.S. Public Health Service)
B and 1	Differential Fertility of Income Classes, Rural and Urban Populations. (Dr. Enid Charles)
B and 2.	Food and Malnutrition Symptoms. (Sir John Orr)
B and 3	Ante-Natal Services and Maternal Mortality. (Ministry of Health (Report 1937))
B and 4	Density of Population and Death-Rates. (Dr. Farr)
B and 5.	Wages and Output. "The Economy of High Wages". (Lord Brassey)

Triplings, etc.	*Scattered Examples*
BC and 4	Infant Mortality by Income Class. (Registrar-General)
AC and 5	Accident Proneness in Factories. (Industrial Health Research Board)
ABC and 5	Retardation of School-children and Poor Homes. (Lloyd and Burt, City of Birmingham)

3. Summary and Conclusions

1. If social medicine is defined as the study of variations in human health and efficiency associated with variations in social living and working conditions, it can be viewed as an extension of studies of industrial fatigue initiated before the War of 1914–18.

2. Such studies, aiming at the scientific observation of social norms of behaviour, can and (where laboratory experiment is impossible) must be based on statistical measurement and summarization. They require full exploration of the possibilities of vital statistics as a measure of health and efficiency as well as statistics of social conditions. A professor of social medicine should have the co-operation of a reader in demography.

3. The social conditions the observation and measurement of which have proved particularly difficult in fatigue studies, and are likely to do so in social medicine, are those relating to psychological social and family relationships. Readerships in social psychology and anthropology would clear up many of the more difficult obstacles in the path of social medicine.

4. Different classes of persons will react differently to similar conditions according to their heredity, sex, age, education and past experience. Such variation due to nature and nurture (apart from present environment) must be studied in a social biology, for which additional provision should be made.

5. A chair of social medicine should thus, in a fully developed school, be supported by a staff that includes experts in demography and social statistics, in social psychology and anthropology, and in social biology.

[1] *Proc. Brit. Assoc.* (1914, 1915).
[2] Florence, "Economics of Fatigue and Unrest", Chap. 4, Table 3.
[3] Florence, "Economics of Fatigue and Unrest", pp. 244–48.
[4] For example, Whitehead, "The Industrial Worker".
[5] Florence, "Economics of Fatigue and Unrest", p. 100.

STRUCTURE OF HETEROCHROMATIN

By Dr. G. PONTECORVO
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IT has long been known that some chromosomes, or chromosome segments, respond to staining during mitosis or meiosis in a different way from the rest of the set. They are called 'heterochromatic' to distinguish them from the 'euchromatic' rest of the set taken as a standard. The cyclic staining reaction of the chromosomes is generally attributed to synthesis, during prophase, and breakdown, during telophase, of desoxyribose nucleic acids—a view recently challenged by Stedman and Stedman[1], but which will be followed here, the substance actually involved being irrelevant for the present discussion. It is now clear, especially from the work of Darlington[2] and his collaborators, that the visible difference between heterochromatin and euchromatin is a consequence of a difference—referred to as 'allocycly'[3]—in the timing and/or in the amplitude of the above cycle. In heterochromatin the maximum nucleic acid charge attained by euchromatin at metaphase may be attained earlier, later, never or even surpassed. This behaviour has been taken as showing that heterochromatin has a lower reactivity in nucleic acid synthesis, and that, therefore, only when the demand for nucleic acid precursors by the more active euchromatin is low can heterochromatin successfully compete for them. It will be seen that another explanation is also possible.

Let us consider the characteristics and behaviour of heterochromatic segments. In the first place, the same segment, or chromosome, may be visibly allocyclic in one tissue and not in another, or it may have different allocyclic behaviour in different tissues. An example of the former type are the sex-chromosomes of many mammals, strongly allocyclic at meiosis but not so at mitosis; and of the latter the *X*-chromosome of the Acrididæ, in which the cycle is shifted one way in certain divisions of the germ track and the opposite way in others[4]. Thus the allocyclic behaviour is determined by at least two factors: the reactivity of the heterochromatic segment itself and the conditions of the cell[3]. As some of the latter can be controlled, what happens in Nature between tissues has been imitated experimentally within one tissue. For example, by low-temperature treatment it has been possible to detect as heterochromatic in mitotic or meiotic metaphase segments that under normal conditions could not be identified as such[3,5].

Secondly, two or more heterochromatic segments in the same nucleus, or even in the same chromosome, often differ from each other, besides differing from euchromatin, in their nucleic acid cycle. A conspicuous example of this is provided by the pairing and differential segments of mammalian sex-chromosomes: both are heterochromatic but with distinct cycles[6]. In this case it is certain that the different cycle goes with different genetical properties.

Thirdly, heterochromatic segments, or chromosomes, have been identified of any visible length. They may be located in any part of the chromosome set. Of course, the greater their length and the stronger their allocycly, the more easily they are detected. Our knowledge of their occurrence in animals and plants is, thus, inevitably a very distorted one.

Fourthly, certain heterochromatic segments in some species have the property of 'non-homologous' association in the prophase of meiosis, or in the polytene chromosomes. This property, however, is of erratic occurrence and tends to occur in groups of related species, rather than at random. This suggests a common origin for a property that, as will be seen later, is by no means a general characteristic of all heterochromatin.

Finally, since the discovery by Muller and Painter[7] of genetically 'inert' chromosome segments, and their identification by Heitz[8] with heterochromatic segments, 'inertness' has been found to accompany allocycly in all unambiguous cases. This 'inertness' manifests itself in two ways. One is that, per unit length, heterochromatic segments carry fewer, or no, genes detectable by sharply alternative effects of different allelomorphs. The other is that deficiencies or duplications for heterochromatic segments have far less harmful effects than deficiencies or duplications for euchromatic segments of the same size. The 'inertness' of heterochromatin may mean that either there are actually few, or no, genes in it, or there are a full quota of genes but the developmental effects of mutation or change in quantity in them are difficult to detect. Recent work[11,12,13,14,15] strongly suggests that the latter alternative is the correct one.

Several trends of thought and lines of research seem to agree in regarding heterochromatin as internally less differentiated than euchromatin. Indeed, this idea was already implicit in Muller's early suggestion that what we now know as heterochromatin originates from mutation towards 'inertness' of genes kept in a permanently heterozygous state, as those of the *Y*-chromosomes. Caspersson[9] and his collaborators consider heterochromatin as "built up of identical or similar elements or genes", a construction that would explain why deficiencies or duplications are so much less harmful than for comparable euchromatic segments. Furthermore, they consider that the greater uniformity of heterochromatin is expressed in the simpler types of proteins which, by means of ultra-violet spectroscopy on salivary gland chromosomes, they found in it. Unfortunately, as the same authors have shown, the types of proteins in the chromosomes change during successive stages of the division cycle, and Painter[10] has discovered that the salivary gland chromosomes undergo a process somewhat comparable to that of mitosis. As heterochromatin and euchromatin have cycles that may not coincide in time, only a comparison covering whole cycles in the same types of cells, and in different species, could show whether the difference in the types of proteins is general and not spurious. Darlington[2] has expressed the idea of the lesser internal differentiation of heterochromatin by saying that the difference between 'activity' (of euchromatin) and 'inertness' (of heterochromatin) is a difference between high

specificity and low specificity. Further, with his collaborators[11,12,26], he has shown that the heterochromatic 'supernumerary' chromosomes, characteristic of many animals and plants, are by no means inert. These 'supernumeraries', though varying in number between cells of an individual and individuals in a population, tend, as noted by Slack[13] in Cimex, towards an equilibrium, which Darlington and his collaborators have shown to be adaptive. Finally, Mather[14,15] has given a concrete expression to the view of the uniform structure of heterochromatin by suggesting that heterochromatin is made up of 'polygenes', and by finding genetical evidence which supports this idea. Study of the genetical and cytological properties of mammalian sex-chromosomes[6] also supports Mather's view.

There seems to be, in conclusion, a considerable amount of agreement for considering heterochromatin as internally less differentiated than euchromatin. On two points, however, the present trend of thought is not equally definite. One is the connexion between this lesser differentiation and the allocyclic behaviour. The other is the question of whether or not the elements that make up heterochromatin are necessarily different from those that make up euchromatin. These two questions will now be discussed.

Let us first consider what makes the nucleic acid cycle of euchromatic regions appear uniform throughout the nucleus. It is proper to raise this question before discussing what makes heterochromatin differ in this respect, because, in fact, during a brief part of the division cycle euchromatic regions are far from uniform along their length. This part is early prophase, especially of meiosis, when nucleic acid has already condensed along the chromosomes but their lengthwise contraction is barely starting. In this short period the chromomeres are distinctly visible and obviously differ from each other in their nucleic acid charge. Each chromomere shows a distinct reactivity of its own in nucleic acid synthesis; it is 'allocyclic' in relation to others, either because its cycle is shifted in time, relative to that of other chromomeres, or because different chromomeres synthesize at different rates or reach different final charges. The giant salivary gland chromosomes of Diptera show this longitudinal differentiation of euchromatic regions even better: their 'bands' present an array of different charges and are intermingled along the chromosomes more or less at random with respect to these charges. As mitosis or meiosis proceeds, the chromosomes contract enormously by spiralization and loss of proteins[9]. Consequently it is no longer possible to distinguish the individual chromomere; all that a chromosome segment can show is the aggregate effect of its component chromomeres. In segments with intermingled chromomeres of different charges, the result is apparently uniform within and between segments. The reaction of euchromatic regions, optically uniform as they are after prophase throughout the whole chromosome set, is, thus, the statistical consequence of their being made up of a mixture of highly differentiated chromomeres. The immediate corollary is that a segment in which chromomeres are more uniform may differ in its aggregate reaction from the former.

If we accept the view that heterochromatin is made up of elements less differentiated than euchromatin, we have only to assume that these elements are chromomeres, and chromomeres of the same type as those which we find intermingled in euchromatin. The essential difference between the two types of chromatin would then lie exclusively in the linear arrangement of chromomeres with the same nucleic acid cycle: a heterochromatic segment being one with a very high proportion of these similar or identical chromomeres. Segments made up of repeated replicas of a single type-chromomere, or few type-chromomeres, would be the extreme term in a series between euchromatin and heterochromatin. Unfortunately, the only case in which, so far, it has been possible to make out the minute structure of heterochromatin in a suitable stage is that of some Dipteran salivary chromosomes. Here each heterochromatic segment actually consists of chromomeres far more uniform than those of the euchromatin; moreover, in Drosophila, some, but not all, heterochromatic segments in a salivary gland nucleus agree in having the same types of chromomeres[16]. The latter feature, however, like that of 'non-homologous' association probably connected with it, is certainly not general.

Clearly the preceding suggestion accounts for the allocyclic behaviour of heterochromatin. In fact, the nucleic acid cycle of the type-chromomere, or chromomeres, making up a heterochromatic segment, will but seldom happen to be identical with the nucleic acid cycle of euchromatin, which is an average. More often it will be distinct, being out of phase or in other ways differing from the latter, just as two 'euchromatic' chromomeres may differ from each other. Furthermore, the type-chromomere, or chromomeres, of each heterochromatic segment need not, and often will not, be the same for different segments, thus accounting for the different allocyclic behaviour of two or more segments in a nucleus. On the other hand, it may be inferred that 'non-homologous pairing' occurs just in those species where these type-chromomeres happen to be the same in more than one segment; in other words, in cases where two or more heterochromatic segments have a common origin, as Prokovjeva[17] and Muller[18] suggest for Drosophila. This would also explain why this property appears erratically but tends to occur in several of a group of related species. Thus allocyclic behaviour can be accounted for by assuming a different linear arrangement of similar chromomeres without need of the further assumption of any difference in the nature of the chromomeres themselves. Can we, on this simple assumption, also account for the functions in cell physiology that are being attributed to heterochromatin?

The main inference is that heterochromatin acts as a regulator of the nucleoprotein metabolism of the cell and therefore controls the reproduction of the chromosomes[2,9,11,19,20]. This function is deduced mainly from consideration of the activity of the nucleolus, and of the disturbances arising in the division of the nucleus as a whole in consequence of excess or defect of heterochromatin, and in the division of parts of the chromosomes in consequence of changes in the relative position of eu- and heterochromatin. Indeed, the weight of part of this evidence would become decisive only if it were established that euchromatin does *not* produce the same effects. However, on the basis of the structure of heterochromatin as proposed here, one would expect each heterochromatic segment to exercise both a localized and a general *specific* effect on the conditions of nucleoprotein synthesis in the nucleus, often different from the *non-specific* effect (in this respect) of any euchromatic segment of comparable length. It is, therefore, permissible to venture a prediction:

namely, that close investigation will reveal very characteristic differences in the action of different heterochromatic segments in the same species, and between species. It is perhaps due to the fact that so much use has been made of Drosophila for the investigation of heterochromatin that this possibility has been overlooked (but see Demerec[27]).

This brings us to speculate upon the origin of heterochromatin. It is implicit in the view expressed here that a heterochromatic segment should arise every time that a minute euchromatic region undergoes repeated reduplications in the genotype and the replicas remain adjacent to each other on the chromosome. Models of some such process are known, and there is every reason to believe that, once a first replica has become established, the mechanical and genetical possibilities of its being repeated are enhanced. The finding by Harland[21] that the same function may be performed in one species by a single gene and in a related species by many is perhaps an example of the genetical consequences of this process. There is, thus, plenty of scope for new heterochromatic blocks to be formed, for old ones to be eliminated, and for variations in size. Furthermore, inversions and other appropriate structural changes may break up an originally compact heterochromatic segment into many small ones interspersed among euchromatin (cf. Kaufmann[22]). Natural selection and accidental variation seem to have a number of possibilities here.

As stressed by Wharton[23] and by White[24], among others, heterochromatin certainly plays an important part in speciation. This part stands out in terms of Mather's[25] theory of polygenic variation. Mather has studied the function of linkage between 'polygenes' (definable perhaps as genes existing in repeated replicas in the genotype) as a basis on which the evolutionary plasticity of a species is founded; he has now reached the conclusion that heterochromatin is made up of polygenes[15]. We see that the formation of new heterochromatic segments, their loss or dispersion and their variation, by the process adumbrated above, are all mechanisms whereby polygenes may arise and linkage between them may be created and varied.

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WORDSWORTH AND SCIENCE

By DR. V. B. WIGGLESWORTH, F.R.S.

> To the solid ground
> Of nature trusts the Mind that builds for aye;
> Convinced that there, there only, she can lay
> Secure foundations.

FOR seventy-five years the first lines of this quotation have appeared on the cover of NATURE. For long enough the quotation was inaccurate; not until 1929 and 1934 were the errors brought to the notice of the Editor and put right. When the lines first appeared in this setting, Wordsworth had been dead for nearly twenty years. Had he been alive he could scarcely have approved the use to which his words were put. To the scientific reader of NATURE (after he has permitted himself perhaps a fleeting smile at the *double entendre*) the words may well convey a sentiment gratifying to his self-esteem. But there is little in the sonnet from which they are taken to justify that feeling, and less in Wordsworth's writings as a whole.

In a moment of enthusiasm in 1833, writing of "Steamboats, Viaducts and Railways", Wordsworth cries:

> Nature doth embrace
> Her lawful offspring in Man's art; and Time,
> Pleased with your triumphs o'er his brother Space,
> Accepts from your bold hands the proffered crown
> Of hope . . .

By 1844, when the railway threatens Kendal and Windermere, the tone has changed:

> Is then no nook of English ground secure
> From rash assault?

He "scorns a false utilitarian lure".

But it is Wordsworth's abstract reflections on science, when writing at the height of his powers, that we shall take more seriously. His attitude to science is almost uniformly hostile. "All *heaven-born* instincts shun the touch of vulgar sense." In 1806 he writes of the "Star-gazers", the public in Leicester Square who, for the price of one penny, are permitted to glimpse the heavens through a telescope. It is a parable on the ultimate dissatisfaction of those who "pry and pore". The same feelings about science find their most unbridled expression in "A Poet's Epitaph" (1799), where men of many sorts in turn approach the poet's grave. The man of science is greeted thus:

> Physician art thou?—one, all eyes,
> Philosopher! a fingering slave,
> One that would peep and botanise
> Upon his mother's grave?

