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## THE APPROACH TO FULL EMPLOYMENT

THE publication of the White Paper on Employment Policy almost on the eve of the launching of the invasion to liberate the peoples of occupied Europe was an imaginative stroke. It has both strengthened confidence in the determination of the Government to pursue resolutely a policy which will effectively implement its declared aim of maintaining a high and stable level of employment after the War, and fortified the nation for whatever may be demanded of it in the weeks that lie immediately ahead. More, it represents not merely a new departure in Government policy and an example of real leadership, but also, in some respects, the shaping of policy in accordance with scientific principles. To the fundamental statements and principles set forth in the report there can be little or no exception. Opinions may indeed differ as to the methods by which particular points of policy are to be implemented, and as to whether those which the Government proposes to use in the first instance are likely to be effective enough, or put into practice with sufficient firmness. Beyond this, however, a great merit of the statement is that it makes unmistakably plain, while acknowledging the Government's responsibilities in the matter of policy and decision, that there are limits beyond which Government action cannot go, and that the success of an employment policy must depend very largely on the understanding and support of the community as a whole. Whether or not the Government could do more than is indicated in this statement to promote a rising standard of industrial efficiency, such action could not be effective without corresponding efforts from both employers and workers. Without such co-operation, even measures already proposed by the Government may be frustrated of their purpose.

If for nothing else, this statement therefore is to be welcomed for its educational value. In the problems of the transition from war to peace—such as demobilization, the necessity for continuing war-time controls, the transfer of workers, their re-training and other measures to increase their mobility—the position is lucidly explained and reasons are given which should go far to assist in gaining public assent and co-operation in proposals which may to some extent be unpalatable and involve a break with professional or trade custom or practice. The necessity of explaining policy and measures in advance has been repeatedly urged in connexion with demobilization and like problems, notably in a valuable report, "The Organization of Employment in the Transition from War to Peace", submitted to the International Labour Conference at Philadelphia, and the White Paper is fully in keeping with the recommendations and spirit of that report. Any demobilization scheme finally agreed upon should be clearly understood by the people and the interests affected by it. If, as the report observes, the scheme is widely discussed, and if, after discussion, it is accepted as fair and reasonable, then some of the pressures apt to cause disorderly mobilization can be relieved or abolished.

Again, not only is it a matter of winning public approval of what is involved in policy. The Government also recognizes that, in its proposals for extending State control over the volume of employment, it is entering a field where theory can only be applied to practical issues with confidence and certainty when experience accumulates and experiment extends over untried ground. It is intended, therefore, to establish on a permanent basis a small central staff qualified to measure and analyse economic trends, and to submit appreciations of those trends to the Ministers concerned. It is also vital for the Government to obtain, more fully and much more quickly than in the past, exact quantitative information about current economic movements, and the Government appeals to industry for co-operation in this task. Only industry can provide the statistical information required, and only a central authority can classify and analyse information drawn from the country as a whole.

In this respect the White Paper points out that the efficient operation of an employment policy will require statistics of employment and unemployment, including quarterly or monthly statements of present and prospective employment in the main industries and areas of Great Britain, based on returns from employers, as well as regular information relating to savings, projected capital expenditure by public authorities, and, so far as possible, by private industry. An annual census of production showing the structure of the main groups of industries in the preceding year, including, *inter alia*, details of the quantity and value of output, stocks, and work in progress, together with monthly figures of production, consumption and stocks, and, if possible, figures of orders on hand, based on sample returns obtained periodically throughout the year from large firms, trade associations and public institutions, must also be provided. The Government has already repeatedly affirmed its intention of extending the provision of official statistics after the War, and it is now stated that the annual White Paper on National Income and Expenditure is to be developed by providing a much more complete analysis of the constituent parts of the country's total expenditure.

This central analysis of our financial position, which will be subject to continuous review and adjustment throughout the year, will serve as a basis for determining what measures are required to maintain employment and secure a rising standard of living. Parallel studies, at every stage, of the man-power situation will be undertaken by the Ministry of Labour and National Service, and these surveys will indicate the probable supply of labour over the coming period, the prospective changes in employment in the different industries, and the effects upon employment of Government projects designed to modify the volume of investment or expenditure. The correlation of these complementary budgets—for total expenditure and for man-power—will play a vital part in the formulation of Government policy for the maintenance of employment.

The debates on the Budget will in future provide an annual opportunity for Parliament to review the financial and economic health of Great Britain as a whole, and to consider the prospects for the coming year. This step may be regarded as part of the programme of educating the country as to what is required in a policy of employment which at the same time aims at securing for the nation the most effective use both of its man-power and of its material resources. Measures to increase total expenditure at the onset of a depression will no doubt be welcome; but the restraining measures appropriate to a boom may meet with opposition unless they are seen and understood as part of a continuing policy for maintaining employment, and accepted as the price that must be paid for the success of that policy over a long period.

It is right that we should turn first to the measures by which the Government seeks to provide itself with the instruments for giving effect to policy in this field, for unless the appropriate instruments are available and the basic data accumulated in readiness, the right decisions and the appropriate policy may not be determined or effectively put into operation. The White Paper, however, shows that in breaking new ground in regard to policy, the Government is providing itself with exactly the instruments required for the formulation of policy for which scientific workers have long pressed. No point, in fact, was more strongly urged in the Barlow Report, for example, than the necessity for more fact-finding machinery in regard to the location of industry and the natural resources that might be affected by industrial location, and the Commission was unanimous in recommending that the functions of the new national authority proposed should include the collection and co-ordination of such information.

Whether the instruments proposed by the Government will in fact prove adequate remains to be seen, and can scarcely be judged until the fuller proposals on particular points are made known. In regard to the collection of statistics, some further organization more on the lines of that recommended by the Council of the Royal Statistical Society in its Memorandum on Official Statistics (see *Nature*, **153**, 88; 1944) may prove necessary; this may indeed be contemplated by the Government, although it is not explicitly mentioned in the White Paper. The provision of statistics cannot be left to returns supplied by industry itself alone, however important the co-operation of industry may be. Nevertheless, it is clear that we have something more of a scientific approach to questions of public policy.

Turning now to the question of policy, the White Paper visualizes some ten different methods by which the Government may influence employment in furtherance of its objective. First, there is the action to be taken in the period of transition from war to peace, to avoid the threefold danger that patches of unemployment may develop where the industrial system fails to adapt itself quickly enough to peace-time production; that demand may outrun supply and create an inflationary rise in prices; and that civilian production, when it is resumed, may concentrate on the wrong things from the point of view of national needs. It is clear from the White Paper

that the Government is fully alive to these dangers; it will be recalled that the report presented to the Philadelphia Conference directed attention to them, as did also an admirable study issued last year by the League of Nations Delegation on Economic Depressions (see *Nature*, **152**, 365; 1943). In regard to the first, plans are being worked out to promote the orderly expansion of peace-time industries throughout the transition period by assisting firms to switch over their capacity to peace-time production as quickly as possible, by finding out in advance where the skilled labour which will gradually become available will be most urgently required, and by arranging, so far as war conditions permit, that labour and raw materials will be forthcoming for urgent civilian work. Steps are being taken to ensure that the machinery of allocation devised in war-time will be adaptable to the special conditions likely to obtain after the end of the War in Europe. Curtailments of munitions production will be made first in areas where the capacity and labour can be used for civilian products of high priority. The disposal of surplus Government stocks will not be allowed to prejudice the re-establishment and development of the normal trade channels for producing and distributing similar goods; and the disposal of Government factories will be regulated so as to help towards the early restoration of employment.

In regard to the second danger, the White Paper insists on the need for public support for such measures as the continuance of rationing and a measure of price control; but it is emphasized that there is no intention of maintaining war-time restrictions for restriction's sake. Some controls there must be; the habit of saving must still be encouraged, though, as Lieut.-Colonel K. E. Edgeworth points out in his book, "Unemployment Can Be Cured" (see p. 40 of this issue), the vital question is how much saving: over-saving can create unemployment. There must be discipline and imagination in peace no less than in war, and nothing will so speedily ensure that the peace is lost as the same craving for indulgence in an easy peace that we yielded to in 1918–20. Again, to avert the third danger it will be necessary to establish certain broad priorities, and to enforce them for a time by means of the issue of licences, the allocation of raw materials and a measure of control over the labour and staff required for industry.

The reasons for all these measures are well put in the White Paper, and this is equally true of the second field, namely, those concerned with the expansion of our external trade, by the creation, through collaboration with other nations, of the conditions of international trade which will make it possible for all countries to pursue policies of full employment to their mutual advantage. Here again the White Paper emphasizes that it is with industry that the responsibility and initiative must rest for making the most of opportunities to recover export markets and to find fresh outlets for products. While this is true, there is a slight tendency to discount the full measure of Government responsibility for securing the conditions in which such expansion can best be promoted, and a like comment might be made on the White Paper's observations on the promotion of industrial efficiency. There is a disposition to regard recent taxation concessions in regard to research and obsolescence as a sufficient contribution; more may well be expected of the Government in this respect than is indicated. The promotion of industrial efficiency is a matter of paramount importance that must be kept under constant review, and further measures will almost certainly be required.

A whole chapter of the White Paper is devoted to the fourth series of measures, namely, those designed to secure the balanced distribution of industry and labour; and this has already been the subject of a debate in the House of Commons, in which attention was once again directed to the Barlow Report. Dealing first with the problems of local unemployment as presented in the 'distressed' or 'special' areas, Mr. Dalton, president of the Board of Trade, said that it is proposed to discontinue the use of these terms; these areas will in future be known as 'development areas'. The Government proposes to attack these problems in three ways: first, by so influencing the location of new enterprises as to diversify the industrial composition of areas which are particularly vulnerable to unemployment; secondly, by removing obstacles to the transfer of workers from one area to another, and from one occupation to another; and thirdly, by providing training facilities to fit workers from declining industries for jobs in expanding industries.