He is besought to take his "ever-dwindling soul, away!"

A more considered variant on this recurrent theme is to be found in Book IV of "The Excursion" (1810–20). Shall those "ambitious spirits" who "have solved the elements, or analysed the thinking principle . . . prove a degraded Race?"—"Oh! there is laughter at their work in heaven!"

> . . . go, demand
> Of mighty Nature, if 'twas ever meant
> That we should pry far off yet be unraised;
> That we should pore, and dwindle as we pore,

Viewing all objects unremittingly
In disconnection dead and spiritless ;
And still dividing, and dividing still,
Break down all grandeur . . .
. . . And if indeed there be
An all-pervading Spirit, upon whom
Our dark foundations rest, could he design
That this magnificient effect of power,
The earth we tread, the sky that we behold
By day, and all the pomp which night reveals ;
That these—and that superior mystery
Our vital frame, so fearfully devised,
And the dread soul within it—should exist
Only to be examined, pondered, searched,
Probed, vexed, and criticised ?

His spirit revolts at the ways of men of science, who prize the human soul and the transcendent universe

No more than as a mirror that reflects
To proud Self-love her own intelligence.

In one passage only, of which I am aware, and that still later in "The Excursion", does Wordsworth admit that science may find "its most noble use . . . in furnishing clear guidance to the mind's *excursive* power" and "then, and only then, be worthy of her name" :

For then her heart shall kindle ; her dull eye,
Dull and inanimate, no more shall hang
Chained to its object in brute slavery.

Ought we then :

To reinstate wild Fancy, would we hide
Truths whose thick veil Science has drawn aside ?

No ! No matter how high we rate "the thirst that wrought man's fall" . . . "the universe is infinitely wide" and reason will ever meet "some new wall or gulf of mystery" which nothing but "Imaginative Faith" can overleap.

The fact is that Nature for Wordsworth has so deep a meaning.

The sounding cataract
Haunted me like a passion : the tall rock,
The mountain, and the deep and gloomy wood,
Their colours and their forms, were then to me
An appetite.

Perhaps that is as far as most votaries of Nature get. But in these lines Wordsworth, "so long a worshipper of Nature" (and if Wordsworth says "worshipper" he means it) is looking back to his "thoughtless youth" before he had learned to hear in Nature "the still sad music of humanity" and had gained "a sense sublime of something far more deeply interfused . . .", the "soul of all my moral being". Indeed, he goes on almost to reproach his sister that "in the shooting lights" of her "wild eyes" he can read only those more superficial joys. She lacked as yet :

. . . the spirit of religious love
In which I walked with Nature.

It is true that, for a time, depressed and bewildered by the excesses of the Revolution in France and the reactions it provoked, he "turned to abstract science" and there sought

Work for the reasoning faculty enthroned
Where the disturbances of space and time,
. . . find no admission.

But he was soon recalled by Dorothy and "preserved a Poet" to "seek beneath that name alone" his "office upon earth" and to derive "genuine knowledge" from "sweet counsels between head and heart".

Such is a fair picture of Wordsworth's view of science. Whether the poet would have deemed it an act of piety to con and sift his writings in this way, to the sorry detriment of his grand use of words, is open to doubt. He might well have cried :

Our meddling intellect
Mis-shapes the beauteous forms of things :—
We murder to dissect.

To-day, when physics ends in the mists of mysticism, it may be that science might claim kinship with Wordsworth the poet. But science now claims all society as her province, and Wordsworth the prophet and reformer would fit less awkwardly into the pages of NATURE. The Wordsworth who, standing at the threshold of the Industrial Revolution, with a mind not warped by politics, can compare with truly scientific objectivity, though with all a poet's feeling, the evil of the factory child with the grinding penury of rural England and the ignorance and degradation of the children on the land. The Wordsworth who can describe the factories wherein "little children, boys and girls" enter and

where is offered up
To Gain, the master idol of the realm,
Perpetual sacrifice,

and who can yet rejoice

(Measuring the force of those gigantic powers
That, by the thinking mind, have been compelled
To serve the will of feeble-bodied Man)

in the conviction that late or soon man will learn that "physical science is unable to support itself" and that

. . . all true glory rests,
All praise, all safety, and all happiness
Upon the moral law.

The Wordsworth who, surveying all these evils present and to come, finds a solution and a hope (this in 1810) in "a System of National Education established universally by Government" and urges that such a system be begun at once even "when oppression, like the Egyptian plague of darkness" is "stretched o'er guilty Europe". For then

Change wide, and deep, and silently performed,
This Land shall witness.

OBITUARIES

Mr. J. Reid Moir, F.R.S.

I FIRST met Reid Moir so long ago as 1911. Rumours had been flying about that it had been demonstrated without cavil that the Garden of Eden had been close to Ipswich, that mankind's birthday had been thrown back millions of years, that the 'missing link' had been at last found ; that all these startling new discoveries were the result of a Mr. Moir's finds in a gravel pit near Ipswich. The facts were that Moir, in business in Ipswich, instead of playing golf in his spare time, spent all his leisure in the gravel pits near his home in the hope of discovering the relics of

early man. In this he was helped and backed up by the late Sir Ray Lankester, without whose aid even Reid Moir might have failed to 'get his ideas over'. The age of the gravels in question has never been doubted. They contain a rich fauna and belong to a period antedating the Cromer Forest bed : in the still current nomenclature they are late Pliocene in date. Moir claimed that *in situ* in these gravels he had found artefacts, that is, flints which had been chipped by man, and which for reasons given could not have been the result of natural operations.

The heat of the controversy which at once burst on Moir's head can only be explained if we remember that theological as well as archæological considerations were involved. The theory of evolution as outlined by Darwin had, it is true, been somewhat grudgingly accepted by the Churches; but here was a little business man in a provincial town who ventured to throw back the antiquity of man to some incredible date, to throw completely out of balance the accepted order of man's history. On no other ground can one explain the fury of the conflict. One of Moir's opponents actually had printed in colour a Christmas card burlesquing the whole theory. But Moir was of Scottish origin and had been hardly brought up by his father, the founder of the tailoring business he was later to inherit. Indeed, he once told me that at first he was made to sweep out the premises in the morning. He just persisted in his theories, collected more and more evidence from the pits, and studied more and more closely the complicated phenomena of flint fracture. Through thick and thin he continued to have the support of Lankester and a small number of scientific men with open minds.

But it was not until 1920 that the great moment came. It must be remembered that prehistory was recognized as a definite subject much earlier on the Continent—more especially in France—than in Great Britain. The two chief exponents there were Profs. Boule and Breuil. Both had written long articles against Moir's ideas. One based his objections on observations of a mortar-making machine at Mantes, the other on some finds of flints flaked as a result of earth pressure. It was in 1920 that Moir discovered certain chipped flints which seemed to him conclusive, and he sent them to the Sedgwick Museum at Cambridge for consideration. The late Prof. J. Marr called me in for consultation and as a result I invited the Abbé Breuil to come to Cambridge at once, which he did. I took him over to Ipswich, and a long afternoon was spent poring over the finds spread out over the floor of Moir's study. Breuil said little, and when driving back in the evening he was still more silent. Then he quietly remarked, "Mon cher ami, aujourd'hui a beaucoup vieilli l'humanité". It was a magic moment ! In the following year he announced his change of ideas at an international congress held at Liège. That each and all of the specimens Moir claimed as humanly fashioned were really artefacts may be doubted : that tool-making animals, almost certainly therefore primitive humans, existed at that remote period is, however, a fact accepted to-day by the vast majority of prehistorians. This is Moir's great work, for which he was eventually awarded a fellowship of the Royal Society.

It would take too long to describe in detail all the investigations Reid Moir undertook in the Ipswich district and elsewhere. Some proved to be important and the results were accepted by the scientific world ; others proved less so, and the explanations put forward at the time had later to be modified. But this is true for any active investigator in the field. Moir was generous with the specimens found in the course of his excavations, and these are now widely distributed in the museums of England and France ; but his first loyalty was to the well-known Ipswich Museum, of which he was the godfather, having, in fact, made it what it is to-day. At the time of his death, he had been studying certain finds made long ago in the Puy Courny district of France. It is to be hoped that his notes are extant. The drawings were already made some considerable time ago ; but the War stopped all idea of publication on a scale necessary for such a work.

Moir was interested in many things besides prehistory, and I have letters of his philosophizing on life generally. He had a soft heart and was much concerned that the slaughter of animals for food should be painless. Indeed, he inaugurated a local campaign to this end. To gain time for his many scientific commitments and interests, he turned his business into a company and as such it did not prosper too well. In fact Moir, in the latter part of his life, was an exceedingly poor man as a result of his scientific toil. He was interested in water geology and took this matter up professionally to some extent. As was to be expected, Moir in his younger days in the heat of controversy could be fierce. I have had letters from him which I promptly burnt ! Nevertheless, his characteristic and ferocious brand of language was part of his robust personality, which never shirked a challenge, and indeed helped to endear him to many of us. But there was a lovable strain right through him, and this, together with his charm of manner, in later years took a more and more prominent place in his nature. I can only add that personally I had a real affection for Reid Moir and sincere regrets that he has gone. This emotion, I am convinced, will be shared by everyone who knew him well. MILES C. BURKITT.

Dr. L. H. Baekeland

IN the passing of Dr. Leo H. Baekeland on February 23 in his eighty-first year, the world of applied science has lost an outstanding man. He was an individual of outstanding character with a high moral status and charming personality. One never tired of hearing his stories of his adventures connected with his travels to most lands and his yachting experiences. He lived to see and to gain the benefit of his two great developments, namely, 'Velox' gaslight paper and 'Bakelite' synthetic resins. Of late years he had been in failing health, and the chemical and technical societies of the United States and Great Britain have missed his presence at their annual meetings for about eight years.

Baekeland was born in Ghent on November 14, 1863. He studied science in the University of his birthplace, making chemistry his chief subject, and afterwards became a lecturer in the University. In 1884 he graduated as a doctor of science at the University of Ghent. Although he was not yet twenty years of age he became professor and taught chemistry at the University from 1882 until 1889, and during 1885–89 he taught both chemistry and physics at the State College of Science, Bruges. During this period he also went to Germany, meeting German men of science and learning their language.

He married Miss Celine Swarts, the daughter of

his professor of chemistry, in 1889, and at the end of the same year he emigrated to the United States of America.

In the United States Baekeland devoted the earlier part of his career to research work which resulted in his discovering a process for the production of photographic printing paper, suitable for use in artificial light. To these papers he gave the name 'Velox', which printing paper is still well known throughout the world. In 1893 he founded the Nepera Chemical Co., and in 1898 he sold his interest to the Eastman Kodak Co.

Afterwards, at the age of thirty-five, he returned to research work in a laboratory in a house at Yonkers, near New York, where he worked on various chemical problems, including those connected with resinous products, and made a study of the reaction between phenol and formaldehyde. In 1907 his United States patent on the process for producing phenolformaldehyde resins under control was filed, and this patent became world-famous. In 1909 he read a paper on "The Synthesis, Constitution and Uses of Bakelite" before the New York Section of the American Chemical Society, in which he described in considerable detail the researches which led up to this patent.

In 1910 the Bakelite Gesellschaft was founded in Germany; six months later the General Bakelite Company of America was founded, both companies being for the large-scale production of phenolic resinous materials, known as 'Bakelite' materials. The latter company with the Redmanol Chemical Products Co. and the Condensite Co. of America was afterwards merged into the Bakelite Corporation, of which Dr. Baekeland was the president in 1922.

It was due to Dr. Baekeland's fine personality, initiative and far-sightedness that Bakelite Ltd. in England was formed by an amalgamation of interests which were active in the synthetic resin field.

Many honours were bestowed upon him. He was a commander of the Belgian Order of Leopold, an officer of the Order of the Belgian Crown and an officer of the Order of the French Legion of Honour. For many years he was president of the American Chemical Society. The W. H. Nichols Medal was presented to him in 1909; in 1910 he received the John Scott Medal of the Franklin Institute, and in 1913 he received the Willard Gibbs Medal. When he belonged to the Instruction Board of the Columbia University, he was presented by that University with the Chandler Medal. He was an active member of the Society of Chemical Industry, which in 1916 presented him with the William Perkin Medal of the New York Section of the Society of Chemical Industry. In 1915 he was made a doctor of chemistry *honoris causa* of the University of Pittsburgh. He was also president of the American Institute of Chemical Engineers and of the American Electrochemical Society. In 1938 he was presented with the Messel Medal of the Society of Chemical Industry.

Dr. Baekeland was a member of the U.S. Naval Consulting Board since 1915, a member of the U.S. Nitrate Supply Commission in 1917, and chairman of the Committee on Patents of the National Research Council. He was also a trustee of the Institute of International Education since 1919, and a member of the Advisory Board of the Chemical Division of the U.S. Department of Commerce since 1925.

WE regret to announce the following deaths:

Sir Colin Fraser, director of materials supply of the Australian Department of Munitions and chairman of the Commonwealth Minerals Committee, and a past president of the Australian Institute of Mining and Metallurgy, on March 10, aged sixty-eight.

Prof. A. E. Jolliffe, emeritus professor of mathematics in the University of London, King's College, on March 17, aged seventy-three.

Dr. A. W. Pollard, formerly keeper of printed books in the British Museum and honorary secretary of the Bibliographical Society, on March 8, aged eighty-four.

Sir David Prain, C.M.G., C.I.E., F.R.S., lately director of the Royal Botanic Gardens, Kew, on March 16, aged eighty-six.

NEW FELLOWS OF THE ROYAL SOCIETY

THE following were elected fellows of the Royal Society on March 16:

BRIGADIER R.A. BAGNOLD, explorer; distinguished for scientific work on desert topography, and in particular for his precise studies of the physical principles governing the movements and deposition of sand under the action of wind.

MR. R. P. BELL, fellow of Balliol College, Oxford; distinguished for his theoretical and practical contributions to physical chemistry, particularly the studies of reaction rates in solutions, and the applications of wave-mechanics.

DR. C. R. BURCH, research physicist, University of Bristol; distinguished for original research in many branches of applied physics, particularly on the methods for attaining high vacua.

PROF. SUBRAMANYA CHANDRASEKHAR, associate professor in the University of Chicago, formerly fellow of Trinity College, Cambridge; distinguished for his contributions to theoretical astronomy and astrophysics, particularly relating to stellar structure and the dynamics of stellar systems.

MR. G. E. R. DEACON, member of the scientific staff of the "Discovery" Committee of the Colonial Office; distinguished for outstanding work, particularly in the Southern oceans, on physical oceanography and marine zoology, and the relations between them.

SIR JACK DRUMMOND, professor of biochemistry, University College, London, and chief scientific adviser to the Ministry of Food, distinguished for his work on practical nutrition.

DR. A. T. GLENNY, immunologist, Wellcome Physiological Research Laboratories, Beckenham, distinguished for his work on immunity and its application to the immunization of man and animals, especially against diphtheria and tetanus.

DR. R. G. HATTON, director of the Fruit Research Station, East Malling; the pioneer of scientific pomology in Great Britain; the research work which he has organized and directed in this field has a world-wide reputation.

PROF. R. D. HAWORTH, professor of chemistry, University of Sheffield; his contributions to the

structure of natural products are of outstanding importance, and by his synthetical investigations he has added greatly to our knowledge of the lignans.

DR. W. O. KERMACK, research chemist at the Royal College of Physicians, Edinburgh; distinguished especially for his contributions to the knowledge of alkaloids and of synthetic therapeutic compounds; and also for his original contributions to mathematics and statistics in subjects of medical interest.

DR. FRANKLIN KIDD, superintendent of the Low Temperature Research Station, Cambridge; he has made important contributions to the study of respiration of fruits and is well known for his work on the gas storage and low-temperature conservation of apples.

PROF. B. A. MCSWINEY, professor of physiology, St. Thomas's Hospital, University of London; distinguished for his researches on the afferent nerves from the viscera and on the control of visceral movements.

PROF. G. F. MARRIAN, professor of medical chemistry, University of Edinburgh; distinguished for his work in biochemistry, especially on the female sex hormones and related substances.

PROF. M. POLANYI, professor of physical chemistry, University of Manchester; distinguished for his fundamental work on elementary reactions, for his theory of chemical activation energies and for many other important contributions to physics and chemistry.

MR. A. SAND, comparative physiologist, Marine Biological Station, Plymouth; distinguished for his studies of the respiratory mechanisms of invertebrates, the pigmentary effector system of reptiles and the sense organs and locomotor mechanisms in fishes.

SIR WILLIAM STANIER, chief mechanical engineer, L.M.S. Railway, scientific adviser to the Minister of Production; distinguished as a locomotive engineer and particularly for his services in the application of science to mechanical engineering.

DR. C. J. STUBBLEFIELD, senior geologist, Geological Survey of Great Britain; distinguished for his knowledge of the invertebrates of the earlier geological formations; especially for his researches on the life-history, classification and migration of trilobites, and the inter-relationships of graptolites.

DR. O. W. TIEGS, zoologist, University of Melbourne; distinguished for his histological and physiological work; in particular for his studies on the embryology and metamorphosis of insects.

DR. H. J. VAN DER BIJL, director of war supply, Union of South Africa; research physicist; distinguished for his electrical researches, particularly on the conduction of electricity through gases, and for his services with regard to the application of science to industry in South Africa.

MR. J. H. C. WHITEHEAD, University lecturer and fellow of Balliol College, Oxford; distinguished for his varied contributions to pure mathematics, particularly in combinatorial topology, the theory of groups and of group-rings.

NEWS and VIEWS

University of Edinburgh : Chair of Public Health

THE University Court of the University of Edinburgh, in appointing Prof. F. A. E. Crew to the Bruce and John Usher chair of public health, has made an interesting and significant break with tradition. Prof. Crew's association with the University, as teacher and research worker, began in the Department of Zoology and continued in the Institute of Animal Genetics, of which he became the first director in 1921, and the first occupant of the Buchanan chair of animal genetics in 1928. In the Institute he gathered about him a notable band of scientific workers from many nations, and these he inspired with his own enthusiasm, so that a steady stream of the results of research in various directions issued from the laboratories. Prof. Crew's transference from animal genetics to public health indicates a change of outlook in health teaching in relation to the populace. In place of emphasizing, as established courses of instruction have done, aspects of control of infection and the improvement of health by better methods of sanitation and environmental conditions in general, the new outlook, from a biological background, envisages a drive for positive health education backed by tuition in social biology and social medicine.

It is obvious that such development of a biological background in public health education cannot entirely take the place of the detailed knowledge of methods of promoting public sanitation and hygiene, which formed a main part of the established and well-tried course, and of which Prof. P. S. Lelean, who is about to retire from the chair of public health in the University, was so capable and thorough-going an exponent. Advantage has therefore been taken of the excellence of the public health services to enlist their aid, and by arrangement between the University and the Corporation of Edinburgh, the Medical Officer of Health, Dr. W. G. Clark, and the staff of the Public Health Department, will collaborate in that part of the course which deals with the application of science to the control of infectious diseases, to public sanitation and to environmental hygiene. Thus it is hoped to develop a comprehensive curriculum in health and social medicine, to which other specialized departments of university study may make their own individual contributions.

Research Workers in Industry

IN the second of the series of addresses on science and industry to the Manchester Chamber of Commerce, delivered on March 16, Dr. A. P. M. Fleming spoke on "Research Workers: Their Education and Place in Industry". Dr. Fleming pointed out that there are only two broad types of research workers: those engaged in pursuit of knowledge for its own sake; and those engaged in applying new discoveries to useful purposes. The latter bridge the gap between the investigations of the fundamental research worker and industry, and Dr. Fleming stressed the importance of such workers having some industrial experience appropriate to their scientific studies although the training required may differ in different industries. In chemical industry, for example, a post-graduate course in an advanced field of chemistry might be followed for a few years before entering an industrial laboratory. An engineer might be advised to leave the university on graduation and spend a

year or two as an apprentice in an engineering firm with a research organization: when he had thus acquired a knowledge of works organization and the character of its problems, he would proceed to the research laboratory, while if he showed unusual ability for research and special capacity in a particular field, he should return to a university, at home or abroad, where there are special facilities for advanced study in that field. Such plans are only practicable in large organizations with established research facilities, but as an alternative method of training use might be made of the facilities of the research associations, on the lines of the plan developed by the Cotton Research Association, for suitable technically trained men from the industry to spend time in the Association's laboratories and then return to posts in the textile industry. Dr. Fleming remarked in this connexion that the industrial research worker should realize he is something of a missionary and use patience and skill in the application of his work, for it is still difficult in some industries to arouse an appreciation of what science can do to assist the manufacturer.

THE fact that Great Britain is still a country of small manufacturing concerns is a particular difficulty, resulting too often in failure to utilize results already being obtained in research, which the research associations might assist to overcome; though it is important that each small company should have on its staff at least one technically trained officer able to translate and make effective all the appropriate new knowledge provided, for example, by the research association of the industry concerned. While the number of research workers in Great Britain is too small, we can hold our own at all times as regards the quality of research, and Dr. Fleming believes the position is more satisfactory than some of the recent comparisons with research activity in the United States and the U.S.S.R. suggest. Numbers may be more important in the future as industrial problems are undertaken by mass attack, and we must encourage a scientific attitude of mind throughout industry and ensure that our technicians and artisans adopt that attitude of mind and mobility and skill which will enable them to turn new developments to account quickly. Scientific advisers to boards of directors of industrial companies might play an important part, since one of the greatest difficulties in many industries is to get into operation quickly an entirely new type of product for which the existing manufacturing facilities are not fully suited.

Royal Institute of Chemistry

AT the sixty-sixth annual general meeting of the Royal Institute of Chemistry held on March 15, Prof. Alexander Findlay made the formal announcement that the style Royal had been added to the title of Institute. The honour was one which, he said, the Institute accepted for the whole profession. Chemists are proud of what they are able to do in the war effort and no less proud of their achievements in advancing the science of chemistry by research, in promoting industrial prosperity, and in promoting and protecting the health of the people by safeguarding the purity of their food and water supplies and by the production of essential vitamins and drugs. The roll of the Institute has increased during the past year by 462 fellows and associates and by 112 registered students. Representatives of the Institute have served on many bodies dealing with questions of public interest, as well as on those directly affecting the profession of chemistry; with the Joint Council of Professional Scientists consideration has been given to problems which will arise in connexion with the further training and the placing in employment after the War of chemists whose normal careers have been interfered with by national service. Other representatives have taken an active part in the work of the Parliamentary and Scientific Committee, which has published a valuable Memorandum on Research and the Universities.

In the post-war world the calls made on the special knowledge and ability of chemists will be greater even than in the past and, if our industrial prosperity and material welfare are to be ensured, a determined and persistent effort will need to be made by Government Departments, by industry, and by the universities and technical colleges to pull level with our chief industrial rivals. The attitude not only of industrial firms but also of the community as a whole towards science must be changed and the scientific habit and a spirit of trust in science must be cultivated. Prof. Findlay also referred to the Chemistry Education Advisory Board and its report on the education and training of those who enter the profession of chemistry through the secondary schools and the universities (see p. 353 of this issue). The Sir Edward Frankland Medal and Prize for registered students of the Institute has been awarded to Dudley Rhoden Scarffe, of the Imperial College of Science and Technology, for his essay on "Introduction of the Chemist to the Public". Prof. Alexander Findlay was re-elected president of the Institute for the ensuing year.

English Education As It Is

THE Education Bill, the main provisions of which have received considerable attention in NATURE, in anticipation of the parliamentary debates, continues to occupy much public attention. The discussion in the House of Commons drags its slow length along, and on the day when the Bill becomes an Act, everything it provides for will remain to be done. Until that day, and in many respects long after that day, English education is unchanged. It is therefore important that all interested persons should know clearly what most people know more or less vaguely —how precisely it stands with English education in its various stages and phases. For that reason we regard it as a happy inspiration on the part of the Royal Society of Arts to secure the services of Mr. P. R. Morris, director of education for Kent, and now in special charge of army education, to lecture on this subject, under the chairmanship of Mr. R. A. Butler. Very few people have the requisite knowledge and experience and vision to describe exactly the present position in regard to elementary and secondary schools, public and private preparatory schools, and the extraordinary variety of 'the adult stage', and Mr. Morris is one of those people. Perhaps his most valuable contribution lies in what he has to say about the adult stage, including first the universities; secondly, "the field known by the rather dreary name of Further Education"; thirdly, the field now known as adult education, with its great achievements in quality and its "appalling inadequacy in quantity"; and lastly, the institutions for the training of teachers, a major issue in the coming educational revolution. Mr. Morris's paper has been published in full in the December number of the *Journal of the Royal Society of Arts*.

British Council Representative for China

THE British Council has appointed Prof. P. M. Roxby, professor of geography at the University of Liverpool and a specialist on Far Eastern matters, to be its principal representative in China. He will take up his duties in the early part of 1945. Prof. Roxby has visited China on three occasions: during 1912–13 as Albert Kahn Travelling Fellow; during 1921–22 as a member of the China Education Commission; and in 1931 as a member of the British group of the Institute of Pacific Relations. His works on China include "The Far Eastern Question in its Geographical Setting", "China as an Entity: The Comparison with Europe", "The Terrain of Early Chinese Civilisation", "China" (Oxford Pamphlets on World Affairs), and contributions on China in the Encyclopædia Britannica. Prof. Roxby's wife, who is lecturer in history at the University of Liverpool, will accompany him to China. With Prof. Roxby's appointment the British Council hopes to be able to expand its work in China, in co-operation with the Chinese authorities. Many valuable activities are already in progress there, particularly in the scientific field, under the direction of Dr. Joseph Needham, who went out to China for the British Council in October 1942.

Summer Schools in Health Education

THE Central Council for Health Education intends holding two Summer Schools during 1944. One will take place at Whitelands College, Bede College, Durham, during July 24–August 3, and the other at Chelsea Polytechnic, London, during August 9–19. The programme of the schools will cover all aspects of health education (including sex education) and should be of value to teachers, youth leaders, educational and medical administrators, nurses and health visitors, social and industrial welfare workers, etc. The mornings will be devoted to lectures which will lay the necessary foundation of basic knowledge, while the evening lectures will relate this knowledge to a wider philosophical, historical and social context. In the afternoons there will be demonstrations and discussions arranged by the various organizations specializing in different fields of health education, and seminars for students with particular interests. Many applicants had to be rejected from the 1943 School owing to lack of accommodation. Those wishing to receive early notification of the forthcoming schools should send their name and address on a postcard to the Central Council for Health Education, Tavistock House, Tavistock Square, London, W.C.1.

Summer School in Social Biology

THE British Social Hygiene Council will be holding a Summer School in Social Biology at the University College of North Wales, Bangor, during August 19–September 2. The theme of the School will be "Social Biology and the Extra School Year". It is planned to throw light upon the aims and content of biology in the school curriculum, with special reference to the coming increase in the school-leaving age. While primarily intended for those responsible for pupils aged 11–15, the School is designed to appeal to all types of teachers, and to people who are interested in education and social questions generally. The morning instructional lectures will be given by a team of experienced lecturers who have assisted at similar summer schools in the past. The evening meetings will be reserved for the addresses of distinguished scientific and social workers upon the broader applications of biology to human life and culture. In keeping with the lecture programme, demonstrations in practical biology will be arranged to suit the needs of teachers working under school conditions. For those who require it, training in the dissection of common animal types will be given. Times will be set aside for seminars and discussions. Further information can be obtained from the British Social Hygiene Council, Tavistock House South, Tavistock Square, London, W.C.1.

The Night Sky in April

FULL moon occurs on April 8d. 17h. 22m. U.T., and new moon on April 22d. 20h. 43m. The following conjunctions with the moon take place: April 3d. 14h., Jupiter 0·1° S.; April 21d. 11h., Venus 3° N.; April 26d. 12h., Saturn 2° N.; April 28d. 09h., Mars 3° N.; April 30d. 21h., Jupiter 0·4° S. The following occultations of stars brighter than magnitude 6 take place: April 5d. 22h. 26·8m., 308 *B* Leon. (*D*); April 6d. 22h. 51·7m., *b* Virg. (*D*). The times refer to Greenwich and *D* refers to disappearance. Mercury attains its greatest eastern elongation on April 12. The planet sets at 19h. 51m., 20h. 51m. and 19h. 42m. at the beginning, middle and end of the month and can be seen as an evening star, but is not very well placed for observation. Venus rises at 5h. 13m. and 4h. 20m. at the beginning and end of the month and can be seen as a morning star. Mars sets at 1h. 58m. and 1h. at the beginning and end of the month and can be seen in the early part of the night. Jupiter sets at 4h. 10m. and 2h. 15m. at the beginning and end of the month, and is stationary on April 13. Saturn sets at 0h. 46m. and 23h. 04m. at the beginning and end of the month. The Lyrid meteor shower is active from April 18–22. These meteors are due to the debris of Comet Thatcher (1861 i).

Announcements

THE Royal Society, from the income of a fund bequeathed to it by the late Edward Thomas Browne for the support of marine expeditions and of pure marine research work, has placed the sum of £1,000 at the disposal of the Allied Control Commission, to be used in the present emergency for the maintenance of the staff and equipment of the Zoological Station at Naples.

THE Society of the Sigma Xi, the well-known American scientific society, founded at Cornell University in 1886 for the "encouragement of Original Investigation in Science, Pure and Applied", with local members organized as chapters or clubs in some hundred and twenty-five American universities and colleges, is extending its activities to non-academic research institutions which qualify because of their participation in, and encouragement of, original research in science. The first industrial research group to qualify and be granted affiliation with Sigma Xi is the Esso Research Club, of Elizabeth, N.J., the membership of which is drawn from the chemists, physicists, engineers and other technical research and development personnel of the companies associated with Standard Oil Company (N.J.).

ERRATUM.—In NATURE of March 11, p. 319, paragraph on "Meiosis in the Striped Hamster", the number of chromosomes should be $2n = 14$, not $2n = 24$ as printed.

LETTERS TO THE EDITORS

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

Radioactivity in Osmium

CURRENT theory of the stability of atomic nuclei indicates that two neighbouring isobars, that is, two nuclei with the same mass number and with nuclear charges differing by one unit, should not both be stable, but that the nucleus of higher energy should undergo radioactive change and transform into the other.

There exist, however, five pairs of neighbouring isobars in which both members of the pair are apparently stable. There are two ways in which this may be explained. Either we may assume that the difference of energy between the two nuclei of the pair is too small to allow a radioactive change, that is, to permit the formation of a neutrino, or we must suppose that the radiation which is emitted by one of them has hitherto escaped detection.

The first explanation leads, as Bethe and Bacher[1] have shown, to the result that the mass of the neutrino must be about one fifth of the electronic mass. From other evidence, this seems improbable and consequently the explanation is suspect.

There are three possible types of change : (1) the emission of a negative electron by the nucleus of lower charge ; (2) the emission of a positron, or (3) transformation by electron capture of the isobar of higher charge. Bethe and Bacher have pointed out that the first two processes should not be difficult to detect, for the rates of transformation, calculated on the basis of known energy differences between the isobars, should bring them well within the limit of ready observation. It seems, then, that since electron capture would be difficult to detect, process (3) is the most probable explanation of the facts.