Mr. Dalton's speech showed that the Government's policy for the location of industry goes a good deal further than is indicated in the White Paper itself. Mr. Dalton stated that the Government has now explicitly accepted the two main ideas of the Barlow Report, namely, the spreading out of the very congested areas over wider areas, and the encouragement of a reasonable balance of industrial development as between the various regions in Great Britain and the suitable diversification of industry within each region. Mr. Dalton was at pains to point out that the Government is already in possession of powers to enable it to exercise a substantial influence over the location of new industrial development, both to prohibit the establishment of a new factory in a district where serious disadvantage would arise from further industrial development, and to steer new factory development into areas which call most urgently for further industrial diversification. It is clear, however, from the debate, that Mr. Dalton was unable to convince the House of Commons that the Government is in earnest in this matter, or that without new powers, it is able to implement the policy disclosed even in the White Paper.

Sufficient reason for such scepticism may well be found in the simple fact that the fundamental recommendation of the Barlow Report—the establishment of a central planning authority, whether advisory as recommended by the majority, or executive as recommended by the minority—is ignored. Mr. Dalton, in indicating his support of the minority proposal, suggested that the required department exists in the Ministry of Town and Country Planning. This

suggestion will satisfy no one who appreciates the importance of a definite policy for the utilization of the land. The location of industry cannot be guided without planning the use of land. The Ministry of Town and Country Planning is neither equipped nor authorized to carry out the function of the central planning authority visualized unanimously by the Barlow Commission as extending far beyond the powers of any Government department then existing, and extending to "continued and further redevelopment of congested urban areas where necessary; decentralization or dispersal, both of industries and industrial population, from such areas; and encouragement of a reasonable balance of industrial development—coupled with appropriate diversification of industry in each division or region throughout the country". The Ministry, it should be remembered, represents not an accretion of new departmental power, but an aggregation of powers and functions from existing departments, and we need look no further than to the history of the Butlin proposal to establish a holiday camp on the Lleyn peninsula for an apt illustration of the limitations of its present powers.

The same chapter of the White Paper covers a further method which the Government also intends to use. The mobility of labour is an important factor both in reducing the dislocation which arises from changes in technique and fluctuations in market conditions, and also in ensuring that the expansion of new industries under the stimulus of a high level of demand is not hampered by a shortage of skilled labour. Such mobility is an essential feature of a full employment policy, but it by no means involves of necessity the large-scale transfer of population, and it seems clear from the White Paper and from the debate that such transference is not contemplated by the Government. Some geographical flexibility and mobility there must be, but much more important is mobility of skill, and the readiness and capacity to transfer from one occupation to another. That was the point on which Mr. G. H. D. Cole insisted in his Mather Lecture to the Textile Institute, and the acquisition of at any rate two kinds of skills should be an objective in the policy of technical education which, in view of its bearing on industrial efficiency, must be a counterpart to any employment policy.

These five methods directly concern many scientific workers. The remaining five, though more of indirect interest, may well prove even more important in ensuring the success of an employment policy. Put briefly, they may be described as the stabilization of private investment, public works, the maintenance of consumer purchasing power, the stabilization of prices and wages, and the discouragement of restrictive practices. In regard to the maintenance of total expenditure the White Paper sets forth as the guiding principles of the Government's policy, first an increase in exports; secondly, the limitation, so far as possible, of dangerous savings in expenditure on private investment; thirdly, the careful planning of public investment both in timing and in volume to offset unavoidable fluctuations in private investment; and lastly, readiness to check and reverse the decline in expenditure on consumers' goods which normally follows as a secondary reaction to a decline in private investment.

One scheme contemplated by the Government when the abnormal conditions of the immediate post-war years have disappeared is for varying social insurance contributions in accordance with a forecast of the average level of unemployment, the rate of contribution actually levied increasing when unemployment falls below the estimated average level and decreasing when unemployment exceeds that level.

In regard to restrictive practices, the White Paper contains warnings both to employers and to workers. An undue increase in prices due to causes other than increased wages might frustrate action taken by the Government to maintain employment; for example, if additional money made available by the Government to maintain employment were absorbed in increased profit margins through the formation of a ring by the manufacturers in a particular industry for the purpose of raising prices, and no increase in employment resulted. Trade union practices and customs may equally constitute a serious impediment to an expansionist economy and so defeat the object of a full employment programme; and they, too, must be examined by workers themselves. There is a note struck here which professional associations of scientific workers will do well to heed, for no professional association long remains altogether free from a restrictionist outlook, which may be at issue with the public interest. Nothing is healthier in the White Paper than this appeal to put the public interest before sectional interest or advantage, and to tolerate no arrangements which obstruct or impede public policy. It is on the response to this appeal that we may best found our hopes of the success of an employment policy.

Critics have already pointed out that the policy outlined in the White Paper is not, except perhaps so far as the transition period from war to peace is concerned, a policy of full employment. It does not propose positive steps to provide jobs at all times for all workers by ensuring that the real needs of the people for housing, health, education and good living are met continuously, to the exclusion, if need be, of demands for less essential things. Much will depend on the other measures in the Government's reconstruction programme, notably on the social security proposals and those for dealing with the use of the land, and the problems of compensation and betterment considered by the Uthwatt Committee.

None the less, the welcome given to the Government's proposal in the three-day debate in the House of Commons to create an economic general staff is a sign of a new approach to the problem of employment and of a realization of the importance of a factual basis for policy. The criticism launched at the White Paper in the debate should dispel any false ideas or extravagant hopes: the means by which rising wages are to be linked with increased productivity are yet to be delineated. The emphasis was placed on the promotion of industrial efficiency, and Sir John Anderson stressed the need for

developing a new technique of control to cover both privately and publicly owned industry.

The White Paper thus outlines a policy which merits the serious attention not merely of the specialist but also of the ordinary citizen, as a further step towards a scientific approach to some of our major economic problems. But no measures put into operation to implement that policy will have their full effect without the co-operation and intelligent support of the whole community. This can come only through full debate and discussion, whereby the country can be fully educated as to the magnitude of the issues and the extent to which co-operation and acceptance of restraints may be required of every individual.

## SCIENCE AND BROADCASTING

### Reshaping Man's Heritage

Biology in the Service of Man. By J. S. Huxley, H. G. Wells, J. B. S. Haldane, W. G. Ogg, J. C. Drummond and W. F. Crick, J. W. Munro and J. Fisher, W. H. Kauntze, L. J. Witts, Major P. G. Edge, J. M. Mackintosh, Sir E. V. Appleton. Pp. 96+7 plates. (London: George Allen and Unwin, Ltd., 1944.) 5*s*. net.

"RESHAPING MAN'S HERITAGE" comprises a series of talks which were broadcast round the theme that, by the use of science, man is achieving greater freedom as well as surer control of his heritage. The series was introduced by H. G. Wells, who spoke about man's accomplishments, opportunities and pitfalls. The other contributors are specified under the title-heading above and their talks included such subjects as man's food, the good earth, reshaping plants and animals, the conquest of the germ, the banishment of pain, and preventive medicine.

Of the talks themselves little need be said. The subjects were chosen carefully, the whole group was well co-ordinated, and the names of the distinguished persons who gave the talks lent sufficient appeal to attract the mass of listeners for whom they were intended. Further, the language used by the speakers was sufficiently clear and non-technical to make the presentation one that should not have taxed any listener unversed in science.

Yet this group of broadcasts raises a problem which will need close attention by men of science. The present writer was privileged to arrange the series as material for an army listening group. The men and women who attended were mostly of a fair standard of education and intelligence, and, although their knowledge of science was limited, attended the broadcasts voluntarily. What were their reactions? It cannot be said that the interest of the Service men and women was aroused to any extent or that they were highly stimulated. In the main the talks were borne patiently, and little animation developed. It was difficult to find out why the majority of talks did not attract, but experience with other army groups may help to throw some light on the matter.

Since the War-Time Army Education Scheme was introduced in 1940, many thousands of talks and lectures have been given to troops on all kinds of 'educational' topics. Those which have been outstandingly successful have been derived from personal experiences of the speaker—travel, exploration, particular employment, etc. (The talk in this series on the control of rats reminds one of the broadcast some months ago by a Cockney rat-catcher on how to trap rats. His methods may not necessarily have been the most successful ones, but troops are still discussing the talk.) Talks which have met with least response have been those which the audiences consider to be academic and detached from their lives. Here lies the crux of the problem.

If we wish to interest the masses in the impact of science on society—we assume that the person who arranged this series of elementary talks wished to interest as many listeners as possible—we must first recognize that the ordinary man and woman only too often regard science as academic and aloof, and are not infrequently a little afraid of it. It is essential, therefore, when planning a programme of popular science talks, to ensure that the subjects chosen fall within the daily interest of the listener. On this score alone, the series under discussion could have been little improved upon. The fault, if fault there be, lay with the presentation.

The time is long overdue when men of science, among others, began to learn of the effect which their discoveries have made, and are making, on the masses of the people. One shilling will produce a comfortable seat 'at the pictures' where education can be absorbed pleasantly and without physical and mental exertion. A third of a shilling will produce a weekly journal where the many photographs are seductively displayed and unencumbered by much wearisome reading matter. These—and others—are the educative rods which inventive man has made for his own back.

How can these opiate effects be combated? It is not enough merely to say that we must raise the standard of films or give John Citizen more information on how or what to read. We must also use the weapons available now and help John Citizen to want to raise the standards himself. Broadcasting is one of the tools. But we must attend to presentation. In this connexion we may take a hint from the Schools Broadcasting Department. When a particular broadcast is being prepared, as much time is given to the way in which a topic is to be 'put over' as to the subject-matter itself. Straight talks, even of fifteen minutes duration, are seldom given. The appeal of different voices has been recognized and the question-answer or discussion method between two or more people is frequently used. (Of the twelve broadcasts under the heading of "Reshaping Man's Heritage", ten were straight talks; two consisted of dialogue conversation.) Again, when a straight talk is given, much more attention is paid to the speaker's degree of 'mike-worthiness' than is the case with the Adults Talks Department of the B.B.C. That a man or woman is an authority on a particular subject is not enough to make him a good broadcaster. He should have a microphone manner which will appeal to the largest body of listeners and make them want to listen again to the broadcast of a related subject. With the exception of two, and possibly three, of the speakers in "Reshaping Man's Heritage", how many succeeded in making the listeners anxious to obtain further information about these all-important issues?

It may rightly be argued that there are few men—and less women—who are expert in a particular field and yet naturally have a microphone personality which is acceptable to the majority of listeners.

It is a remarkable fact that the number of first-rate broadcasters on any special subject number less than half a dozen. How, then, can science topics be presented to make the appeal which they inherently possess for the bulk of the population?

One of the answers lies in the greater use of feature programmes. Script-writers of the calibre of Louis MacNiece would have made any of the topics of "Reshaping Man's Heritage" so attractive that many more listeners would have been attracted. It is not suggested that straight talks be eliminated from broadcasting. Great names are themselves an attraction and many people listen at first not for the subject-matter but because Dr. So-and-So is broadcasting. But when Dr. So-and-So is the authority on a particular subject which lends itself to broadcasting and he is not suitable either in manner or personality to make the subject attractive over the microphone—this was even more evident in the recent series "Science at Your Service" than in "Reshaping Man's Heritage"—he might well be asked to prepare a script which could be presented in 'feature' form by skilled broadcasters. To soften criticism on this point, perhaps it is worth mentioning that the B.B.C. has a maxim, developed from experience, that to make a broadcast sound natural it must be 'staged'. Examples of this are constantly being referred to by W. E. Williams in his sagacious column called "The Spoken Word" which appears each week in *The Listener*.

This brings the discussion to its focus. The B.B.C. should have on its directing staff a man of science of the standing of the co-ordinator of "Reshaping Man's Heritage". He should be instructed to develop the place of science in broadcasting and to use the necessary discrimination in the selection—and rejection—of speakers. He should be given a staff whose duty it would be to investigate the various methods of making scientific broadcasts attractive.

In conclusion, it should be said that "Reshaping Man's Heritage" makes good reading for the elementary student wishing to extend his knowledge of the application of biological research to human welfare.

T. H. HAWKINS.

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# CONTROL OF UNEMPLOYMENT

## Unemployment Can Be Cured

By Lt.-Col. K. E. Edgeworth. Pp. 158. (Dublin: Eason and Son, Ltd.; London: Simpkin Marshall, Ltd., 1944.) 10*s*. 6*d*.

THE conclusions and suggestions put forward by Colonel Edgeworth in this book run closely parallel with the policy set out in the White Paper on Employment Policy. The four serious types of unemployment which Colonel Edgeworth considers need handling are all recognized in the official statement, and the measures he advocates find a place in the Government's policy.

First, for example, there is unemployment caused by fluctuations in the demand for industrial equipment and for buildings, to be remedied by a certain measure of national planning and control over the volume of output. This control, Colonel Edgeworth suggests, might be, as suggested in the White Paper, in part voluntary, assisted and supplemented by an appropriate control of Government expenditure. Secondly, there is unemployment caused by the decline of existing industries owing to the development of new industries of greater technical efficiency. For this the remedy is to facilitate the transfer of the displaced workers to other occupations, the scheme including the cost of training and the payment of wages or part wages during the period of transition. Co-ordination of such transference with plans for the development of housing and for the expansion and location of new industries would also be required.

Thirdly, unemployment is caused by the decline in purchasing power which arises from over-saving. This is the distinctive feature of Colonel Edgeworth's book, where the influence of this factor is worked out in considerable detail and with some approximation to quantitative computation. Fourthly, unemployment is caused, especially in the smaller countries, by the competition of larger and more efficient industries abroad. Apart from this, Colonel Edgeworth just touches on the question of agriculture, to which the White Paper makes only passing reference. Schemes for sustaining agricultural prices by increasing the bargaining power of the farmer in marketing his surplus, national schemes for storing the surplus output of exceptionally good years, and some international planning in respect of international purchases of agricultural products, are among the measures he advocates for securing a healthy and well-balanced agriculture.

Colonel Edgeworth's analysis leads him to conclude that individual saving should not exceed 3 per cent of the national income, and that it can be kept down to this figure by a suitable system of taxation and death duties. Business saving tends to increase with undesirable rapidity when trade expands, and acts as a brake on expansion, preventing the attainment of full employment. To provide the remedy of passing on to the consumer, in the form of reduced prices, the reduced costs which are associated with expanding output, he suggests that the boards of management of all large business enterprises should include representatives of workers and consumers to see that this principle is observed. The volume of Government saving should be determined by the opportunities for utilizing the money in an investment worth while, and if other means of controlling the surplus saving prove inadequate, he suggests that the Government should borrow the surplus savings and expend them on social services, rather than on public works. This is in effect what the White Paper suggests in the differential scheme of contributions to social insurance.

With regard to international trade, Colonel Edgeworth suggests a combination of moderate tariffs with a system of price control through the control of wages and associated with the control of profits. Here he appears to go somewhat beyond the measures the Government is at present prepared to contemplate; but he recognizes that the smooth working of any such scheme will depend very largely on how far each country is prepared to accept the principle that a properly adjusted system of international trade is to everybody's advantage, and that it can only be secured by mutual co-operation.

There can be no question as to the value of Colonel Edgeworth's little book as a stimulant to public interest in these problems and as an indirect comment on Government policy as outlined in the White Paper. It should provoke further discussion on the causes of unemployment and assist to clarify the issues, whether or not the remedies he suggests be regarded as appropriate.

# THE GALACTIC SYSTEM*

By SIR JAMES JEANS, O.M., F.R.S.

THERE is a promontory on Mount Wilson from which the visitor to the Observatory can look down at night and see the lights of Pasadena and Los Angeles on the plain 7,000 ft. below. He cannot distinguish individual lights, but sees two patches of luminosity which indicate the outlines of the cities and the distribution of density—if not of population, at least of the street-lights. It is so easy to study this distribution from up here, and so difficult from inside the cities, where one cannot see the forest for the trees.

This is, of course, an astronomical parable. In the night sky we see a number of distinct stars, and also a far greater number which are merged into the continuous band of light we call the Milky Way. These together constitute the galactic system—the city of stars in which we reside. But far out beyond this we see objects of another kind—the extra-galactic nebulæ—which we believe to be other cities of stars, external to our own.

It is easy to study the distribution of light, and so of stars, in these external galaxies; we need only take a photograph or, better, photometric measurements, and the thing is done. But our own galaxy presents problems of an entirely higher order of difficulty.

If the stars were distributed uniformly through infinite space, the number in a sphere of any size would, of course, be proportional to the cube of the radius of the sphere, and this would lead to the simple law that vision down to stars of one magnitude fainter would increase the number of stars which could be seen fourfold. If the uniform distribution of the stars fell off after a certain distance, this distance would be revealed by the failure of this law. Using this method, the two Herschels studied the distribution of the stars in space, and were led to picture the galactic system of stars as a flat disk, the plane of the Milky Way being, of course, the plane of the disk. This plane is observed to divide our sky into exactly equal halves, and the sky looks about equally bright in all directions in it; whence the Herschels concluded that we are close to the centre of the disk.

At a later date, the globular clusters seemed to tell a different story. These are compact clusters of millions of stars, all being very similar in appearance. So far back as 1911, A. R. Hinks had noticed that they all lie in one half of the sky. A detailed study by Shapley confirmed this—nearly all lie within a range of 130° of galactic longitude. Cepheid variables abound in the clusters, so that their distances are easily measured, and Shapley could map out the distribution of the clusters in space. He found that all except one—possibly a stray—lie in or near a circle of about 100,000 light-years radius, in the galactic plane. But the sun is not at or near the centre of this circle; it is about 40,000 light-years distant. It was natural to think that the boundary of this system of clusters must mark out the limits of the galaxy, but it seemed strange at the time that this did not coincide with the boundary of the visible stars.

The discovery that space is filled with obscuring matter has now removed this difficulty, and brought all the elements of the problem into harmony. Observation shows that this obscuring matter makes a fog of which the density varies greatly in the different parts of space. As might be expected, it is densest in the galactic plane; here a beam of light is halved in intensity after traversing about 3,000 light-years of distance. Thus the range of visibility in the fog is not a very great number of thousands of light-years. The Herschels, and many after them, who did not know of the fog, mistook the range of visibility in the fog for the radius of the galaxy. This is why we seemed to live at the centre of things; for in a fog, we each have our own sphere of vision, of which we are always at the centre.

The figure just mentioned shows that the fog reduces light to a ten-thousandth part of its original intensity in travelling from the centre of the galactic system to the sun. Thus individual stars near this centre are invisible to us, and we see less than a half of the whole system of stars. For the same reason, we cannot see external objects which lie in or near the galactic plane; there is too much obscuring matter between them and us for their light to get through.

If the fog were much denser than it actually is, we should see only the stars in our immediate proximity, and a few of exceptional brightness beyond. If we were unaware of the fog, we should conclude that there is an excessive concentration of stars in our immediate proximity. Astronomers made exactly this mistake for a time, thinking that we lived in the midst of a 'local cluster' of exceptionally bright stars. Now that we know of the fog, we can allow for its effects and, for any assumed density of fog, can calculate the arrangement of stars which will exactly fit the observations. If we underestimate the fog, we shall obtain a 'local cluster'; while if we over-estimate the fog, we shall get the opposite result, namely, that stars are exceptionally few in our neighbourhood, so that we are living in a 'hole'. Actually both results have been obtained in recent years by different investigators, but the simplest interpretation of their results is, I think, that they have respectively underestimated and over-estimated the density of fog. There are rather strong reasons for thinking that there can be neither a 'local cluster' nor a 'local hole'—these are, in brief, that the whole galactic system is rotating with different speeds in different parts, so that both clusters and holes would soon be smoothed out. Thus the most likely value for the coefficient of absorption by the fog would seem to be that which just gets rid of the 'local cluster' without replacing it by a 'local hole', and this is about equal to the value mentioned above.

For a long time it was something of a puzzle to understand why a disk-shaped group of stars such as our galaxy should not all fall together at its centre of gravity, and it has often been suggested that our galaxy must be in rotation, as many of the external galaxies are known to be. In 1913 Poincaré calculated that our galaxy could be saved from this fate if it rotated about once every 500 million years. In the same year, Charlier found that the invariable plane of the solar system appeared to be moving against the background of the stars. Now the solar system keeps its invariable plane always fixed in the same direction, just as a spinning gyrostat does, so that, as Eddington immediately pointed out, the apparent motion found by Charlier could only mean that the background of stars was not at rest but was itself in

* Abstract of a Royal Institution discourse delivered on April 28.

motion. Such a movement of the background is now one of the well-established facts of astronomy.