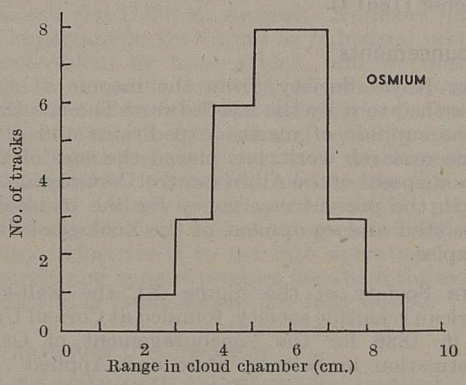

FIG. 1.

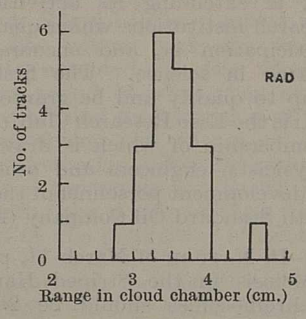

FIG. 2.

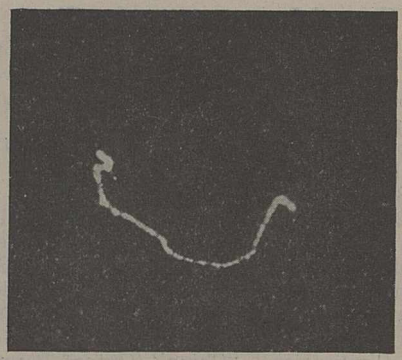

FIG. 3. AN ELECTRON TRACK, 5·1 CM. LONG, RECORDED IN THE CLOUD CHAMBER CONTAINING OSMIUM METAL.

A systematic examination of the pairs of neighbouring isobars was begun in this laboratory some time ago ; but only in one case, that of osmium, has any definite evidence of transformation been obtained. The osmium isotope of mass 187 (abundance 1·64 per cent) is isobaric with a rhenium isotope (abundance 61·8 per cent), so that on the hypothesis outlined above we might expect a sample of osmium to emit K-radiation of rhenium as a result of the capture of a K-electron. The rhenium K-radiation has an energy of 59 keV. and would give a photo-electron of range about 5 cm. in air. This is convenient for measurement in an expansion chamber ; on the other hand, the absorption coefficient of the X-rays is so small (half-value thickness 30 metres in air) that the chance of conversion in the chamber is very small.

A layer of finely divided osmium metal was spread on a tray 20 cm. × 6·5 cm., which was placed in the large expansion chamber described by E. J. Williams[2]. Nearly three hundred photographs were taken, and on these, thirty electron tracks of short range, which started in the gas, were observed. The distribution in range of these tracks is shown in Fig. 1, and it suggests a definite group of electrons of mean range in air, corrected to 15° C. and 760 mm. pressure, of 5·0 ± 0·5 cm. The energy of the electrons was estimated by photographing the photo-electron tracks due to the 47·2 keV. γ-radiation of radium D under similar conditions of operation of the expansion chamber. The distribution of these tracks is shown in Fig. 2, giving them a mean range of 3·0 ± 0·25 cm. in standard air. Assuming that in this region the energy is proportional to the square root of the range[3], this experiment gives an energy for the osmium radiation of 61 ± 6 keV., in good agreement with the energy of the rhenium K-radiation.

With such an extended source it was difficult to assess accurately the half-value period of the activity, but it is possible to make a rough estimate from the geometry and sensitive time of the chamber. The value is 3×10^8 years, but this may be inaccurate by so much as a factor of ten. Attempts, by Dr. J. Rotblat and Mr. D. G. E. Martin, to detect the activity in a Geiger counter were inconclusive and set a lower limit to the half-value period six times greater than the above value. It is interesting to note that Scherrer and Zingg[4] also examined osmium with a Geiger counter and found a small effect which they attributed to impurity.

We wish to thank the Mond Nickel Company, which lent the pure osmium powder.

E. T. LOUGHER.
S. ROWLANDS.

George Holt Physics Laboratory,
University of Liverpool.
Feb. 16.

[1] Bethe, H. A., and Bacher, R. F., *Rev. Mod. Phys.*, **8**, 198 (1936).
[2] Williams, E. J., *Proc. Roy. Soc.*, A, **172**, 194 (1939).
[3] Klemperer, O., "Einführung in die Electronik", p. 272.
[4] Scherrer and Zingg, *Helv. Phys. Acta*, **12**, 283 (1939).

Banded Meson Spectrum and the Rossi Second Maximum

A VERTICAL counter telescope, designed on the basis of Bhabha's method[1], was set up as shown in Fig. 1. 5·25 cm. of lead used in positions II and III together absorb all but the very high-energy electrons. Such high-energy electrons produce showers in the lead in position II and are cut out from being counted by the shower particles tripping the anti-counters 4 or 5 or both. The effect of side showers on this counter telescope is found experimentally to be negligible[2]. The fact that this arrangement measures the hard component only has also been experimentally verified[2].

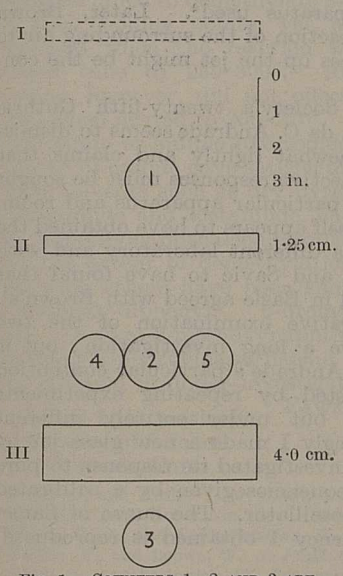

Fig. 1. COUNTERS 1, 2 AND 3 ARE IN COINCIDENCE. COUNTERS 4 AND 5 ARE CONNECTED IN PARALLEL AND IN ANTI-COINCIDENCE WITH COUNTERS 1, 2 AND 3.

The absorption of mesons was measured by placing lead in position I. This is not objectionable, as it is known that penetrating non-ionizing cosmic rays form a negligible portion of the total intensity[3]. The results obtained after taking every possible care to test the counters, circuits, etc., at the end of each measurement are shown in the accompanying table and graphically in Fig. 2.

There is an abrupt drop in the total intensity between the points *A* and *B* on the graph, that is, when the total amount of lead increases from 21·05 to 23·7 cm. This drop is outside the limits of statistical error of the measurements. The slope of the curve before and after the abrupt drop is the same. The drop in intensity, therefore, appears to be real and not spurious. It occurs when the thickness of lead above the counters 4, 2 and 5 lies between 17·05 cm. and 19·7 cm. This is the region in which the well-known Rossi second maximum has been observed by those who get it[4]. Such a drop in the meson absorption curve has not so far been reported by anybody to my knowledge; but its appearance in this experiment is due to the use of the counter arrangement based on Bhabha's method, which is such as to bring out any existing discontinuities. The interpretation of this experiment, together with the results of further experiments now in progress, will be given in a paper with Prof. Bhabha.

Lead in position II = 1·25 cm. Lead in position III = 4·0 cm.

Lead in position I	Counts	Time in hours	Counts/hour
—	7680	81	94·8 ± 0·72
5·2 cm.	4826	52	92·8 ± 0·89
9·3 ,,	6905	76	90·8 ± 0·73
13·7 ,,	5430	61	89·0 ± 0·81
15·8 ,,	3175	36	88·2 ± 1·05
18·45 ,,	4030	48	84·0 ± 0·89
21·45 ,,	2581	31	83·3 ± 1·10
24·45 ,,	3948	48	81·5 ± 0·88

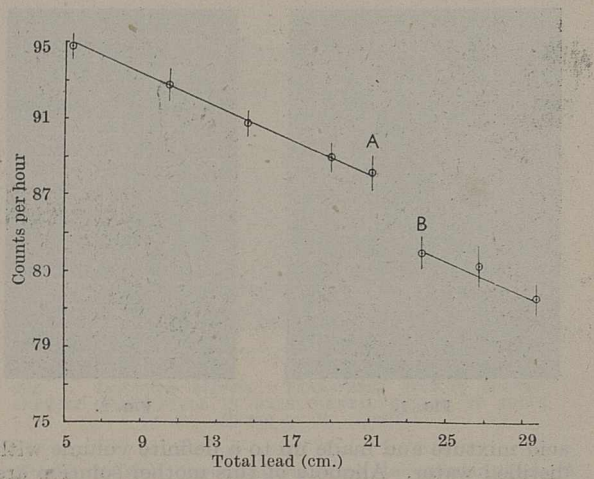

Fig. 2.

I desire to thank Prof. H. J. Bhabha for his interest and encouragement.

S. V. CHANDRASHEKHAR AIYA.
Cosmic Ray Research Unit,
Indian Institute of Science,
Bangalore.
Jan. 31.

[1] Bhabha, *Proc. Ind. Acad. Sci.*, A, **19**, 23 (1944).
[2] In the course of publication.
[3] Jánossy and Rochester, *Proc. Roy. Soc.*, A, **181**, 399 (1943). Rossi and Regener, *Phys. Rev.*, **58**, 837 (1940).
[4] See *Proc. Roy. Soc.*, A, **180**, 220 (table I) (1942).

Base Electrolytes for Use in Polarographic Determinations

IN the course of recent research on the application of the polarographic method to the routine analysis of magnetic materials of the 'Permalloy' type, we have found several new base electrolytes which offer considerable advantages for quantitative polarography. They are characterized by the very satisfactory shape of the 'waves', in general free from disturbing maxima, which they yield with a number of metal ions.

Our main problem at the commencement of this work was the determination of iron (12–18 per cent) and molybdenum (2–5 per cent) in the presence of more than 70 per cent nickel and some copper, manganese, etc. We have succeeded in devising and applying our methods to give extremely rapid and accurate routine determinations of these elements in particular, so that to date some six thousand individual determinations have already been made, with a considerable saving of time.

The sample is dissolved in a sulphuric acid–nitric

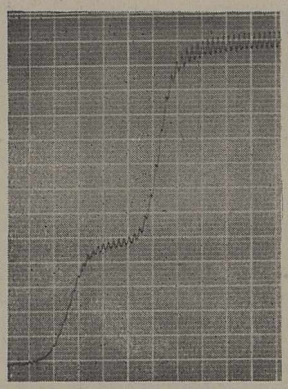

FIG. 1.

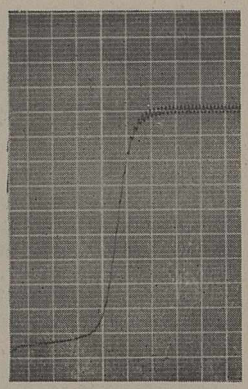

FIG. 2.

acid mixture and made up to a definite volume with distilled water. Aliquots of this mother solution are used in the separate estimations of iron and molybdenum. In the determination of the last-named element, it has been found necessary to remove all traces of nitric acid by heating the aliquot to fumes of sulphur trioxide. After diluting with water and transferring quantitatively to a volumetric flask, the base electrolyte is added and the solution made to volume with water. This base electrolyte is a mixture of citric acid and sulphuric acid chosen so as to give a final concentration in the solution of approximately 0·5 molar and 0·75 *N*. respectively. Under these conditions, molybdenum yields two waves with half-wave potentials — 0·35 volt and — 0·85 volt versus the sulphate electrode (Fig. 1). Since iron and copper are also electro-reduced and interfere with the first wave, we have made use of the second wave. We have observed a deterioration of the wave when the drop time of the capillary in this solution is less than 2·5 sec. at zero applied potential. The *m* value of the hand-drawn capillaries which we use is of the order of 1·6 mgm.sec.$^{-1}$.

In the presence of the other alloying elements in 'Permalloy', we could not determine accurately the iron content by any polarographic method with which we were familiar, but by adding triethanolamine to an aliquot of the mother solution, very useful current/voltage curves were obtained. Some slight advantage was obtained by the addition of ammonia and ammonium chloride, so that the final concentration of the base electrolyte which we employ is triethanolamine 0·3 *M*; NH_4OH 1·0 *M*; NH_4Cl 0·85 *M*. The iron is reduced in two stages in this medium $Fe^{+3} \rightarrow Fe^{+2}$, $E\frac{1}{2}$ — 0·5 volt vs. the S.C.E. (Fig. 2), which is the wave employed in this method, and $Fe^{+2} \rightarrow Fe$, $E\frac{1}{2}$ 1·6 volts vs. the S.C.E. Copper interferes to some extent with the iron wave in this medium, and a rough preliminary separation is necessary in those alloys which contain copper.

These results have led us to study further the ethanolamines as complex-forming agents which can be used, either alone or in conjunction with inorganic salts, as base electrolytes. Some preliminary work has also been started on related organic amines. It appears that these reagents constitute a new and valuable class of base electrolytes.

The properties of the amines can be considerably modified by adding sodium (or ammonium) hydroxide, chloride, sulphate, etc., to achieve separation, suppression or shift of the waves corresponding to various metal ions. It appears as if these electrolytes will be of great use for determining, *inter alia*, iron, copper, nickel, lead, cadmium, barium, cobalt and zinc. Some work has also been started which seems to indicate that aqueous ammonium acetate has a distinct advantage in certain quantitative determinations, notably cobalt, lead, manganese, cadmium, nickel, copper and zinc.

We hope to be able to publish a full account of this work at a later date.

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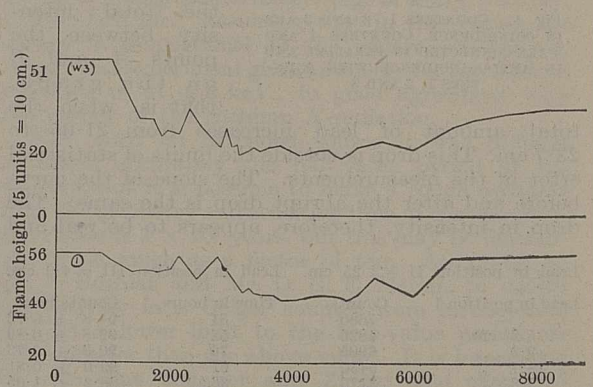
Simple Sensitive Flames

MANY years ago a communication of mine on this subject appeared in NATURE[1]. My interest at the time was only in producing a simple detector of sound waves, but as one of the jets I then prepared was afterwards used by Dr. G. Burniston Brown in his investigation of the properties of sensitive flames in general, and is described by him as the most sensitive he used, I was naturally interested in his conclusion, surprising and difficult to explain, that the sensitive frequencies found expressed a property of the particular gas and not one due to causes inherent in the apparatus used[2]. Later, Brown suggested that the reaction of the surrounding air to the passage of vortices up the jet might be the controlling factor[3].

In the Physical Society's twenty-fifth Guthrie Lecture[4], Prof. E. N. da C. Andrade seems to dismiss Brown's results somewhat lightly and claims that the origin of such selective responses must be sought in resonances of the particular apparatus and room, although Brown himself appears to have obtained the same frequencies in a different laboratory and with different apparatus[2], and Savić to have found that frequencies measured in Basle agreed with Brown's[5].

A critical comparative examination of the two claims would involve a long investigation; but it occurred to me that Andrade's particular contention could be simply tested by repeating experiments similar to Brown's but under entirely different conditions. Accordingly I made a new glass jet by the old process and investigated its response to pure tones of different frequencies given by a calibrated Muirhead beat-tone oscillator. The curve of flame-height against frequency I obtained is reproduced



Upper curve: London, 1931. W3 brass jet (Brown). Lower curve: Manchester, 1942. No. 1 glass jet (Sutherland).

and for comparison I have plotted Brown's curve for the brass jet *W3* operated under a different gas pressure in a room quite different in size and character.

By kind permission of Dr. Ewing my experiments were carried out in a very heavily lagged room in the Department of Education for the Deaf in the University of Manchester, and Dr. T. S. Littler kindly assisted in taking the readings. Though this set of observations and Savić's cannot be held to prove Brown's theory, they do suggest that his results were not fortuitous.

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[1] NATURE, **108**, 533 (1921).
[2] *Phil. Mag.*, **13**, 161 (1932).
[3] *Proc. Phys. Soc.*, **49**, 519 (1937).
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[5] NATURE, **147**, 241 (1941).