A superficial study of the nearer stars suggests that they are moving at random, with differing speeds and in different directions. But a careful statistical investigation reveals law and order in the motions, not of individual stars but of statistical groups. The motion is best described by the statement that each group of stars (sufficient in number to justify statistical treatment, but also comprised within a sufficiently small volume of space) is describing an orbit about a centre. This centre is the same for all groups, and coincides exactly with the centre of the galaxy, as determined by Shapley from the arrangement of the globular clusters. Those groups which are farthest from the centre move most slowly, just as, in the solar system, those planets which are farthest from the sun move most slowly. The reason is, of course, that each star describes an orbit under the gravitational force of the rest of the stars, just as each planet describes an orbit under the gravitational force of the rest of the solar system.

Detailed statistical study of the stars near the sun shows that, on the average, the orbital speed of a star falls off by 1 km. a second for every 200 light-years increase of distance from the centre of the galaxy. This single datum, which is quite well determined, shows that the sun must take about 250 million years to perform its journey round the centre of the galaxy. Thus it must have completed some ten or a dozen orbits since the earth was born. If the sun is at a distance of 40,000 light-years from the centre of the galaxy, then it must describe its orbit at a speed of about 300 km. a second, a conclusion which agrees well enough with independent estimates made by spectroscopic measurements of the speed of the sun relative to the external galaxies and remote globular clusters.

The various data which have just been mentioned provide the means for weighing the mass which keeps the sun in its orbit, and so the galaxy as a whole. Estimates vary from 110,000 million to 180,000 million times the mass of the sun, so that it seems safe to say that the galaxy contains hundreds of thousands of millions of stars, although the majority are rendered invisible by the thick layer of fog which lies between them and us. It used to be thought that our galaxy was more massive than the others we see in the sky, but this no longer appears to be the case. We are familiar with groups of stars which are held together by their mutual gravitational attractions—the globular clusters provide an instance. There are also clusters of nebulæ which are held together in the same way. It is possible to determine the speeds of motion of the individual nebulæ of a cluster, and so deduce the gravitational forces needed to hold the cluster together. In this way, the average galaxy is found to have a mass of the order of from 100,000 million to 200,000 million suns. Thus there can be no doubt that the external galaxies are at least comparable with our own galaxy in mass.

Finally, it used to be thought that the external galaxies are substantially smaller than our own in size, but it has recently emerged that this too is fallacious. We only see a small part of a galaxy when we study its apparent size on a photographic plate; there is a much larger part beyond, which can only be detected by delicate photometric measurements. When we take this into account, the galaxies still show considerable differences in size, but the majority of the larger prove to be comparable with our own. On the whole, then, our galaxy is simply one of many similar galaxies. Probably about four million such can be seen photographically in the great Mt. Wilson telescope. If we allot 100,000 million stars to each, this makes a total of about $4 \times 10^{17}$ stars—a large number, although still small in comparison with the number of molecules in a cubic centimetre of ordinary air.

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# REGIONAL PLANT ECOLOGY IN THE UNITED STATES

By DR. V. J. CHAPMAN
Botany School, Cambridge

THE last four years has seen the publication, by J. H. Davis, of three important papers on the vegetation of Southern Florida*. These three valuable papers yield a clear picture of the vegetation and its interrelations with soil types, climate and physiography. The area is especially interesting because climax vegetation is normally related to the climate, but Davis establishes a good case in this area for relating it primarily to the physiography. If the author continues these studies—as one sincerely hopes he will—the vegetation of Southern Florida will be known and understood in very considerable detail. This will be no mean feat for an area of such size. The majority of ecological studies usually refer to relatively restricted areas, and it is refreshing to find a study that embraces such a large region. A broad survey with accompanying detailed studies opens up major problems that would not be so evident in a study of a small area.

In the first paper, on the mangrove vegetation, Davis points out that they are primarily edaphic forests, a conclusion with which I agree, though I would add that there is also a physiographic element involved. Tropical forest of the 'hammock' type is regarded as the climax vegetation, though in the third paper it is also, albeit incorrectly, implied that mangroves represent a climax type. There is no evidence of a transition to brackish or freshwater marsh such as may be found in Jamaica. Davis studied the environmental factors in some detail and he shows that the mangrove species possess a wide tolerance of salinity and grow on at least four types of soil, one of which is a marine peat. I have arrived at similar conclusions from work in Jamaica. Davis relates the mangrove zonation to the height of the surface water, but here one feels that more evidence would be desirable. Some exceedingly interesting information is provided about dispersal. 10,000 Rhizophora seedlings are estimated to float towards the Tortugas every year; this represents only a proportion of the total crop because about 50 per cent of the seedlings from a tree remain embedded in the mud beneath it. The rate of survival at the end of one year is 50 per cent for Rhizophora, 30 per cent for Avicennia and 20 per cent for Laguncularia.

One of the important features of these three papers is the great use made of aerial photography in the study of the communities and the preparation of the

* Davis, J. H., "The Ecology and Geologic Rôles of Mangroves in Florida", Carn. Inst. Wash. Pub., 517 (1940); "The Ecology of the Vegetation and Topography of the Sand Keys of Florida", Carn. Inst. Wash. Pub. 524 (1942); The Natural Features of Southern Florida", State of Florida Dept. of Conservation, Bull. 25 (1943).

vegetation maps. At the present time vast quantities of air photographs of Europe, Africa and elsewhere must be accumulating, and it is to be hoped that they will become available to ecologists, who will then be in a position to study vegetation on a scale comparable to that of Davis.

The second paper, on the sand keys of Florida, is of particular interest because it adds a new set of vegetation maps to the series started by Millspaugh in 1907 and continued by Bowman in 1917. Changes in the vegetation of these keys over a period of thirty-seven years can therefore be studied. The Marquesas, like Jamaica, have few or no living corals, whereas living corals abound in the Tortugas. This is a peculiar feature of the Caribbean and one which greatly needs investigation. Davis concludes that marine currents are the main agents in the formation of these keys; but it is clear also that hurricanes have had a profound influence in the past upon their structure and also their vegetation. Two types of vegetation are recognized, the sea-strand and the mangrove swamp. The use of habitat is employed in the ecological nomenclature. This has been discouraged by most ecologists working in temperate climates, but tropical vegetation, and especially that of maritime regions, appears to have problems of its own. It may eventually prove desirable in such cases to employ a habitat nomenclature. I encountered a similar difficulty in Jamaica. The number of species recorded by Davis is not large; but this is typical of small islands of this type. The climates of the island groups vary sufficiently for the biological life-form spectra to show significant differences. The Schimperian view of 'physiological dryness' is adopted for the mangrove habitat; but the evidence available to-day scarcely supports such an interpretation.

The third paper covers the whole of Southern Florida, and all the various features are considered with a view to future regional utilization and planning. Aeroplanes, cars, special tractors and 'airboats' enabled the author to visit many areas that were previously almost inaccessible. Much of the region is, of course, covered by the famous Everglades. 'Glades' are grasslands flanked by forests, the 'ever' being added to signify that they remain green throughout the year. Much of the Everglades is dominated by the saw-grass, *Mariscus jamaicensis*, but there are also prairies, sloughs and 'hammocks'. These swamps originated as a result of regular seasonal flooding. The 'dismal' swamps with pine and cypress do not form part of the glades. The whole area can be regarded as a huge alkaline peat-bog, in many ways comparable to what the British Fens must have looked like in the past. Vast deposits of peat are here being formed under subtropical conditions. Unfortunately the natural water conditions have been upset and this is bringing about changes in the organic soils and the vegetation. The area is becoming drier and saw-grass is being replaced by bushes (= carr stage of Wicken Fen). The annual transpiration and evaporation from the saw-grass area is often more than the annual rainfall, and hence the water relations are closely bound up with those of Lake Okeechobee. Less water now flows out from this lake than formerly, and this is the main factor responsible for the present changes. Piles of marine shells found inland indicate past ease of travel by innumerable waterways many of which have now silted up. There is evidently scope here for a combination of archæological and botanical research in a manner similar to that so successfully carried out by Godwin and his co-workers in Great Britain.

Ten physiographic regions are recognized for Southern Florida and at least three old shore lines. The sands left by these seas form the main shallow sand soils in which little or no profile has developed. Beneath the Everglades there is an impervious marl layer, and Davis believes that these swamps would never have arisen were it not for this marl layer which effectively impedes drainage. If this is true, then the Everglades are related neither to the present climate nor to existing physiography but to past geological changes. Although twenty soil types are recognized, peats and marls are the outstanding features of this region. The soils are generally shallow and they have been much reduced by fires, which form an important determining factor of the environment. A detailed correlation is made between the different vegetation communities, individual species and the soil types.

A study of the water relations showed that the ratio, time water-logged to time dry, is the most important factor. Because of the low relief a few inches change in elevation makes a profound difference in the drainage relations.

Nine main types of vegetation are recognized and fifteen types are represented on the vegetation map. There is a very high proportion of woody plants, and Davis concludes that at least one half of the area is economically unprofitable and best left in the wild state. The characteristic 'hammock' forests represent the climax vegetation in Southern Florida. These possess a great diversity of plants, many of the species being tropical. If the fire danger were controlled these forests would be larger, while even at present their arrangement provides an indication of the drainage relations. Davis also considers that the cypresses (Taxodium) will not invade an area where water is continually standing on the surface because the seedlings require atmospheric oxygen.

These three papers contain many more valuable observations, but sufficient has been said to indicate their scope and importance.

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# BIOLOGY IN WAR-TIME CHINA*

By Dr. PEI-SUNG TANG

Director of the Tsing Hua University Physiological Laboratory

THIS article will be of the nature of a report on the movements of biological institutions during the War and the activities of biologists associated with those institutions. No attempt will be made to survey the entire field of biology in war-time China, or to evaluate the work at present being done by Chinese biologists.

During the decade immediately preceding the War, there were several centres of biological investigation in China from which came a steady output of research. There were, for example, the physiologists at the Peiping Union Medical College, gathered round Robert K. S. Lim†, who virtually founded the science of physiology in China; the biochemists, whom H. Wu brought together in the same College; the Fan

* Condensed version.