Dealkylation of Phenolic Ethers

SEVERAL methods have been reported in the literature for the dealkylation of ethers; for example, with hydrobromic acid[1], hydriodic acid[2], aluminium chloride[3], aluminium bromide[4], alkyl magnesium iodide[5], aldsol[6], piperidine or moist pyridine[7], aniline hydriodide in aniline[8], and magnesium iodide. Some of these methods appear to be of specific nature only.

I have found that although piperidine and moist pyridine failed to demethylate β-methoxynaphthalene at their boiling points, yet partial demethylation occurred when the reaction was carried out in a sealed tube to 250–300°. Aniline hydriodide in aniline, however, did not effect this demethylation even when heated to 250–270°. The use of quinoline hydriodide or aniline hydriodide in boiling quinoline instead of aniline gave satisfactory results. Although other solvents such as dry pyridine, diphenyl-amine, phthalimide and acetanilide, but not dimethylaniline or α-methylnaphthalene, could replace quinoline, yet the extent of demethylation is much less. The following ethers have been similarly demethylated: 4-methoxy-diphenyl, 6-bromo-2-methoxynaphthalene, 4-nitro-2-methoxynaphthalene, 2- and 4-methoxy-1-benzoylnaphthalene. The mechanism of the reaction is under investigation.

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Experimental Observations on the Relation between Leaf Development and Stelar Morphology in Species of Dryopteris

THE classical accounts of vascular structure in leptosporangiate ferns show clearly that the interruption of the conducting cylinder of the shoot is associated with the 'insertion' of the leaf-traces, that is, the vascular strands of the petiole or leaf-base. Thus, in a solenostelic fern, a cross-section at the level where a leaf-base joins the shoot will show the presence of a leaf-gap; in other words, the vascular

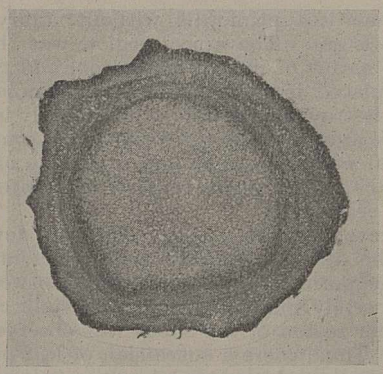

Fig. 1. *Dryopteris aristata*: TRANSVERSE SECTION SHOWING INDUCED SOLENOSTELE IN EXPERIMENTAL REGION OF SHOOT. (× 4.) (PHOTO BY E. ASHBY.)

cylinder which would otherwise be continuous is interrupted by non-vascular tissue, usually parenchyma. In shoots where the leaf-gaps overlap, the vascular system becomes an open meshwork, or dictyostele, each individual strand being described as a meristele. Various tentative physiological explanations have been advanced to account for the development of these leaf-gaps. A considerable volume of literature also deals with the question as to what extent the vascular tissue of the shoot is of truly cauline origin, or alternatively, is a composite structure largely composed of decurrent leaf-traces. So far as I am aware, these problems have not been approached by direct experimental methods. The simple and easily repeatable technique, described below, has resulted in experimental observations of very considerable interest.

The distal ends of erect shoots of *Dryopteris aristata* and *D. filix-mas* were completely defoliated and the scales removed so that the terminal region was left 'naked'. The apical meristematic cone was left intact, but the minute leaf primordia round its base were destroyed by needle-puncturing. For this purpose a Zeiss micromanipulator was used, the material being observed under a binocular microscope. Alternatively, by using a needle on its side and gently moving it over the surface of the shoot away from the base of the apical cone, it was possible to 'smooth

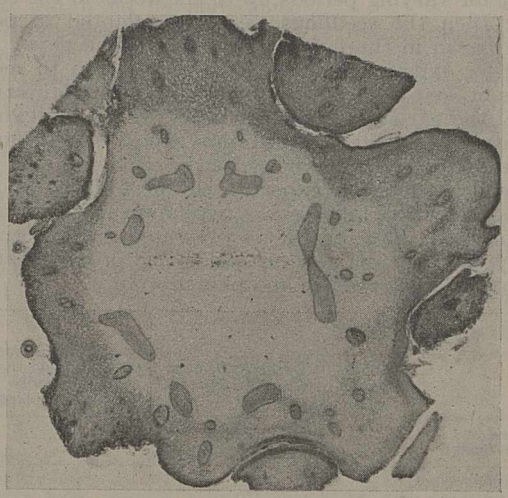

Fig. 2. TYPICAL DICTYOSTELE AND LEAF BASES IN THE UNTREATED REGION BELOW. (× 4.) (PHOTO BY E. ASHBY.)

out' all new leaf primordia without injury to the apical meristem. The apical region was then protected by means of moist cotton-wool and the piece of shoot placed in peat. New leaf primordia were similarly destroyed at weekly or fortnightly intervals. New roots were abundantly formed and some pieces of material were kept alive and in a state of growth for several months, until, in fact, the material was fixed for sectioning.

Transverse serial sections from the apex downwards showed the apical meristem to be still intact and apparently normal, and every stage between complete solenostely and the normal dictyostelic condition of the older region of the shoot was observed (Figs. 1 and 2). Thus where a succession of leaf primordia had been destroyed immediately after their inception, a complete, uninterrupted vascular ring was to be observed; but where a primordium was rather older before it was destroyed, leaf-gaps of small size were present.

A full account of these observations will be given elsewhere.

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Vernalization of Rice by Short Days

VERNALIZATION by light or the treatment of seedlings to exposures of different light periods in order to accelerate flowering has been effected in temperate cereals. Cailahjan[1] vernalized several varieties of winter wheat and winter rye by continuous light when low temperature had no effect on flowering. Purvis and Gregory[2] have shown vernalization of winter rye both by low temperature and by short days of ten hours. These results indicate the use of light periods for vernalizing cereals which do not respond to Lysenko's method of low-temperature treatment.

Experiments performed by me have shown that vernalization of rice by chilling (3°–6° C.) produces no significant earliness, while treatment of young seedlings by exposures to short days accelerates ear-emergence and increases growth-rate and grain-yield. Seven days old seedlings of a winter variety, 'Bhasamanik', were exposed to eight and ten hours of daylight for varying periods up to six weeks in the seed bed, then the seedlings were transplanted in pots and grown in the field under natural long days. In another experiment short days were given to seedlings in seed bed and continued after transplantation until the ear-emergence was noted in the individual plants. The control plants were exposed all through to normal daylight. Of the seed bed treatments for varying periods an exposure to short days for six weeks duration induces the maximum earliness and grain yield. The results are presented in the accompanying table and the ear-emergence in the treated plants is illustrated in the photograph.

Treatment		Earliness in days (Mean of 15 plants)	Percentage increase of grain yield over the controls (Mean of 15 plants)
	Short days in hours		
Seed bed for 6 weeks	8	10·3	16
	10	12·5	10
Prolonged until ear emergence	8	25	35·3
	10	26·5	18·3

Although greater earliness and yield is obtained by the prolonged treatments, the application of the method in field practices is possible only by the treatment of seedlings in the seed bed. This method of inducing earliness and increased yield is of agricultural importance for the variety of rice grown after transplantation.

A detailed report of the work will be published elsewhere.

I desire to thank Prof. S. P. Agharkar for the facilities to carry out this investigation.

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Excretions, Ecology and Evolution

PROF. E. J. SALISBURY's important remarks on the probable significance of excretions in biological competition[1] should not need emphasis, although the work of Pickering[2] in 1917 provides yet another reference regarding the excretions of roots. It is to be hoped that the present interest in penicillin may attract the attention of biologists to what appears in reality to be another aspect of that great field of biological study which embraces chemical morphogenesis, endocrinology and, as is now emphasized, ecological and evolutionary succession. In each of these the production of metabolites plays a part in the mediation of subsequent events.

While working under Prof. A. C. Hardy at the time when he was developing his theory of 'animal exclusion'[3], I became interested in such relationships in the sea. Having in mind the striking collection of references collected by Allee[4,5], I was later led to suggest[6] that these 'exclusive' processes might not only be comparable with others in which the excretions of one form were found to be harmful in some instances, but also with those in which the effects of excretions appear to be beneficial at least to some section of the community. The suggestion was made that such processes may, through the continued

biological conditioning of the environment, play a part in the phenomenon of succession in the sea and elsewhere. If this is correct, then it seems likely that Prof. Salisbury's suggestion regarding biological competition may fairly be seen within the wider field of general ecological succession. In particular relation to penicillin, it would be of interest to know whether its effects on the ecological successors of *Penicillium notatum* are harmful or beneficial, since it is possible that at least one of these has acquired tolerance of the excretion, or even 'made use' of it in an adaptive manner.

As a further example of the possible importance of such processes, I should like to refer again[6] to the part which biological conditioning of both types may have played in that major 'succession', evolution itself. It has been pointed out by P. G. 'Espinasse[7] that physiologically active substances are frequently metabolites in which the present-day effects have followed upon their first production. Much of the history of evolution has concerned the development by living things of responses to metabolites, sometimes their own and sometimes produced by others. Those organisms which developed 'satisfactory' responses succeeded, and those which did not, failed. Particularly in so far as evolution may first have proceeded in an aquatic environment, the gradual production of different external metabolites must at each stage have determined to some extent which of new genetic forms should 'succeed' in the field.

Since this letter was written, H. McIlwain's important article has been published[8], and attention should be directed here to his most relevant remarks on biological interactions.

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p-Aminobenzoic Acid and its Effect on the Sulphanilamide Inhibition of the Growth of Oat Roots

THERE have been many observations on the inhibitory effect of sulphanilamide on the growth of various organisms such as bacteria, yeast, fungi and higher plants. In a recent letter by Brian[1], it was shown that sulphanilamide caused an inhibition of the coleoptile growth of wheat seedlings. The general observation was also made that root-growth was stunted. Brian's results seemed to indicate that the antisulphanilamide activity of *p*-aminobenzoic acid could be absolute, indicating that *p*-aminobenzoic acid was an essential metabolite for wheat seedlings.

In view of these findings, it might be of interest to others in this field to record some observations made in these laboratories on the growth of oats, during the course of some work on *H* 11 extract. It was desirable at one stage to maintain a stock solution free from bacterial growth, and attention naturally turned to sulphanilamide and to the range of concentrations which would be non-toxic to the plants. The seeds (var. Victory, *ON* 160) were germinated and grown for 48 hours in the dark at 25° C. using the technique previously described[2].

TABLE 1. GROWTH OF ROOTS IN TEST SOLUTIONS AS A PERCENTAGE OF THE GROWTH IN WATER.

Test substance	Molar concentration 0·00005	0·0001	0·00025	0·0005	0·001
Sulphanilamide ..	101·1	97·4	85·8	74·8	45·1
p-Aminobenzoic acid ..	96·8	96·0	97·3	93·2	91·0

TABLE 2. GROWTH OF ROOTS IN TEST SOLUTIONS AS A PERCENTAGE OF THE GROWTH IN WATER.

Concentration of sulphanilamide	Concentration of *p*-aminobenzoic acid nil	0·000005 *M*	0·00005 *M*	0·0001 *M*	0·00025 *M*	0·0005 *M*	0·001 *M*
0·001 *M*	46·0	42·1	50·0	50·5	57·0	55·3	53·0

From Table 1 it is seen that the inhibition of growth by sulphanilamide alone first began to be observable at a concentration of approximately 0·0002 *M*, while in a concentration of 0·001 *M* the growth of the roots was approximately 45 per cent of that in tap water. With *p*-aminobenzoic acid alone, the roots showed no stimulatory effects, and indeed some slight degree of inhibition appeared at 0·001 *M*. Using *p*-aminobenzoic acid in relatively non-toxic concentrations, it was not possible to neutralize completely the inhibitory effect of sulphanilamide (Table 2). Some degree of anti-sulphanilamide effect could be obtained, the growth-value increasing from about 45 per cent to a maximum of 57 per cent, a difference representing that between the inhibition caused by a 0·001 *M* and a 0·0008 *M* solution of sulphanilamide. That is to say, a concentration equivalent to about 0·0002 *M* sulphanilamide had been 'neutralized' in its effect by *p*-amino-benzoic acid. With a weaker concentration of sulphanilamide (0·0005 *M* or less) there can be an absolute anti-sulphanilamide effect by the *p*-amino-benzoic acid.

There is thus a 'residual' inhibitory effect not affected by the concomitant application of *p*-amino-benzoic acid when the sulphanilamide is present as a 0·001 *M* solution. These results have been confirmed several times, and we must conclude that the 'residual' inhibition noted above represents an effect of sulphanilamide other than the usually accepted one. Sulphanilamide may indeed be able to 'lock' more than one system of reactions, as, for example, the anti-catalase effect noted by Shinn, Main and Mellon[3], and the inhibition of the oxidation of *p*-aminobenzoic acid catalysed by peroxidase[4].

From the present findings it would appear that *p*-aminobenzoic acid is not, in the fullest sense of the term, an 'essential' metabolite for the growth of oat roots (var. Victory) when these are grown for 48 hours in the dark at 25° C. It does, however, play some part in the physiology of the seedling growth and is, no doubt, present in the seed. It may well be that some other analogue of sulphanilamide could be shown to be such an 'essential' metabolite, a point of interest to workers on the growth of isolated roots of monocotyledons.

I wish to express my thanks to Mr. L. G. Wilkinson for his assistance in this work.

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Fat of Sow's Milk

Ellis and Zeller[1] studied the changes in composition of the body-fat of hogs at successive intervals of growth and reared on a ration low in fat. A steady decrease in linoleic acid content occurred from a maximum in suckling pigs up to a weight of 170 lb. They concluded from the low iodine value of sow's milk fat (51·6) that sow's milk was not the source of the relatively high proportion of linoleic acid in the small animals. Callow[2] showed that the iodine value of pig back-fat increased with age until weaning, and regarded this increase as due to assimilation of unsaturated acids from sow's milk. Milk from a slaughtered sow, milk from an unspecified source, and colostrum were shown[3] to have fats with iodine values 80·9, 53·6 and 101·8 respectively. In a subsequent discussion[4] of the relationship between age, rate of growth, and iodine value of pig fat, Callow considered that pre-weaning and post-weaning growth differed in some way not understood.

A sample of sow's milk (130 ml. containing 7·0 per cent fat) obtained by hand-milking a Berkshire sow at appropriate intervals over the period of a week has been examined in this laboratory.

COMPONENT FATTY ACIDS (MOLS PER CENT)

	Steam-volatile	Myristic	Palmitic	Stearic	Hexadecenoic	Oleic	Octadecadienoic	C_{20-22}
Sow's milk fat (Laxa[5])	1·5	2·7	28·0	—	—	67·8	—	—
Sow's milk fat (this investigation)	2·4	1·8	28·3	6·1	8·8	35·0	14·0	3·6
Pig outer back fat (this investigation)	—	1·0	28·8	11·5	5·8	46·0	5·7	1·2

The results of this investigation confirm the presence of not more than small amounts of steam-volatile fatty acids, as found by Laxa[5], whose method did not involve ester-fractionation and gave no indication of the proportion of unsaturated components other than oleic acid. The palmitic acid content is within the range of 28–30 mols per cent typical of animal depots, as found by other workers for buffalo and camel milk fat, but not for sheep, goat, or cow milk fat[6]. The hexadecenoic acid content, and the content of polyethenoid C_{20-22} acids, are both rather greater than found for cow and other animal milk fats[6].