† The Romanized names of the biologists mentioned in this article are those used by the authors in their publications.

Memorial Institute of Biology, where H. H. Hu and C. Ping established their School of Systematic Biology; and the Biological Institutes of Academia Sinica and of the Peiping Academy. The extent to which the work of these Institutes has been affected by the War differs greatly in individual cases.

The group led by Robert Lim included such men as H. C. Chang, known for his work on acetylcholine, and T. P. Feng, a pupil of Prof. A. V. Hill, whose review of muscle-nerve physiology appeared in the *Ergebnisse der Physiologie* shortly before the outbreak of war. Around this group was built the Chinese Physiological Society, and to it goes the credit of publishing the *Chinese Journal of Physiology*, perhaps the Chinese journal best known abroad. When war broke out in 1937, Lim was away in Malaya; but he returned to China and offered his services to the Government. In the winter of 1937, shortly before the fall of Nanking, he had but a handful of helpers. From that small start his Medical Relief Corps grew in three years to a sizeable army numbering thousands. This body rendered invaluable service to the fighting troops, not only in China but also in the Burma campaign, for which services Lim was decorated, by both the British and the United States Governments.

Lim is still with the Chinese Expeditionary Forces, serving in the capacity of medical supervisor, but he has now the added responsibility of establishing an Institute of Experimental Medicine for Academia Sinica. Of his former colleagues in Peiping, T. P. Feng has just arrived in Chungking and is temporarily attached to the Shanghai Medical College.

To the best of my knowledge, of the biochemists in H. Wu's department only C. Y. Chang, who is now attached to the Chung Cheng Medical College in Kiangsi, has as yet reached Free China. He was called to that College by Iping Chao, formerly of Tsing Hua University. With them is T. H. Chang, a nerve physiologist, formerly with the Biological Institute of the Science Society of China.

Of the original staff of the Fan Memorial Institute of Biology in Peiping, only its director, H. H. Hu, has reached the interior; this was shortly before the attack on Pearl Harbour. The work of the Institute is now carried out in part by the members of the Yunnan Institute of Economic Botany, established in the early part of the War as a result of Hu's far-sightedness. The Institute continues the survey work started by the Fan Memorial Institute some years ago, paying particular attention to the economic possibilities of plants endemic in the south-western provinces. Also located in Yunnan is the former Botanic Garden of Lushan, directed by the fern specialist, J. C. Ching. Part of the Fan Memorial Institute has moved to Chung Cheng University, in Kiangsi, of which Hu was president for several years.

Shortly after the fall of Nanking, the Biological Institute of the Science Society of China moved from Shanghai to the interior. The director, T. H. Chien, a veteran botanist held in affection by all, suffered great hardship on the long journey from the coast to the interior; but, undaunted, succeeded in moving practically all the equipment and a library of that Institute to a town not far from Chungking, where with a group of faithful colleagues he continues his work on systematic botany. Situated in the same town is the Institute of Zoology and Botany of Academia Sinica, which moved to the interior with its personnel and equipment almost intact during the early years of the War. H. W. Wu, C. C. Wang, C. C. Jao, Sicien Chen, C. C. Teng and others are carrying out research work on freshwater biology, entomology, parasitology, mycology and plant pathology.

Formerly there were four Institutes of Biological Studies in the Peiping Academy, namely the Zoological, Botanical, Physiological and Pharmacological Institutes. Of these the first three moved to Yunnan at the beginning of the War, and the last was left in Shanghai. On the death of Ting-heng Lou, the Zoological Institute was combined with the Physiological Institute, under the direction of Li-ping King. King himself is working on the pharmacology of Chinese herb medicine, while Tchang-si of the same department is conducting extensive surveys of the fishes of Yunnan from the point of view of their economic possibilities. Liou Tchenngo of the Botanical Institute has been making botanical surveys in the south-western parts of China. The director of the Pharmacological Institute, Tzan-Quo Chou, is still in Shanghai.

Also in Shanghai are two other well-known biologists who when last heard of were still engaged on their peace-time researches. One of these is C. Ping, the veteran zoologist who remained behind after the Biological Institute of the Science Society moved to the interior. The other is Tshou-su, who was provided with working facilities in his Institut de Biologie de Shanghai by the British Fund Committee.

C. Tsai has been the moving spirit behind the Medical School of the National Central University, which was transferred to Chengtu shortly after the War began. He has gathered around him a group of young men, including F. Y. Hsu and J. P. Chu, who are working mainly on the anti-hæmolytic action of lecithin and cholesterol. Tsai is now in the United States as one of six university professors invited by the State Department. With Tsai for a time were T. C. Tung and Mrs. Tung, who have now joined the national Tung Chi University in Szechuan and have been able to keep up their work on experimental embryology.

The National University of Chekiang moved to the interior shortly after the War began, first to Kiangsi, then to Kwangsi, and finally to Kweichow. Under the leadership of Sitsan Pai there has arisen one of the most active centres of biological research in war-time China. Apart from Pai, who published two articles on cytogenetics in the first issue of *Science Record*, the department has on its staff C. C. Tan, the geneticist, and T. L. Loo. Burg Tsai, formerly attached to the same department, is now director of the newly established Chinese Institute of Sericulture in the same province. This Institute was opened three years ago and is supported by the British Fund Committee.

The Institute of Psychology of Academia Sinica was moved to Kweilin during the first years of the War. It is situated in a picturesque town not far from the provincial capital, along with the Institutes of Physics and Geology of Academia Sinica. G. H. Wong, the director of the Institute, is continuing his work on physiological psychology, with tadpoles as experimental material. From the city of Kweilin comes news that Amos Kwangchin Penn has discovered in Kwangsi several species of plants which give fairly good yields of rubber and is exploring their industrial possibilities. Penn was formerly connected with the National Tsing Hua University, but

joined the National Kwangsi University after the fall of Hong Kong.

The work of the Physiological Laboratory of the National Wuhan University is in charge of Zangying Gaw, who works on cellular physiology, especially on the growth and metabolism of nitrogen-fixing bacteria. His work is partly supported by the Rockefeller Foundation.

At the National Southwest Associated University are to be found under one roof the National Tsing Hua University, the National University of Peking and the National Nankai University. Here four groups of biologists are engaged in research. In the Department of Biology of the University proper, Sesan Chen, the ecologist, works on the behaviour of ants. In the same Department, under the leadership of C. Y. Chang, head of the Department of Biology of the National University of Peking, a group of young men are working on physiological aspects of plant morphology. Mrs. Chang (*née* C. L. Tsui) is head of the Department of Biology at the nearby National Yunnan University, and continues her embryological studies with a group of young colleagues.

In the same University are the three divisions of the Tsing Hua University Institute of Agricultural Research. The Entomological Division is in charge of C. L. Liu. With him is C. J. Lu, formerly attached to the group of entomologists at Soochow University. Liu is particularly interested in the biological control of insect pests. A wealth of information on this subject has been accumulated and now awaits publication.

The second division of the Tsing Hua University Institute of Agriculture Research is the Division of Plant Pathology headed by the veteran mycologist F. L. Tai. With the able assistance of T. F. Yu, they are accumulating information on the fungi of Yunnan and on the breeding of disease-resistant varieties of crop plants.

My own department, the Physiological Laboratory of Tsing Hua University, is the third division of the Agricultural Institute. It was established in 1938 after the University had moved to Yunnan. It has been my good fortune to invite to my laboratory such able men as H. C. Ying, C. H. Lou, T. Shen and S. C. Pan. Although Ying is now officially on the staff of Peking University, Pan on the staff of the Department of Engineering and Shen in the Department of Biology, common interests and the convenience of sharing our limited resources have kept us together ever since their arrival at the laboratory. The Tsing Hua University Physiological Laboratory is dedicated to research in the broad field of general physiology, attacking certain fundamental physiological processes with the aid of physical and chemical procedures. Ying is engaged in plant hormone research and biochemical aspects of plant physiology. Lou is studying action potentials in plants and is interested in the problems of electro-physiology in general. Pan has been concerned with the industrial applications of micro-organisms, especially with the problem of alcoholic, acetic and lactic fermentations, while Shen's main interest is in the field of nutrition. My own work on cellular respiration still continues. For their work on the physiology of the silk-worm, several members of the laboratory were awarded the Ting Prize of Academia Sinica last year.

Interest in nutrition research is at present sweeping the country like wildfire, and a large number of biologists and biochemists are now engaged on work in this field. The reason for their enthusiasm is twofold. In the first place, existing conditions in the country necessitate the most economical management of our food resources; secondly, nutritional data are much needed for planning agricultural production in the general scheme of post-war reconstruction. Early in 1941 the National Bureau of Public Health called a conference on nutrition in Chungking which has resulted in the mapping out of a comprehensive programme of co-ordinated research in nutrition and food planning for the nation, to be carried out in collaboration with existing centres of investigation. Another result of the conference has been the formation of the Chinese Society of Nutrition, an organization devoted to the advancement of nutrition research in China.

Among the various institutions in which nutrition research is being carried out at the present time may be mentioned the Central University Medical College Department of Biochemistry, where Libin T. Cheng and his colleagues are determining the nutritive values of Chinese foods. At the National Szechuan University C. Y. Chen is doing similar work on certain food products commonly found on the market, such as soya bean flour and preserved eggs. Chen's work is published in his own journal, the *Nutrition Bulletin*, which came into being while he was at the National Peiping Agricultural College. At that time T. Y. Lo was his associate, but at present Lo is conducting a laboratory of his own at the National Chekiang University.

An Army Nutrition Institute has recently been set up at the Army Medical College in Kweichow, with H. Wan as director. The work of the Institute, as its title indicates, is chiefly concerned with nutrition problems in the Chinese Army. A number of publications have already come from that Institute in the form of bulletins and pamphlets, mainly for the benefit of army officers. At about the same time a nutrition laboratory was set up by the National Bureau of Public Health under C. F. Wang. The Institute is chiefly interested in Chinese diets and children's nutrition. As mentioned above, an important part of the work on nutrition at the Tsing Hua University Physiological Laboratory is directed by T. Shen, who has made extensive surveys on nutrition conditions in the Chinese Army and the diets of college students.

An outstanding event in war-time biology in China has been the arrival of Dr. Joseph Needham, of the Cambridge Biochemical Laboratory. Through his extensive visits to many of the centres of biological research he has brought new information and fresh ideas to Chinese workers. He has also helped materially in obtaining chemicals and apparatus, as well as microfilmed literature, through the British Council's Cultural Scientific Office in Chungking. To Dr. Needham and to Dr. John K. Fairbank, of the Office of the Cultural Attaché of the United States Embassy, biological workers in China are indebted for generous assistance.

Almost all the biological journals which were in circulation before the War have temporarily suspended publication because of insufficient facilities and economic pressure. The exceptions are *Sinensia* and the *Chinese Journal of Experimental Biology*, which are making a heroic struggle to appear, albeit irregularly. This accounts for the failure of other journals to reach our friends and libraries abroad. In place of these suspended journals, certain publications in foreign languages (mostly in English) have been brought out as a temporary measure.

These include the *Science Record* of Academia Sinica, which has a section on biology. In addition, there are the *Proceedings* of the Chengtu Branch of the Chinese Physiological Society and the *Biochemical Bulletin* of the Tsing Hua University Physiological Laboratory.

The impression created by this article will perhaps be that practical aspects of biological research predominate in present-day China. This is true to a large extent; but there are still a number of centres where a major part of the work is on academic aspects of biology. This is especially true of the Institute of Psychology of Academia Sinica, and to a certain extent of the Tsing Hua University Physiological Laboratory. The trend towards research of practical value is in fact unavoidable. In the first place the need of the country at the present is certainly on the practical side, and in the second place it is extremely difficult to carry out academic research of real importance under present conditions. Added to these reasons is the desire of every biologist to make himself useful to the country in its war effort. It is therefore not surprising to find biochemists, for example, putting their energy into such problems as army nutrition, the industrial possibilities of certain rubber-producing plants, vegetable oils and fermentation; while most of the systematic biologists have either turned their attention to agricultural problems or undertaken biological surveys of hitherto unexplored country.

# OBITUARIES

## Mr. Emil Hatschek

EMIL HATSCHEK, who died in London on June 4, at the age of seventy-five, carried out pioneer work in many branches of colloid science and did much to direct attention in England to this subject. In spite of the stimulus supplied by the classical researches of Thomas Graham, little was being done in this country on colloids when, in 1911, Hatschek started a systematic course of lectures on colloidal chemistry at the Sir John Cass Institute. This was, I believe, the first regular course on the subject to be given in England, and it continued until 1935, when Hatschek reached the age limit for retirement. From about 1910 until 1932 Hatschek was producing original papers, all marked by elegance and strong individuality, which appeared in various periodicals, including the *Proceedings of the Royal Society*, the *Transactions of the Faraday Society*, *Chemistry and Industry*, the *Biochemical Journal* and the *Transactions of the Institute of Mining and Metallurgy*, apart from the twenty-six or so that appeared in the *Kolloid-Zeitschrift*. These names do something to indicate the width of interest of his work. His services to colloid science were acknowledged when he was made the guest of honour at the Colloid Symposium at Ottawa in 1932, a distinction much appreciated by him. His contribution at Ottawa was a paper on "The Study of Gels by Physical Methods", a subject to which he had devoted much attention.

Hatschek was a Hungarian by birth, but his family migrated to Vienna when he was a child, and it was in that city that he studied at the famous Polytechnicum. Engineering, however, was his subject in those days, and it was as an engineer that he came to England in 1888, at the age of twenty. He became a naturalized British subject in 1900. He concerned himself professionally with matters of chemical engineering, especially filtration, in both England and America: problems that he met in this work first directed his attention to colloid science. About 1910 he retired from active professional work, although he still acted as consultant to certain undertakings, and, possessing private means, devoted most of his time to original experiment.

Hatschek's fancy took him into unusual fields, and in each he found matters of interest and importance. Two curious contributions of his were, one, on the changes in form of spherical segments of elastic gelatine, which on drying formed a gastrula reminiscent of the behaviour of living embryos, and, the other, on the growth of crystals in gels, which had a marked bearing on the growth of minerals. In particular, he showed that with gold the various forms that can be observed when crystals are formed in silica gel closely resemble the natural appearance of gold in quartz. His work on periodic precipitation bore on the banding observed in some natural minerals. He carried out many other elegant and unusual researches, but his greatest body of connected work was on various aspects of viscosity, especially on the anomalous viscosity of many classes of colloids. For this work his wide chemical knowledge, his clear-cut physical conceptions and his good general mathematical powers fitted him admirably. His co-axial cylinder viscometer for investigating the properties of colloidal solutions has been widely used.

In 1913 Hatschek published his "Introduction to the Physics and Chemistry of Colloids", which went into five editions. His "Laboratory Manual of Colloid Chemistry" also achieved wide popularity. In 1928 he produced his "Viscosity of Liquids", a standard work which was at once translated into German. He edited the "Foundations of Colloid Chemistry", a collection of classical papers, and wrote the articles on "Colloids" and "Viscosity" in the last edition of the "Encyclopaedia Britannica".

Hatschek was a man of very wide learning, with a fund of precise information on most matters. He had an excellent knowledge of botany, especially of field botany; he was well versed in the history and theory of music, and was a good pianist; in philology and general history he could hold his own in most companies; and he had a wide knowledge of the literature of England, France and Germany. He was a familiar figure at the Royal Institution and at the Faraday Society, in the government of which he played a prominent part for many years. In 1930 he became a member of the Savage Club, and was there almost daily to his death, acting in an oracular capacity. He never married and, in fact, all his attachments were intellectual rather than emotional. A powerful and original personality, his passing leaves a gap in British science.

E. N. DA C. ANDRADE.

## Dr. Burgess Barnett, M.B.E.

DR. BURGESS BARNETT, superintendent of the Rangoon Zoological Gardens since 1938, died on April 9 at Dooars, Bengal, at the age of fifty-six. He is perhaps best known for his work on the use of snake venom in the treatment of hæmorrhage and epilepsy, mainly carried out while holding the appointment of curator of reptiles of the Zoological Society of London during 1932–37.

He was the son of the late H. F. Barnett of Bescot

Hall, Walsall, and was educated at Marlborough College and St. Bartholomew's Hospital. After the completion of his medical training he took up practice in the Lobitos oilfields of Peru. When the War of 1914–18 broke out he returned to Great Britain and served as a captain R.A.M.C. in France and Macedonia. After the War he returned to Peru, where he continued his study of snakes and supplied many specimens to the London Zoological Society. His appointment as curator of reptiles enabled him to develop his main interest—the study of snake venom and its application in medical practice. His publications relate mostly to this subject, but he also wrote popular articles on natural history and chapters on herpetology.

In 1938 Barnett proceeded to Rangoon, where a new reptile house was being built, so that he could have the opportunity of establishing a snake farm for the collection of venom and making further studies on its medical applications.

During the present War he was awarded the M.B.E. for bravery in Burma, when, as principal medical officer of the Burma-China railway construction unit, he remained behind with refugees during the evacuation through the Chankan Pass, and gave them medical attention on a long march through uninhabited jungle country. E. HINDLE.

WE regret to announce the following deaths:

Mr. E. Bruce Ball, past-president and honorary life member of the Institution of Mechanical Engineers, and an honorary life member of the American Society of Mechanical Engineers, known for his work on hydraulic engineering, on June 17, aged seventy-one.

Prof. A. H. Reginald Buller, F.R.S., emeritus professor of botany in the University of Manitoba, on July 3, aged sixty-nine.

Prof. A. E. Conrady, formerly professor of optical design in the Imperial College of Science and Technology, on June 16, aged seventy-eight.

Dr. J. J. Lonsdale, organizing science master at the Sloane School, Chelsea, during 1914–33, an early worker on ionization by splashing, on June 12, aged seventy-one.

Sir Prafulla Chandra Ray, C.I.E., formerly senior professor of chemistry, University College of Science, Calcutta, on June 16, aged eighty-three.

Mr. George Steiger, formerly chief chemist of the U.S. Geological Survey, on April 18, aged seventy-four; and Dr. Roger C. Wells, who succeeded Mr. G. Steiger as chief chemist of the U.S. Geological Survey, on April 19, aged sixty-six.

# NEWS and VIEWS

## University of Reading: Chair of Agriculture

### Prof. R. Rae

PROF. ROBERT RAE, who has been professor of agriculture in the University of Reading for the past eleven years, has resigned from academic work on his appointment as agricultural attaché to the British Embassy at Washington. During his tenure of office at Reading, Prof. Rae has expended a large amount of time and energy on the expansion of the Department of Agriculture. This work has been highly appreciated by his colleagues and the many students with whom he has come in contact. The acquisition and development of the University Farm at Sonning-on-Thames was entirely due to his efforts. Before his appointment to Reading, Prof. Rae was professor of agriculture in Queen's University, Belfast, and previous to this he had teaching experience at the East Anglian Institute of Agriculture and the Hertfordshire Farm Institute. Many of his friends regret his departure from the sphere of agricultural education. Since the beginning of the War Prof. Rae has served on several agricultural committees connected with greater food production. More than a year ago he went on a lecture tour to the United States, which proved most successful, and where he is recognized as one of the leading authorities on British agriculture.

### Prof. H. G. Sanders

The University of Reading has appointed Dr. H. G. Sanders, fellow of St. John's College, Cambridge, as professor of agriculture, from October 1944. Dr. Sanders was educated at Wellingborough School until 1917 and, after serving for two years in the Army, proceeded to St. John's College, Cambridge, qualifying for the degree of B.A. in 1920. After a period of practical farm work, Dr. Sanders became an assistant in the Animal Husbandry Institute, Schoo of Agriculture, Cambridge. In the winter terms of the sessions 1926–29 he gave courses of lectures in the University of Reading on animal physiology. In 1932 he was appointed a University lecturer in agriculture at Cambridge. In 1940 he was appointed deputy executive officer of the Cambridgeshire War Agricultural Executive Committee, and in 1941 executive officer to the Hertfordshire War Agricultural Executive Committee. Dr. Sander's researches and publications cover a wide range of agricultural problems in both crop husbandry and animal husbandry. His best-known work is "An Outline of British Crop Husbandry", published in 1939.