As in the case of cow-milk fats[7], only traces of ether-soluble, petrol-insoluble bromides were obtained by bromination of unsaturated C_{18} fractions. It is unlikely, therefore, that the large amount of polyethenoid C_{18} acids present in these fractions was assimilated by the sow from dietary maize meal and barley meal, the polyethenoid C_{18} acid from which consists largely of linoleic acid. The high unsaturation of the C_{18} fractions from this sample of sow's milk fat may have originated from pasture lipids which are known to contain an octadecadienoic acid isomeric with linoleic acid[8]. Linolenic acid, however, which is a major component acid of pasture lipids, was not detected in this sample of sow's milk fat. It is interesting to note that the milk of pasture-fed cows contains only small proportions (2–4 per cent) of octadecadienoic acid, and the addition of oils containing linoleic and linolenic acids to cow's diets produces no significant increase in the amount of polyethenoid acids in milk fats[9,10].

As compared with butterfat, therefore, it seems probable that sow's milk fat contains more octadecadienoic acid, and the assimilation of this acid from the diet of the suckling pigs provides a reasonable explanation of the increase in iodine value of pig depot fat from birth until weaning.

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A Standardized Antibacterial Pyrogen-free Metabolite Preparation containing Living *Penicillium notatum*

A SUSPENSION of *Penicillium notatum* (Fleming) hyphæ in a fluid medium, obtained from below the mycelium of the mould at the stage of its highest rate of penicillin production and freed from pyrogens and other impurities, contains also antibacterial metabolites which are normally present in penicillium culture fluid. From its therapeutic results on animals, it appears that the effects of this suspension, in addition to the penicillin effect, are due to the presence or production of other potent bacteriostatic compounds—which are destroyed or left behind in the manufacture of penicillin—and to the continuation of the formation of penicillin *in vivo*.

From observations on animals it has been found that the suspension is active in the presence of serum, pus, blood and tissue autolysates, and is not inactivated by sulphonamides or sulphonamide inhibitors. It has, so far, not proved pyrogenic in animals or man, and has shown no signs of local or general toxicity, allergic sensitization or discomfort except for a slight local burning sensation after injecting, lasting only a few minutes. It appears to differ, therefore, from crude penicillin extracts containing no living cultures, which can cause toxic and sometimes painful reactions due to impurities present. Whereas a single dose of several thousand Oxford units of penicillin is rapidly eliminated in the urine, the therapeutic effect of one injection of the suspension (1 c.c. per 20 lb. bodyweight), on the other hand, appears to last for 36–48 hours. Where the response to one intramuscular injection did not completely clear an infection, a second injection in most cases did so. The characteristic fall of fever in pyrogenic infections within three to four hours of administering a dose of the suspension, and the immediate relief of pain observed in a number of infections in the experimental animals, are clear and typical indications of the promptness of the therapeutic response to the preparation.

Twenty-one cases of animal infections were treated with the suspension. Of these, fourteen were absolutely positive—three of them astonishingly rapid in response—three were doubtful and inconclusive, and four were negative. No ill-effects were observed in any of these cases. In the four negative cases

no harmful effects could be attributed to the injection, even when given intravenously. The infections which responded to treatment were gastro-intestinal (*B. coli*), staphylococcal, streptococcal and pneumococcal types, while virus infections do not seem to respond.

This preparation from *Penicillium notatum* seemed exceptionally potent in the treatment of open wounds with pyrogenic mixed infections, and also when used intramuscularly for the treatment of pyrogenic and gastro-intestinal infections. The evidence of its value in old chronic infections is inconclusive. It appears that intramuscular injections are as efficient as intravenous injections. The preparation is standardized for the hyphæ content by the turbidity against barium sulphate (nephelometer) or by an indirect all-count in comparison with a drop of blood. The antibacterial activity can be assayed *in vitro* by the Florey-cup or by the Fleming dilution method, or *in vivo* by animal protection tests.

In human beings the preparation is well tolerated without toxic reactions or sensitization becoming apparent. The therapeutic response is prompt, usually within 3–4 hours after the first injection. Controlled clinical results have already been obtained in sulphonamide-resistant pneumonia, acute staphylococcal, streptococcal and other infections, and it is hoped they will be published shortly.

We wish to express our thanks to Mr. E. von Lustig-Lendva, who was responsible for carrying out the preliminary animal tests.

H. E. ENOCH.
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50 South Audley Street, Grosvenor Square,
London, W.1. Jan. 28.

Origin of Indo-European Languages

COMMENTING on Prof. Alexander Jóhannesson's recent article, Mr. Allan S. C. Ross[1] states: "In all languages known to us . . . for the great majority of words, the connexion between sound and sense is random". But he does not say whether this also applies to the connexion between mouth gesture and sense, which was what Prof. Jóhannesson has been particularly investigating.

Yet it can scarcely be disputed that the sounds of speech are, in fact, a secondary effect of the gestures of articulation which produce the various sounds of speech. If this is so, then it would appear that the "excellent minute" of the Société de Linguistique which Mr. Ross quotes is out of date, and that the "origin of language" is now ripe for discussion, on the basis of mouth gesture.

Having made a fairly wide examination of the connexion between mouth gesture and sense in various languages, and of the meaning which hand gestures (in sign language) and mouth gestures (in speech) actually convey, I can offer evidence of the survival of significant mouth gestures. In English, for example, about 75 per cent of all the short words are 'gestural'; that is, the mouth gestures which produce the words are themselves a pantomimic representation of the primitive meaning of the words. Thus, of the 79 short words beginning with *GR-* (a gripping, surrounding, enclosing or clawing gesture), 73 per cent are gestural; of the 25 short words beginning with *SCR-*, *SKR-*, 88 per cent are gestural, and of the 39 short words beginning with *STR-*, 90 per cent are gestural, while 100 per cent of short words ending in *-OOP* or *-OUP* are gestural.

In Chinese the same conditions obtain; and of 36 words pronounced *KU* or its variants (*K'U*, *χU*, *χUA*, *KÜ* and *KUAI*) 34 (94 per cent) are found to be gestural. Similarly, of 19 short Greek words beginning with γλ- (*GL*), 15 (78·9 per cent) are gestural. Such connexions can certainly not be described as random.

Mr. Ross also states that "linguistic changes which must have operated in the long period intervening" (that is, between the origination of a language and its development as a written language) "would certainly have quickly reduced a non-random sound-sense relation to a random one". On this count also the gestural evidence is against him.

Investigation of the mouth gestures involved in "linguistic changes" and "ablaut" shows that, as a rule, the original significant gestures do not change; what changes is the manner in which the individual gestures are made, the changes being mostly in the direction of unconsciously making the gesture easier to perform. Thus, a complete closure of the tongue against the throat, palate or back of the teeth may become a partial closure *in the same position*. A complete lip closure may become a partial closure, a voiced consonant may become unvoiced, or the level of the tongue or the opening of the lips may be varied, for convenience in combining a given vowel posture with a particular consonant gesture. In other words, the 'fashions' in performing the mouth gestures vary—like other human fashions—but the gestures persist. Philologists should study mouth gestures. If they fail to do so, they will be in no position to criticize Prof. Jóhannesson's theories.

Human speech is, admittedly, a highly important branch of human behaviour; if its votaries will study the system of gestures to which audible speech is due, philology will indeed become a science, and—linked with the study of sign language—will take its place as an essential part of anthropology.

R. A. S. PAGET.
Cranmore Hall, Shepton Mallet.

[1] NATURE, **153**, 257 (1944).

Pectoral Gland in Apes and Monkeys

PROF. OSMAN HILL'S interesting account of the gland on the chest of a male drill[1] reminds me that nearly twenty years ago[2] I described and figured a somewhat similarly situated gland in two adult male gibbons from Borneo. In these apes, the glandular area superficially is an elongated triangular patch of thickened skin sparsely covered with short hairs, and in one of the specimens with blackish secretion. It is broad above and narrowed below, and extends from the region of the inner ends of the collar-bones downwards and terminates in a point a little below the mammæ. Although I had one of these gibbons under observation in the Zoological Gardens at Regent's Park, London, neither I nor the keeper in charge ever saw the animal evince the least sign of being aware of the existence of the gland; but Prof. Hill's amusing description of the conduct of the drill in connexion with its pectoral gland shows that there is still a great deal of interesting information about the behaviour of wild animals to be learnt by observing them in captivity.

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[1] NATURE, **152**, 199 (1944).
[2] *Proc. Zool. Soc.*, 1492 (1925).

ELECTRICITY SUPPLY IN GREAT BRITAIN

TWO documents have recently been published on this subject which are likely to have important repercussions in the electricity supply industry of Great Britain. The first of these is a memorandum issued by the Incorporated Association of Electric Power Companies*, and the second is the report made to the Council of the Institution of Electrical Engineers by its Post-War Planning Committee, on electricity supply, distribution and installation†.

Administrative Aspects

The memorandum issued by the Incorporated Association of Electric Power Companies refers to the progress of, and developments and legislation in, the supply industry, to the Electricity Commission, and to the work and recommendations of the McGowan, Cooper, and Scott Committees. Proposals are then made for the consideration of the Minister of Fuel and Power in respect of (1) electricity distribution, and (2) the Electricity Commission. Their essential features are abstracted in the following.

Electricity Distribution. Improvement should be generally on the lines of the McGowan Report, subject to the amendments cited later. Legislation should be passed at or before the end of the War to suspend the exercise of the rights of purchase by local authorities and others of any electricity undertaking, but such suspension should not prevent the completion of negotiations for the voluntary acquisition or amalgamation of such undertakings. The Electricity Commissioners should delimit suitable electricity districts and appoint a scheme committee for each district to prepare and submit to the Commissioners a draft scheme for the improvement of distribution in the district in accordance with the terms of the McGowan Report. The scheme committee should consist of representatives of the authorized undertakers in each electricity district. Should the scheme committee fail to prepare or forward a draft scheme for any electricity district, the onus would fall on the Electricity Commissioners.

The Electricity Commissioners should be empowered to make any scheme, but should not make one other than an agreed scheme without holding a local inquiry. The Minister of Fuel and Power should be empowered to confirm any scheme made by the Electricity Commissioners, and any scheme confirmed should be subject to the approval of Parliament. The proposed legislation should prescribe the basis of the purchase price to be paid for the acquisition of any undertaking. Tariff forms throughout Great Britain should be standardized so far as possible. Complete uniformity of charges for the whole country is not economically possible, but may be feasible in an electricity district, and has already been attained in a number of large areas. Retained undertakers should be under an obligation to standardize voltages and systems, as may be determined by the Electricity Commissioners. Legislation should provide in the case of retained undertakers for the application of an effective sliding scale relating prices to costs and charges, including a reasonable return on capital employed. All retained undertakers should be obliged to submit periodically to the Electricity Commissioners proposals for the development of the supply of electricity for general domestic purposes, including lighting in any part of their area where there is a demand for such a supply and a prospect of such supply affording reasonable return to the undertakers.

The Electricity Commissioners should appoint a local committee in each area to consult with the retained undertakers on matters affecting development of supplies and prices. The local committee should be representative of local authorities and consumers and should have power to initiate applications to the Electricity Commissioners regarding such matters.

The present system of valuation and rating as affecting the industry has been adversely commented upon by various departmental committees, and it is considered that the whole system should be reviewed. The proposed legislation should include various provisions recommended by the McGowan Committee on matters such as the procedure for obtaining wayleaves, fixing wayleave rentals and compensation, public supplies of electricity by unauthorized undertakers, and the consolidation of the numerous Electricity Acts into one up-to-date enactment. It is considered that the conclusions of the McGowan Committee and the Cooper Committee and also the views already expressed regarding public corporations and regional boards apply equally to 'public ownership'. If, however, Parliament decides that retained company undertakings should be liable to purchase by some form of public authority, it is considered that the prescribed period should be not less than fifty years and that the option to purchase should be exercisable at the same date for all undertakings. If, at the expiry of fifty years, purchase were not deemed expedient, there should be recurring options at reasonably lengthy intervals.

The Electricity Commission. It is the view of the Incorporated Association of Electric Power Companies that the establishment of the Electricity Commission was and is still necessary to the industry. The Minister should have the widest choice in appointing suitable men to the Commission, and the Commissioners, in turn, should be enabled to appoint an experienced and well-paid staff. It is recommended that five Commissioners be appointed at the earliest possible date and that all the Commissioners, including the chairman, should be men of long and wide experience in the industry. The staff of the Commission should be strengthened and reorganized at the earliest possible date and there should be removed any obligation that its members should be governed by Civil Service conditions and rates of pay. The Electricity Commissioners should have the assistance of an advisory committee to be appointed by the Minister of Fuel and Power after consultation with the electricity supply associations, in regard to the delimitation of electricity districts and other proposals.

Technical Aspects

The second report, sponsored by the Institution of Electrical Engineers, is confined to technical matters of immediate urgency in connexion with electricity supply, distribution and installation in Great Britain, and it excludes problems of generation and main

* Memorandum with regard to the Electricity Supply Industry in Great Britain. Pp. 30. (Incorporated Association of Electric Power Companies, 58 Abbey House, Victoria Street, London, S.W.1. 1943.)

† Electricity Supply, Distribution and Installation: a Report to the Council of the Institution of Electrical Engineers from the Post-war Planning Committee. Pp. ii+26. (Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2. 1944.)

transmission, for which technical policy is already co-ordinated by the Central Electricity Board.

For low-voltage distribution systems, a four-wire, three-phase, 400/230 volt system is the national standard. Its extension throughout Great Britain is recommended as an urgent post-war national industrial plan. Data are given on which a scheme to secure standardization may be based. Complete standardization of all low-voltage distribution systems presents no technical difficulties and could be completed within five years. As the benefit of such voltage standardization mainly accrues to the entire community, it may be the subject of financial discussions with Government, and a detailed estimate has been made of its cost, which amounts to some £17·5 millions, based on 1939 conditions and price-levels.

A brief historical review of the development of urban electricity in Great Britain leads up to the position in 1939, when of 10·7 million urban dwellings, 7·9 million were supplied with electricity; among 2·25 million rural dwellings, 1·1 million received a supply, together with at least 35,000 farms. For the completion of rural electrification financial aid will be required for connecting consumers remote from transmission lines, preferably granted for schemes embracing districts as a whole. Wayleave procedure should be simplified and the use of under-eave construction facilitated. Agreement by undertakings on a standard length of underground service cable, laid free, is recommended. A free overhead service line to a total cost not exceeding that of installing the agreed length of underground service cable is suggested. Simplified and less expensive constructions for high-voltage spur lines are proposed, and agreed standards are recommended. Expenditure on such overhead lines must usually be justified by adequate revenue, unless the consumer contributes to first cost or a subsidy is available. Legislation is recommended to bring English law into conformity with Scottish law, which allows a tenant to secure compensation from the landlord for the cost of any wiring installation put in by the tenant. Low-interest loans for wiring, etc., or hire-purchase terms for a ten-year period are advocated.

A report issued in 1930 of a committee set up by the Electricity Commissioners gave a comprehensive picture of the situation at that time and remains largely applicable. The time is appropriate for securing uniformity of tariff forms, and recommendations are made to this end. The merits of the two-part tariff are discussed and recommendations for its wide extension are made. Consumers are classified into the groups domestic, farm, industrial and commercial, and recommendations are made for the equitable assessment of the fixed or primary charge component of the tariffs appropriate to each group. The Electricity Commissioners, it is suggested, should be authorized to permit any undertaking to offer a two-part tariff only, with no alternative flat-rate, subject to certain safeguards to the consumer. Descriptions are given, and the advantages are discussed, of two-part variable-block tariffs, for the above groups, and examples of the working of each are quoted.

Basic changes in the Regulations for the Electrical Equipment of Buildings of the Institution are proposed, leading to their division into Basic Safety Regulations (accompanied by a Code of Practical Interpretation) and supported by Codes of Good Practice to be prepared by the independent Codes of Practice Committee, set up under the ægis of the Ministry of Works. It is recommended that this very important matter be given early consideration.

No full assessment of the matter of legislative control of the electrical equipment of buildings has been attempted, but an appraisement of the technical aspects of the available evidence does not support a need for the compulsory registration of contractors and operatives or for the exactment at present of compulsory wiring regulations. If necessary, the proposed Basic Safety Regulations could later be given the force of law. Extension of inspection of installations by supply undertakings, more general observance of the wiring regulations, wider use of the voluntary system of registration of installation contractors, insistence on the use of non-kinkable cords for portable apparatus, and the manufacture of accessories and apparatus to extended and specific British standard specifications are recommended.