## Royal Society of South Africa: Marloth Memorial Medal

THE Council of the Royal Society of South Africal has awarded the Marloth Memorial Medal to Dr. J. L. B. Smith, senior lecturer in chemistry in Rhodes University College, and D. Rivett, for a paper on "The Essential Oils of Agothosma". The Marloth Memorial Fund was initiated by the Cape Chemical and Technological Society, and is devoted to the perpetuation of the memory of Dr. Rudolph Marloth, the famous South African chemist and botanist. In 1939 it was handed over to the Royal Society of South Africa for administration. It is awarded in the form of a small payment towards publication of papers of outstanding merit in either chemistry or botany, and a printed medallion heads the paper. The Medal has never been awarded before, but the present paper is considered as of sufficient merit, both from the botanical and from the chemical points of view, to be the first for which this honour is conferred.

## Society for Freedom in Science

FOUR years ago, a circular letter was sent to a few scientific men suggesting the formation of a new society to promote the causes of pure science and of freedom in science. A group of thirty was thus formed, which became the nucleus of the Society for Freedom in Science. The Society has recently issued a statement of its purpose and aims, which are summed up in five propositions; put briefly, these are: (1) increase of knowledge by scientific research and its diffusion have a primary human value; (2) science can only flourish in an atmosphere of freedom; (3) scientific life should be autonomous; (4) conditions of research appointments should give workers freedom to choose their own problems; (5) scientific men in countries not under dictatorial rule should co-operate to maintain freedom of research.

The Society claims a present membership of 134, chiefly as the result of correspondence and the circulation of memoranda; but an effort is now being made to increase this number, so as to have firm backing for the Society's objects. It is feared that with the approaching period of reconstruction those who stress the applications of science to the detriment of so-called pure science and support the view that research should be centrally planned will be allowed undue influence, and the Society hopes to be in a position to insist on the claim for freedom in science. The Society is an informal body, with no rules, no regular subscription and no official president. Its affairs are conducted by a committee consisting of Dr. J. R. Baker, Prof. V. H. Blackman, Mr. R. Brown, Prof. J. A. Crowther, Prof. M. Polanyi, Dr. L. E. Sutton, Prof. A. G. Tansley and Prof. A. E. Trueman; the honorary secretary is Dr. J. R. Baker, University Museum, Oxford, from whom particulars can be obtained.

## Visual Education

MR. G. PATRICK MEREDITH of the Education Department, University College, Exeter, took up the investigation of the use of visual media in education in 1940, and his lectureship was converted in 1941 into a lectureship in visual education—a novel appointment. The work expanded. The accommodation and equipment provided enabled a centre to be established with a staff which now includes an assistant lecturer, Dr. Renée Marcousé. Their researches on the comparative values of different visual teaching techniques were described at a conference held at the centre during July 1–2. One of the most interesting features was the testimony of the teachers who took part in the research. Their enthusiasm for the new media was striking and the demand for new materials and methods was made clear. The following subjects were included in the discussions: the design of the experiment, the statistical techniques and interpretation of the results (including a new technique of analysis); classroom methods, the film and still pictures used, the children's responses; the functions of the museums, exhibitions and other resources; and lastly, the planning of educational film production. The speakers included Mr. G. Patrick Meredith, Dr. Renée Marcousé, Mr. Bernard Gillett, Mr. Edgar Anstey, Mr. Neilson Baxter and the teachers concerned in the research. Representatives of the museums, film industry and Board of Education were present. A detailed report is to be published in the autumn.

## Carnegie Corporation of New York: Annual Report

THE annual report of the Carnegie Corporation of New York, for the year ended September 30, 1943, includes the reports of the president, Mr. W. A. Jessup, and of the secretary and of the treasurer, and gives a complete list of grants voted during the year totalling 2,562,900 dollars. Income for the year was 4,114,952 dollars in the Main Endowment Fund applicable to the United States, and 355,288 dollars in the fund applicable to the British Dominions and Colonies, the interest on the funds being equivalent to 2·7 per cent on investment securities, as compared with a yield of 4·5 per cent in the period 1932–33. The president points out that by means of reserves for various purposes the Corporation has spread allocations for the payment of appropriation for certain long-time interests over a period of years and has built up a depreciation reserve as partial protection of the endowment and legacy. The fact that the income to-day is only three fifths of the income ten years ago has, however, modified the grant-making policy of the Corporation. The Trustees are faced with the necessity of reducing either the number of grants made or the amounts involved, and possibly both.

The president also refers to the growing practice among donors of naming the specific purposes for which money is to be used. A recent inquiry among some twenty institutions showed that less than 10 per cent of the current gifts were free to be administered or allocated by the board of trustees and executive officers of the institutions. The president points out that in many instances a better method would be for the giver to expect the recipient institution to be capable and informed enough, and ready to accept, a larger share of responsibility for determining the allocation of gifts to research, to improvement in teaching, for equipment and for other important purposes within its own organization. Foundations such as the Carnegie Corporation have an obligation to continue to use their freedom from local and regional prejudices and from the pressures to which even privately endowed educational institutions are suffering, to foster new ideas and to nurture the pioneer spirit in education. Speaking of experimental projects, he said that those responsible should not expect support to be continued long after the undertaking has passed the experimental stage. These views are based on a review of the record of academic and foundation experience in administering grants during the past thirty years. During the year 1942–43, 12,000 dollars were voted to the Institute of International Education for continued support of the American University Union in London; grants totalling 225,300 dollars were made to agencies and organizations concerned with international understanding including the Carnegie Endowment for International Peace, the Institute of Pacific Relations and the Ethnogeographic Board under the National Research Council.

## Gas Research Board: Annual Report

THE fourth annual report of the Council of the Gas Research Board has a special importance, covering as it does a period when the Board became associated with the Department of Scientific and Industrial Research. This, however, is only another step in a long course of development extending over nearly half a century, during which the gas industry

has maintained organized co-operative industrial research. Dr. J. G. King, formerly of the Fuel Research Station, has been appointed director, and Dr. F. J. Dent, who has been responsible for a large part of the research activity of the Joint Research Committee of the Gas Research Board and the University of Leeds, has been appointed joint assistant director.

Of the items mentioned, gas technologists will note with interest the progress in the work on the complete gasification of coal. This shows that several lines of work are being followed—direct hydrogenation under pressure, gasification in oxygen and steam under pressure, and catalytic synthesis of hydrocarbons from carbon monoxide and hydrogen. The laboratory work on these themes is in course of transference to large-scale working in plant erected in a provincial gas works. Research on gas purification holds promise of reducing the sulphur content of purified coal gas to one tenth of the figures currently obtained in public supply in Great Britain. Drying by infra-red radiation emitted by gas-heated sources is being studied and apparently offers certain advantages. Methane, a gas of high calorific value, is a principal constituent of coal gas, from which it can be separated by liquefaction to give a portable liquid fuel which in future may be of great service. Gas engineers have always taken great interest in refractory materials, and the present report again reveals this interest. The report may be said to show that the research association under its new style shows already a wide and widening range of activities.

## Terms Used in Telecommunication

THE modern rapid growth of the applications of radio and telecommunications technique makes it desirable, even in war-time, to keep as up to date as possible a collection of definitions of the various terms and phrases used by workers and students in this field. To give effect to this point of view, the British Standards Institution has just issued a revised and enlarged edition of B.S. 204 entitled "Glossary of Terms used in Telecommunication" (obtainable from the British Standards Institution, 28 Victoria Street, London, S.W.1, 2*s*.). This publication has been prepared in collaboration with the General Post Office and other organizations concerned with communications technique and practice. It comprises revised sections of earlier glossaries dealing with telegraphy, telephony, radiocommunication, television and radio direction-finding, together with a new section on fire alarms. An appendix collects together the various symbols used for the quantities defined in the glossary. While it is doubtful if all workers in this field will agree with all the definitions, the revision, collection and rearrangement of the terms in this new publication will be found of considerable use as a reference manual by all those concerned with the preparation of technical documents and publications, as well as by the large number of other scientific and technical workers in this rapidly expanding field of telecommunications.

## Radio-Telegraph Signals

A PAPER on high-speed recording of radio-telegraph signals was read recently in London before the Institution of Electrical Engineers by Messrs. R. B. Armstrong and J. A. Smale, in which the authors first describe the systems in most general use, and then give a brief definition of modulation requirements for telegraph services. The various sources of distortion encountered are fading, noise and interference from other stations, but chiefly phase distortion due to propagation over more than one route between transmitter and receiver. The on-and-off character of Morse signalling enhances the difficulties which come from most sources of distortion. The paper then describes the general characteristics required in radio receivers designed for the purposes under discussion, including a description of two types of receiver in current use. This is followed by a consideration of special requirements of the recording units into which the receivers work, with a description of a typical unit. The special measures provided to offset the three types of distortion previously mentioned are also dealt with.

Diversity reception is discussed, with particular reference to the special problems of combining the automatic gain-control systems and the receiver outputs. Recording by undulator is chiefly considered in the paper as a whole; but the discussion on the effects of distortion, and the counter-measures taken, is even more applicable to machine-printing systems, since the latter have less margins of tolerance in operation. The paper concludes with an indication of the trend of development towards different methods of signalling, which may reduce difficulties of reception and recording in comparison with the old on-and-off methods of conveying intelligence.

## Lighting Reconstruction

THE Illuminating Engineering Society has just issued the first three of a series of Lighting Reconstruction Pamphlets which are planned to be of service to Government departments, local authorities, borough engineers, architects and others who are preparing now for the lighting problems which will confront Great Britain during the period of post-war reconstruction. The present pamphlets relate respectively to "Principles of Good Lighting", "The Lighting of Public Buildings" and "The Lighting of Schools", and they provide excellent summaries of the broad principles of what is needed to make lighting efficient according to the particular application. The pamphlets are obtainable from the Society at 32 Victoria Street, S.W.1, at the uniform price of 1*s*. each, 9*s*. per dozen, or £3 per 100.