OPHTHALMOLOGY IN GREAT BRITAIN

THE work of the modern ophthalmologist and the tasks he has to face in the future are the subjects of two articles in the *British Medical Bulletin* (1, No. 9; 19 3). These articles inaugurate a series of outlines of special aspects of British medicine which that journal will publish at irregular intervals in the future.

Discussing the future work of the ophthalmologist, Prof. Arnold Sorsby gives most of his space to blindness, adopting the criterion that blindness means being "so blind as to be unable to perform any work for which eyesight is essential". He finds that there are at least 100,000 blind people among the population of about 40 million in England and Wales, which is a rate of 2·5 per thousand. It is likely that even now all the blind are not registered by a medical examiner for the benefits obtainable under the Blind Persons Act of 1920.

In 1910 it was estimated from the census returns of various countries that there were about 3 million totally blind people in the world, but, on the basis of the rate for England and Wales, the world figure would be 5 million. Blindness is, however, much more frequent in India, China and the Middle East than it is in Britain. China alone probably has 4–5 million blind people and India may have almost as many. Prof. Sorsby suggests that there are probably 15 million blind people in the world, and that many millions more have grossly defective sight. Apart from the immediate exciting causes of blindness, the great determining causes are ignorance and poor social and medical services.

The prevention of blindness—surely one of the major tasks of the future—is considered under five headings. Among the infective processes causing blindness, ophthalmia neonatorum of the newborn is no longer significant, nor is smallpox now a serious cause of eye disease. Trachoma and the acute ophthalmias of the tropics are not yet controlled. Trachoma probably affects about 15 per cent of the world's population, and its cause is not understood. Possibly a remedy may be found among the sulphonamides. The control of tuberculosis has helped greatly to diminish phlyctenular ophthalmia, the prevalent ophthalmia of childhood, due to tuberculous sensitization. Advances in public health and hygiene have

also helped the tasks of the ophthalmologist. But the lack of any specific treatment for tuberculosis makes it difficult to control tuberculous allergy of the eye. Until we find an antisyphilitic agent which will reach and act on the brain and the eye, treatment of ocular syphilis will be unsatisfactory.

Among genetic affections of the eye, malformations and hereditary anomalies cause the blindness of some 50 per cent of blind children. Geneticists should find interesting material in the study of *glioma retinæ*, a disease which behaves as an irregular dominant in some families. We need to know why it does not behave as a dominant in those transmitters of it who do not suffer from it.

Among nutritional and metabolic disorders, xerophthalmia is a major problem in China and India. Work is needed on the correlation of nutrition with ocular health and we need better methods of studying the physiology of the eye, so that problems which, like diabetic retinitis, are related to faulty metabolism of the body as a whole, may be tackled on a proper basis. Such methods would also help the study of cataract and glaucoma, which are, according to English and North American statistics, responsible for 25–40 per cent of blindness.

Finally, in children and young adults, injuries are important. War is the greatest single cause of blindness, and it poses its own special problems—the extraction, for example, of non-magnetic fragments from the interior of the eye, such fragments being, in the present War, largely non-magnetic, while those encountered during the War of 1914–18 were not.

In a section on ocular hygiene Prof. Sorsby echoes the opinions of the leaders of modern medical thought when he reminds us that nowadays we tend to take 'optical aids' as a matter of course, and to forget the environmental conditions of those who have to use them. It is good to learn that England may have a national eye service for all, an important part of which will be the research facilities which are essential to its progress. The *British Medical Bulletin* points out that the Oxford University Ophthalmic Research Endowment Committee is appealing for funds for the endowment of the newly established Department of Ophthalmology at Oxford after the War. Reference was made to this project in NATURE of September 18, 1943, p. 323.

In another special article in this issue of the *British Medical Bulletin*, R. R. James gives an outline of the history of English ophthalmology since its beginnings in the days of the Roman occupation. After the Romans left, the Anglo-Saxons and Normans did little to improve ophthalmic practice, but in the thirteenth century Roger Bacon and John of Peckham initiated the use by old people of lenses for reading, and the science of optics began. Early in the seventeenth century the itinerant oculist Richard Banister of Stamford directed attention to hardness of the eyeball as a cardinal sign of glaucoma, a discovery which was forgotten for 150 years. Banister seems to have been an honest and remarkable member of an itinerant fraternity whose practices should make entertaining reading. Mr. James describes the eighteenth century as the age of ophthalmic quackery, but during it modern ophthalmology was founded by Cheselden, Sharp, Warner and others. In 1805 the Moorfields Eye Hospital, now the Royal London Ophthalmic Hospital, was founded. Exeter established an eye hospital in 1808 and Manchester in 1814. The subsequent landmarks in ophthalmic history given by Mr. James indicate that, when Sir William Bowman, who gave his name to Bowman's membrane, abandoned general surgery to become the first ophthalmic specialist, he began that specialist service which to-day must face so many urgent tasks.

G. LAPAGE.

THIOUREA AS PROTECTIVE AGENT FOR VITAMIN C

FOOD products rich in ascorbic acid, such as those made from citrus and other fruits, should be processed under conditions in which the vitamin is not destroyed. Ascorbic acid loses its antiscorbutic action when the cyclic structure of the molecule is changed by the opening up of the lactone ring. In alkaline solution this takes place spontaneously with formation of diketogulonic acid, which afterwards breaks down to threonic and oxalic acids from which the vitamin cannot be recovered by simple reduction. This does not readily happen in acid solution, and the vitamin may be oxidized to the dehydro form and quantitatively recovered by the use of the appropriate reducing agents.

Oxidation of the vitamin can occur in the absence of molecular oxygen provided the solution is activated by (1) ultra-violet light, (2) copper, (3) pyridine nucleotides, or (4) enzymes of the type of ascorbic acid oxidase. The possible significance of copper contamination has been recognized in an order by the Ministry of Food by which manufacturers of fruit concentrates containing vitamin C are required to satisfy the Ministry that their process plants do not come in contact with fruit juices.

It may be sufficient for industrial purposes to ensure that the boiling pans are not lined with copper, the effect of copper parts of the cold sections of the plant being disregarded. Contamination by ionic copper is likely to be much more troublesome, since the metal may be introduced in the water and carried by the fruit, which is often copper-sprayed. Substances capable of protecting the vitamin from destruction following oxidation are (1) substances which stabilize the vitamin in its oxidized (dehydro) or its reduced forms, since either are of equal value in nutrition; (2) reducing agents capable of maintaining the vitamin in the stable or reduced form; (3) buffers which keep the solvent from becoming alkaline; and (4) substances which act as anti-catalysts either by depressing the ionization of copper present in the solution or by combining with ascorbic oxidases.

Reduced ascorbic acid is stable in tissue fluids and in natural and processed food materials containing appreciable quantities of copper. This stability is due to the presence of substances such as glutathione which form copper compounds of a low degree of ionization. E. Kawereau and W. R. Fearon (*Sci. Proc. Roy. Dublin Soc.*, 23, 171; 1944) have recently investigated a large number of substances which might protect ascorbic acid from oxidation in the presence of copper. Of all the simple solutes tested, thiourea was outstanding in its protective power. It appears to be of very low toxicity and is excreted unchanged by the kidney after administration to human subjects. It displays none of the pharmacological effects possessed by some of the substituted thioureas. The authors, however, consider that more work is required on the effects of long-continued

administration and the possible formation of decomposition products during prolonged boiling with fruit extracts, before the general use of thiourea as a protector of vitamin C in large-scale industrial work can be advocated; but it appears most promising of all compounds tested. Boiled vegetable extracts display a similar power of protection, which in some preparations is so complete as to suggest the presence of specific stabilizers of possibly the thiol class. Cabbage, for example, contained an unidentified volatile thiol compound and potato juice yielded an active distillate on boiling.

EFFECT OF DRINKING SMALL QUANTITIES OF SEA WATER

DR. W. S. S. LADELL, of the National Hospital, Queen Square, London, has studied the effects of drinking small quantities of sea water (*The Lancet*, Oct. 9, 1943, p. 441). The work was done for the Medical Research Council's Committee on the care of shipwrecked personnel (M.R.C. War Memo. No. 8, which does *not* recommend the drinking of sea water). A full report of Dr. Ladell's work will be issued later.

A man requires 800–1,000 c.c. of water a day. With less than this he contracts a water debt to his tissues. With a water debt he continues to produce only 350–450 c.c. of urine a day (instead of the normal 1 litre or so), whether the water debt is large or small. During this low urinary output, the urea concentration in the urine rose to as much as 6 per cent; but the total urea output was inadequate and there was nitrogen retention with a rise of blood urea. At the same time, the salt losses in the urine were high on the first day, but they fell in a day or two to a low level. The diet of each subject of all the experiments was 'shipwreck diet' of 1 oz. daily of biscuits, sweetened condensed milk, butter fat or margarine, and chocolate. This provided not more than 1 gm. of sodium chloride daily, but more than this was excreted, so that, when no sea water or saline was drunk, there was always a slight negative salt balance. There was a definite psychological value in having an extra volume of fluid to drink (water supplemented with 3·5 per cent sodium chloride solution or with sea water), even though it tasted salty.

The results, briefly stated, were that the effects of drinking up to 400 c.c. of sea water a day, when the subjects were either totally or partially deprived of fresh water, were, on the low-calorie and low-salt diet provided, an increase in the output of urine, with an improved total urea clearance; a slight gain to the body of water, because the extra water lost in the urine is less than the extra water taken in as sea water; and an initial retention of chloride equal to the chloride lost before the subjects began to drink sea water and, after this, a full excretion of all the chloride ingested. This restoration of the total sodium chloride content of the body may have been a manifestation of the body's tendency, indicated by the work of others whose work is quoted, to conserve its extracellular, at the expense of its intracellular, fluid.

Readers interested in the medical problems presented by the survivors of shipwrecks will find useful Surgeon-Captain Critchley's book, "Shipwreck Survivors, a Medical Study" (J. and A. Churchill, London, 1943, 7*s*. 6*d*. net).

FORTHCOMING EVENTS

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

Saturday, March 25

ASSOCIATION FOR SCIENTIFIC PHOTOGRAPHY (at the Caxton Hall, Westminster, London, S.W.1), at 2.30 p.m.—"The Assessment of Lens Performance" (Mr. A. Cox: "General Theory of Lens Performance"; Mr. H. W. Martin: "Lens Types and their Characteristics").

BIOCHEMICAL SOCIETY (at the Courtauld Institute of Biochemistry, Middlesex Hospital, London, W.1), at 2.30 p.m.—Annual General Meeting.

Monday, March 27

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. Franklin Kidd: "Dehydration of Foodstuffs" (Cantor Lectures, 2).

Tuesday, March 28

INSTITUTE OF FUEL (joint meeting with the BRITISH COAL UTILIZATION RESEARCH ASSOCIATION) (at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10.30 a.m.—Symposium on "Underfeed Stokers as applied to Furnaces".

INSTITUTION OF BRITISH AGRICULTURAL ENGINEERS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. F. A. Secrett: "Mechanisation in Market Gardening".

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. Arnold Sorsby: "Blindness in Childhood; Past Achievements and Present Problems".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Sir Henry Dale, G.B.E., Pres.R.S.: "Chemical Factors in Nervous Effects", 2: "The Appearances of Two of these Substances in Nervous Activity; Adrenergic and Cholinergic Nerves".*

INSTITUTION OF ELECTRICAL ENGINEERS (TRANSMISSION SECTION) (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on the Supply and Distribution Sections of the Report on "Electricity Supply, Distribution and Installation" prepared by Sub-Committee No. 3 of the Post-War Planning Committee (to be opened by Mr. P. E. Rycroft).

ROYAL PHOTOGRAPHIC SOCIETY (SCIENTIFIC AND TECHNICAL GROUP) (at 16 Princes Gate, South Kensington, London, S.W.7), at 6 p.m.—Annual General Meeting. Mr. F. W. Coppin: "Production of Photographic Templates".

SHEFFIELD METALLURGICAL ASSOCIATION (at 198 West Street, Sheffield), at 6.30 p.m.—Mr. J. H. G. Monypenny: "The Sigma Phase and its Significance".

Wednesday, March 29

INSTITUTION OF NAVAL ARCHITECTS (at the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2), at 12 noon—Annual General Meeting.

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Mr. E. R. Hamilton: "Education To-day and To-morrow", 7: "The Training of the Teacher".

Thursday, March 30

TOWN AND COUNTRY PLANNING ASSOCIATION (at 1 Grosvenor Place, London, S.W.1), at 1.15 p.m.—Rt. Hon. Earl De La Warr: "National Planning Policy in relation to Agriculture".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 2.30 p.m.—Mrs. Kathleen Lonsdale: "Diamonds—Natural and Artificial".*

ROYAL COLLEGE OF SURGEONS OF ENGLAND (at Lincoln's Inn Fields, London, W.C.2), at 4 p.m.—Prof. Arnold Sorsby: "The Sulphonamides in Ophthalmology; their Use and Limitations".

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. J. A. Harle and Mr. R. W. Wild: "Restriking-Voltage as a Factor in the Performance, Rating and Selection of Circuit-Breakers"; Mr. H. E. Cox and Mr. T. W. Wilcox: "The Influence of Resistance Switching on the Design of High-Voltage Air-Blast Circuit-Breakers".

INSTITUTION OF ELECTRICAL ENGINEERS (CAMBRIDGE AND DISTRICT WIRELESS GROUP) (at the University Engineering Department, Trumpington Street, Cambridge), at 8.15 p.m.—Mr. R. H. Angus: "Transients on Transmission Lines".

Friday, March 31

OIL AND COLOUR CHEMISTS' ASSOCIATION (MANCHESTER SECTION) (at the Engineer's Club, Albert Square, Manchester), at 2 p.m.—Mr. W. A. Silvester: "Patents at Home and Abroad".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5 p.m.—Mr. Stanley Unwin: "Publishing in War and Peace".

Saturday, April 1

BRITISH ASSOCIATION OF CHEMISTS (LONDON SECTION) (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 2.30 p.m.—Prof. R. G. W. Norrish, F.R.S.: "Chemistry and the Community".

Thursday, March 30—Tuesday, April 4

BRITISH PSYCHOLOGICAL SOCIETY (at the Training Centre, Jordanhill, Glasgow, W.3).—Annual General Meeting.

APPOINTMENTS VACANT

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

LABORATORY ASSISTANT (temporary), experienced in pathological and bacteriological work, in the County Public Health Department—The County Medical Officer, County Hall, Wakefield (March 28).

LECTURER IN MATHEMATICS AND CHEMISTRY in the School of Building—The Principal, West Ham Municipal College, Romford Road, Stratford, London, E.15 (March 29).

SENIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.902A), and a JUNIOR ASSISTANT DRAINAGE AND IRRIGATION ENGINEER (Reference No. E.903A), by the Sierra Leone Government—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting the appropriate Reference No.) (March 31).

TECHNICAL ASSISTANT, Grade I (location, London, with travelling) (applicants must be qualified electrical engineers with experience of electrically driven excavating machinery)—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. D.776A) (March 31).

PRINCIPAL OF TOXTETH TECHNICAL INSTITUTE, Liverpool—The Director of Education, Education Offices, 14 Sir Thomas Street, Liverpool 1 (April 1).

TWO FULL-TIME LECTURERS FOR (1) MECHANICAL ENGINEERING and (2) ELECTRICAL ENGINEERING, in the East Ham Technical College—The Secretary for Education, Education Office, Town Hall Annexe, Barking Road, East Ham, London, E.6 (April 1).

WELDING OFFICERS by a Government Department to give technical assistance in designing for welding and the welding of armour plate and fabricated steel structures, etc.—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.2060A) (April 3).

EXECUTIVE ENGINEERS by the Gold Coast Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.908A) (April 3).

PRODUCTION ENGINEER with mechanical and electrical training and experience, to assist Works Director of large company of manufacturing electrical engineers having several factories in England—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. C.1973XA) (April 3).

ASSISTANT TO THE DIRECTOR—The Secretary, National Institute of Agricultural Botany, Huntingdon Road, Cambridge (April 5).

METALLURGIST with a sound physical metallurgical or physical-chemical training, for research work connected with Metallic Arc Welding—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. F.2182XA) (April 6).

READERSHIP IN MINERALOGY—The Registrar, University Registry, Oxford (April 8).

WAYNFLETE PROFESSORSHIP OF METAPHYSICAL PHILOSOPHY—The Registrar, University Registry, Oxford (April 13).

RESEARCH WORKER (who should be a PHYSICIST) in the Coal Treatment Laboratory of the Mining Department—The Secretary, The University, Edmund Street, Birmingham 3 (April 15).

LECTURER (preferably a woman) IN BIOLOGY—The Warden, Goldsmiths' College, at University College, Nottingham (April 15).

ASSISTANT HYDROGRAPHIC SURVEYORS by the Kenya Government Public Works Department—The Ministry of Labour and National Service, Central (Technical and Scientific) Register, Advertising Section, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. E.904A) (April 15).

PROFESSORSHIP OF ENGINEERING SCIENCE—The Registrar, University Registry, Oxford (April 30).

CHAIR OF PHILOSOPHY at the University of the Witwatersrand, Johannesburg—Dr. William Cullen, 4 Broad Street Place, London, E.C.2 (May 1).

DIRECTOR OF THE INSTITUTE OF MEDICAL AND VETERINARY SCIENCE, Adelaide—The Agent-General and Trade Commissioner for South Australia, South Australia House, Marble Arch, London, W.1 (May 31).

CHAIR OF NATURAL PHILOSOPHY, United College, St. Andrews—The Secretary, The University, St. Andrews (June 15).

BOTANIST (male) in the Branch of Plant Pathology and Botany of the Department of Agriculture, Southern Rhodesia—The Official Secretary, Rhodesia House, 429 Strand, London, W.C.2.

SENIOR LECTURER IN THE PHYSIOLOGY DEPARTMENT—The Secretary, Royal (Dick) Veterinary College, Summerhall, Edinburgh 9.

GRADUATE TEACHER FOR MATHEMATICS with some GENERAL SCIENCE (ordinary National Certificate standard)—The Principal, Technical Institute, Beckenham.

GRADUATE LECTURER IN MECHANICAL ENGINEERING SUBJECTS to Engineering Degree and Higher National Certificate standards—The Principal, Kingston Technical College, Kingston, Surrey.

ASSISTANT MASTER to teach MATHEMATICS, TECHNICAL DRAWING and SCIENCE in the Junior Technical School of the Oldham Municipal Technical College—The Director of Education, Education Offices, Union Street West, Oldham.

TEACHERS (temporary full-time) OF ENGLISH SUBJECTS AND MATHEMATICS; ENGLISH, MATHEMATICS and ELEMENTARY SCIENCE; RADIO and PHYSICS—The Secretary, Northern Polytechnic, Holloway Road, London, N.7.

ASSISTANT (male or female) IN THE CHEMICAL DIVISION of the County Laboratory—The County Analyst, County Buildings, Worcester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

British Rubber Producers' Research Association. Publication No. 39: The Elasticity of a Network of Long-chain Molecules, 2. By L. R. G. Treloar. Pp. 6. Publication No. 40: The Physical Chemistry of Rubber Solutions. By G. Gee. Pp. 30. Publication No. 41: Rubber, Polyisoprenes and Allied Compounds, Part 5: The Chemical Linking of Rubber and of other Olefins with Phenol-Formaldehyde Resins. By J. I. Cunneen, E. Harold Farmer and H. P. Koch. Pp. 6. Publication No. 42: The Statistical Length of Paraffin Molecules. By L. R. G. Treloar. Pp. 18. Publication No. 43: The Course of Autoxidation Reactions in Polyisoprenes and Allied Compounds, Part 7: Rearrangement of Double Bonds during Autoxidation. By E. H. Farmer, H. P. Koch and D. A. Sutton. Pp. 8. (London: British Rubber Producers' Research Association.) [212

Royal Astronomical Society. List of Fellows and Associates, 1943 December. Pp. 40. (London: Royal Astronomical Society.) [222

Sex Teaching in Schools. Statement by the Executive of the National Union of Teachers. Pp. 12. (London: National Union of Teachers.) [242

Regulations for the Electrical Equipment of Buildings. Eleventh edition, revised. Pp. vi+174. (London: Institution of Electrical Engineers.) Paper, 1*s*. net; cloth, 1*s*. 6*d*. net. [252

Association of University Teachers. Report on University Developments. Pp. 16. (Bristol: J. W. Arrowsmith, Ltd.) 1*s*. [282

Philosophical Transactions of the Royal Society of London. Series A: Mathematical and Physical Sciences. No. 807, Vol. 239: Invariant Theory, Tensors and Group Characters. By D. E. Littlewood. Pp. 305–365. (London: Cambridge University Press.) 9*s*. 6*d*. [292

University of London: University College. Annual Report, February 1943—February 1944. Pp. 52. (London: Taylor and Francis, Ltd.) [63

Post-War Plenty for All: How to Make It Possible. By Wilfrid Hill. Pp. 8. (London: Joint Council for Monetary and Economic Research.) [63

Industrial Planning and Research—Catchwords or Realities? By Dr. F. J. North. (Inaugural Address for Session 1944, read before the South Wales Institute of Engineers, at Cardiff, January 20th, 1944.) Pp. 38. (Cardiff: South Wales Institute of Engineers.) [73

Freshwater Biological Association of the British Empire. Scientific Publication No. 8: Keys to the British Species of Aquatic Megaloptera and Neuroptera. By D. E. Kimmins. Pp. 20. (Ambleside: Freshwater Biological Association of the British Empire.) 1*s*. 6*d*. [93

Management in Action. Report of the October 1943 Conference of the Institute of Industrial Administration. Pp. 136. (London: Institute of Industrial Administration.) 2*s*. 6*d*. [93

National Smoke Abatement Society. Fourteenth Annual Report for the Year ended 31st December 1943. Pp. 16. (London: National Smoke Abatement Society.) 2*d*. [103

Other Countries

Tanganyika Territory: Department of Lands and Mines, Geological Division. Bulletin No. 16: The Mineral Resources of Tanganyika Territory. By Sir E. O. Teale and F. Oates. Pp. viii+192. (Dar es Salaam: Government Printer.) 15*s*. [212

Transactions of the San Diego Society of Natural History. Vol. 10, No. 1: On the Generic Relationships of Certain Californian Xerophile Snails. By S. Stillman Berry. Pp. 24 (plates 1–2). Vol. 10, No. 2: New Mollusks from the Round Mountain Silt (Templor) Miocene of California. By A. Myra Keen. Pp. 25+60 (plates 3–4). Vol. 10, No. 3: Growth in the Western Blue-Tailed Skink. By Thomas L. Rodgers and Viola H. Memmler. Pp. 61–68. Vol. 10, No. 4: A New Snake of the Genus Sonora from Lower California, Mexico. By Laurence M. Klauber. Pp. 69–70. Vol. 10, No. 5: A Desert Subspecies of the Snake *Tantilla eisenii*. By Laurence M. Klauber. Pp. 71–74. Vol. 10, No. 6: The Coral King Snakes of the Pacific Coast. By Laurence M. Klauber. Pp. 75–82. Vol. 10, No. 7: The Subspecies of the Rubber Snake, *Charina*. By Laurence M. Klauber. Pp. 83–90. (San Diego, Calif.: San Diego Society of Natural History.) [222

Proceedings of the United States National Museum. Vol. 93, No. 3170: The North American Parasitic Wasps of the Genus Tetrastichus—a Contribution to Biological Control of Insect Pests. By B. D. Burks. Pp. 505–608. (Washington, D.C.: Government Printing Office.) [232

Annual Report of the Indian Central Jute Committee for the Year 1942–43. Pp. iii+170. (Calcutta: Indian Central Jute Committee.) [282

Academy of Sciences of the U.S.S.R.: Department of Geological and Geographical Sciences. The Progress of Geological and Geographical Sciences in the U.S.S.R. for 25 years. Edited by V. A. Obruchev. (In Russian.) Pp. iii+200. (Moscow and Leningrad: Academy of Sciences of the U.S.S.R.) [292

Annals of the New York Academy of Sciences. Vol. 44, Art. 5: Sulfonamides. By Colin M. MacLeod, Paul H. Bell, Henry Irving Kohn, J. S. Lockwood, Richard O. Roblin, Jr., James A. Shannon and H. B. van Dyke. Pp. 445–538+4 plates. (New York: New York Academy of Sciences.) [13

U.S. Department of Agriculture. Farmers' Bulletin No. 1945: The Pea Aphid on Peas and Methods for its Control. By J. E. Dudley, Jr., and T. E. Bronson. Pp. ii+14. (Washington, D.C.: Government Printing Office.) 5 cents. [13

Ceylon. Part 4: Education, Science and Art (D). Administration Report of the Acting Director of Agriculture for 1942. By E. Rodrigo. Pp. 16. (Colombo: Government Record Office.) 35 cents. [13

Svenska Hydrografisk-Biologiska Kommissionens Skrifter. Ny Serie, Biologi, Band 2, Nr. 6: On the Biology and Larval Development of *Leander squilla* (L.) forma *typica* de Man. By Hans Höglund. Pp. 44+4 plates. (Stockholm: Svenska Hydrografisk-Biologiska Kommissionen.) [23

The vacancies advertised in these columns are available only to applicants to whom the Employment of Women (Control of Engagement) Orders, 1942-3, do not apply.

MURDOCH TRUST

For the BENEFIT of INDIGENT BACHELORS and WIDOWERS of good character, over 55 years of age, who have done "something" in the way of promoting or helping some branch of Science. Donations or Pensions may be granted to persons who comply with these conditions. For particulars apply to MESSRS. SHEPHERD & WEDDERBURN, W.S., 16 Charlotte Square, Edinburgh, 2.

MARINE BIOLOGICAL ASSOCIATION OF THE UNITED KINGDOM

THE LABORATORY, PLYMOUTH

Limited supplies of marine biological material are still available, but orders should be placed well in advance.

For prices and detailed information apply to: The Director, The Marine Biological Laboratory, Plymouth.

UNIVERSITY OF LONDON

THE ROGERS PRIZE

(Nathaniel Rogers; administered by the University of London)

The ROGERS PRIZE, of the value of £100, will be offered by the Senate in 1945 for an Essay or Dissertation on the following subject:

"THE PATHOLOGY AND TREATMENT OF BURNS."

The Prize is open to all persons whose names appear on the Medical Register of the United Kingdom.

Applications must be submitted to the Academic Registrar, University of London, at Richmond College, Richmond, Surrey (from whom further particulars can be obtained) not later than Monday, April 30, 1945.

UNIVERSITY OF BIRMINGHAM

A research worker, who should be a physicist with some research experience, is required in the Coal Treatment Laboratory of the Mining Department of the University for investigations connected with the cleaning of coal (with particular reference to fundamental work connected with suspensions of fine solids in aqueous media).

The salary offered is up to £450 per annum according to qualifications and experience.

Further particulars may be obtained from the undersigned, to whom applications must be submitted not later than April 15.

The University, Edmund Street, Birmingham, 3.
March, 1944.

C. G. BURTON, Secretary.

GUY'S HOSPITAL MEDICAL SCHOOL

(UNIVERSITY OF LONDON)

Demonstrator in Chemistry required to take up his duties in London on May 1, 1944. Present salary £300 plus £50. Applications, stating age, academic training and experience, together with the names of three references should be sent not later than March 31, to: The Dean, Guy's Hospital Medical School, St. Thomas's Street, London, S.E.1.

IMPERIAL COLLEGE OF SCIENCE AND TECHNOLOGY

Applications are invited for the post of Lecture Assistant in the Physics Department. Applicants should have a good knowledge of Physical apparatus and experiments, and preferably some laboratory experience.

Commencing salary according to experience. There is a war bonus in addition, and the man appointed will participate in the laboratory staff superannuation scheme.

Applications to be sent as early as possible to Professor H. Dingle, D.Sc., Imperial Institute Road, South Kensington, S.W.7.

UNIVERSITY OF LONDON

The Senate invite applications for the Chairs of Mathematics, Philosophy and Physics, tenable at Bedford College for Women. Salary not less than £1,000 a year in each case. Applications (10 copies) must be received not later than first post on April 24, 1944, by the Academic Registrar, University of London, Richmond College, Richmond, Surrey, from whom further particulars should be obtained.

NEWNHAM COLLEGE, CAMBRIDGE

The Council invites applications for the post of resident Lecturer in Chemistry for October, 1944. Candidates should be specially qualified in Physical Chemistry. Further particulars may be obtained from the Principal, to whom applications should be sent not later than April 15.

NATIONAL INSTITUTE OF AGRICULTURAL BOTANY

HUNTINGDON ROAD, CAMBRIDGE

The Council of the Institute invite applications for the post of Assistant to the Director of the Institute. Salary £400–£650 (plus War Bonus) according to qualifications of the candidate.

Applications should be addressed to the Secretary of the Institute not later than April 5.

Assistant Biochemist required by Midland firm of manufacturing chemists to work mainly on Pharmacological problems. Applicants should preferably be graduates with some experience in industrial laboratories, but this is not essential. Thorough experience of Biochemical technique will be a definite advantage. Salary £450–550 plus war bonus according to experience. Superannuation scheme in operation.—Replies to Box 168, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Pharmaceutical Manufacturers, West London area require laboratory assistant to take charge of experimental animal stock and assist in pharmacological and physiological work. Experience of animal husbandry and interscience qualifications would be advantageous. Salary according to qualifications.—Box 167, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Man wanted for Ceramic research. Must have Chemistry degree. Knowledge of Physics. Good permanent job for right man. Write stating qualifications and if free. Expenses paid for interview.—Box 170, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Editorial Assistant, male or female, required by London Metallurgical Society.—Write, giving particulars and salary required to Box 171, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Technicians required for Radon Centre in the country; scientific qualifications not essential.—Apply Barnato Joel Laboratories, Middlesex Hospital, London.

Research Fellow (Biochemist) required. Applications with full particulars to Secretary, Research Institute, 117 Grove St., Liverpool, 7.

Export: Managing Director established New Zealand distributors, visiting England shortly, desires contact Manufacturers binoculars and Cameras and Associated lines. Buying Agencies required now. Substantial orders can be placed immediately manufacturing facilities available.—Write Sawell, 4 Ludgate Circus, London, E.C.4. Central 4353.

Laboratory Apparatus suitable for Food Analysis required. Send particulars and prices to Easiwork Cookery Research Laboratories, 242 Tottenham Ct. Rd., London, W.1.

Wanted: books on the microscope and microscopy.—Chards, Forest Hill, S.E.23.

Wanted: Freezing or rotary microtome, new or second-hand.—Box 169, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Reflecting Telescopes: 5¾" Mirrors of excellent quality £9 9s. Flat 7s. 6d.—Roland Lee, "Infield," Babell, Holywell, Flintshire.

Translations of Scientific and Technical Papers from Danish, Dutch, French, German, Italian, Norwegian, Russian, Spanish and Swedish originals. Thirty-five years experience.—George Borrow, 6 St. Stephen's Grove, London, S.E.13.

For Sale: About 750 Volumes, mainly Marine Zoology, Fisheries, Whaling, card-catalogued, also many pamphlets.—Box 172, T. G. Scott & Son, Ltd., 9 Arundel Street, London, W.C.2.

Microscopes, of all descriptions, only a few available second-hand, perfect condition. Send details of your requirements enclosing 3d. stamp.—Chards, Microscope Specialists, Forest Hill, S.E. 23.

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