## Distilled Water

THE development of the water-still has been slow, the normal type of apparatus being an externally heated metal boiler and a condenser. These are very inefficient, due to the fact that the number of calories required to heat the incoming cold water to boiling point is small compared with the heat required to convert the water into steam, and many kilowatts are required for an output of 20 gallons per hour. There is also the disadvantage of fur deposition from hard water, which can be diminished by taking only a fraction of the rated output.

A new type of still, called the "Strip-Action Still", is announced by Messrs. Townson and Mercer Ltd., 390 Sydenham Road, Croydon, which uses raw steam such as is available in a factory, and is made in units with a capacity of one gallon per hour. The initial design was in heat-resisting glass. The steam passes through an outer jacket which is air-cooled, and deposits dirt and high-boiling liquids with part of the condensed steam. The clean steam then passes down a multi-surface spiral condenser and comes out at the bottom as distilled water. By avoiding much contact with air, the water is of appreciably better

quality in regard to *p*H value than ordinary distilled water. The inner condenser is water-cooled, and the flow is adjusted so that the distilled water issues nearly at the boiling point.

## Processing Quartz

THE production of a small thin quartz plate from a large crystal weighing several pounds involves a long succession of operations, including repeated cutting, surfacing and checking. Each step requires some form of grinding or lapping, and with the extremely high precisions required and material so hard as quartz, these processes are slow and exacting, although multiple processing reduces the net time per crystal considerably. Until crystals began to be used extensively in electrical work, the grinding of hard brittle substances was limited chiefly to jewels, and the techniques and materials employed were not very well suited to a large-scale processing of quartz. As a result, a considerable amount of research and development was carried out in the Bell Laboratories to discover the most satisfactory methods and to design the most useful machines. An article by W. L. Bond (*Bell Lab. Rec.*, **22**, No. 8 ; April 1944) describes the various lapping and grinding processes employed.

## Accidental Poisoning in the United States

IN the United States, about 1,200 deaths occur each year from accidental poisoning. Analysis of the 355 cases occurring among policy-holders of the Metropolitan Life Insurance Company during 1940–43 (*Statist. Bull.*, **25**, No. 2 ; 1944) reveals the following. More than a quarter of the victims were pre-school children, and among these the commonest poison was strychnine (20 cases), taken in the form of sugar-coated strychnine pills intended for adults, followed closely by oil of wintergreen (17 cases), taken by drinking the pleasant smelling liquid intended for external application. Among the adults the list was headed by overdose of sleeping drugs (72 cases) ; 49 took poison (commonest were lysol, sodium fluoride) in mistake for medicine ; 41 drank methyl alcohol believing it to be a satisfactory substitute for ethyl, and 18 drank poison in mistake for an alcoholic beverage.

## Anti-plague Campaign in Chimborazo

ACCORDING to Dr. C. S. Vera, of Riobamba (*Bol. Of. San. Panamer.*, **22**, 875 ; 1943), a successful anti-plague campaign was carried out in the province of Chimborazo, Ecuador, during August 1, 1942–July 21, 1943. The central office set up in Riobamba directed the activities of the groups organized in each section of the province. 'Cynogas' and flame-throwers were used in destroying rat nests, and a paste of arsenic and phosphorus was used in rat burrows. During the year 43,876 rats were trapped (*rattus* 13,730, *alexandrius* 10,322 and *musculus* 19,815), and almost complete extermination was accomplished in some areas. The spleens of 23,629 rats were examined, but only one (*rattus*) was positive. The incidence of plague in Chimborazo was as follows : 1939, 82 cases ; 1940, 40 cases ; 1941, 30 cases ; 1942, 1 case, and in the first six months of 1943 nil.

## Swedish Town Population

ACCORDING to recent statistics in the *Anglo-Swedish Review* of April, the population of the Swedish capital rose during 1943 by more than 21,000, which is the largest annual increase ever recorded, to 636,000. Greater Stockholm including the suburban districts of the capital now has 800,000 inhabitants, or one eighth of Sweden's entire population. The same increasing tendency is registered for most Swedish towns, 111 out of the country's 123 towns showing rising population figures ; Sweden's second town, Gothenburg, has 290,000 inhabitants and the third largest, Malmö, 163,000.

## Summer School in X-Ray Crystallography

A Summer School in X-ray crystallography applied to industrial problems is being held in the University of Cambridge in September along the lines of the school organized last year which proved to be very successful. It is being arranged again by the Departments of Physics and of Mineralogy and Petrology in co-operation with the Board of Extra-mural Studies. In the course, which has been modified as a result of the experience of last year, emphasis will be placed on the interpretation of practical work and on the application of different techniques to various problems. It is particularly designed for scientific workers and technicians who are using the methods of X-ray diffraction in industry and who have had no systematic training in the subject. The Summer School will extend from September 4 to September 16. In view of the present shortage of staff, apparatus and materials, it will be possible to accept only a limited number of people, and application to attend must be made before July 24. Further information can be obtained from the Secretary of the Board of Extra-mural Studies, Stuart House, Mill Lane, Cambridge.

## Announcements

MR. G. D. H. COLE, University reader in economics, Oxford, and director of the Nuffield College Social Reconstruction Survey, has been appointed Chichele professor of social and political theory at Oxford as from October 1.

THE honorary degree of LL.D. has been conferred by the University of St. Andrews on Sir Robert Robinson, Wayneflete professor of chemistry in the University of Oxford.

THE honorary degree of LL.D. has been conferred by the University of Aberdeen on Prof. Alexander Findlay, professor of chemistry in the University during 1919–43 ; Prof. V. M. Goldschmidt, professor of mineralogy and geology, University of Oslo ; Sir William Wright Smith, regius professor of botany in the University of Edinburgh.

The degree of D.Sc. has been conferred on Dr. G. A. Cowie, for a thesis on "Study of the Effects of Manures and Rainfall on Yields of Crops grown in Rotation" ; J. S. Farquharson for a thesis on "(1) Haboobs and Instability in the Sudan, (2) The Diurnal Variation of Wind over Tropical Africa" ; Dr. H. W. Kosterlitz, for a thesis on "Some Observations on the Conversion of Galactose to Glucose in Mammalian Liver and in Yeast". The degree of Ph.D. has been conferred on Charity Waymouth, for a thesis on "An Investigation of Various Substances of Biochemical Importance for Tissue Growth".

MESSRS. H. K. LEWIS AND CO., LTD., 136 Gower Street, London, W.C.1, have been appointed sole distributing agents for the reproductions of German technical books issued by Mr. J. W. Edwards and Edwards Brothers Inc., of Ann Arbor, Michigan. A catalogue of the titles is in preparation. A copy will be sent on request.

# LETTERS TO THE EDITORS

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

## Mechanism of Brittle Rupture

THE low strength of brittle materials has been ascribed by A. A. Griffith[1] to the presence of discontinuities which have the properties of small cracks in these materials. Since this theory was published, however, several investigations have established the fact that glass exhibits the phenomenon of delayed rupture to a marked degree, and this is not easily explicable by Griffith's theory alone. The most recent of these investigations, by F. W. Preston[2] in the United States, reports the variation in strength of glass when loads are applied for periods of $10^{-2}$ sec. up to $10^{5}$ sec., the breaking stress falling from 14·3 kgm./mm.$^2$ for $10^{-2}$ sec. duration of load to 4·47 kgm./mm.$^2$ for $10^{5}$ sec. duration.

As a result of investigations which will be published shortly, I have been led to the hypothesis that glass consists of an elastic matrix which contains small pockets of 'quasi-viscous' material. These pockets take the place of Griffith's 'flaws'; and when the glass is subjected to a stress the initial load carried by the viscous material is conveyed to the matrix as relaxation of the stress occurs in the viscous material. In this manner a stress concentration grows with time in the matrix surrounding a 'viscous pocket'. Finally, such a pocket would become the equivalent of a hole in the matrix when the viscous material carried no stress.

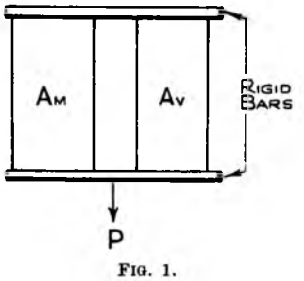

FIG. 1.

To represent the stress concentration occurring in the elastic material surrounding a viscous pocket, I have used the model illustrated in Fig. 1. This is intended to represent *local* conditions at a pocket, and it consists of two cylinders of the same height connected by rigid bars at each end. The area of cross-section of the elastic cylinder is $A_M$, and that of the cylinder of viscous material $A_V$. The sum of these areas is taken as 1, so that when a stress $P$ is applied to the system,

$$S_M A_M + S_V A_V = P,$$

where $S_M$ is the stress in the elastic matrix and $S_V$ the stress in the viscous material. This relation holds at any instant after the application of the load.

Now the *strain* in the two cylinders must always be the same (this means that the strain in the edge of the matrix surrounding a pocket is equal to the strain in the pocket material); and if we designate the strain at any instant as $\sigma$, then the stress in the elastic cylinder is $E\sigma$, where $E$ is Young's modulus.

If the viscous body had a true Newtonian viscosity, the stress-strain-time relationship for it would be

$$S_V t = \eta\sigma, \text{ or } S_V = \frac{\eta\sigma}{t},$$

where $\eta$ is the viscosity.

Hence, at all times,

$$E\sigma A_M + \frac{\eta\sigma}{t} A_V = P.$$

Now if the glass breaks when the strain in the elastic matrix reaches a constant value, say $B$, then the breaking stress, $P_B$, is related to the time of breakage by the expression

$$EBA_M + \frac{\eta B A_V}{t} = P_B,$$

which may be simplified to

$$P_B - a = \frac{b}{t},$$

where $a$ and $b$ are constants.

Hence if $\log (P_B - a)$ is plotted against $\log t$ a straight line should be obtained, and this has been done with F. W. Preston's results, as shown in Fig. 2. The value of $a$ was determined by plotting values of $\log (P - 1)$, $\log (P - 2)$, etc., against $\log t$; the result being that $\log (P - 3)$ yielded the line shown in Fig. 2.

It will be seen that the slope of the line is not unity; in fact $\frac{\delta \log (P_B - 3)}{\delta \log t} = 0{\cdot}126$, so that the equation for the line in Fig. 2 is

$$P_B - 3 = \frac{6{\cdot}3}{t^{0{\cdot}126}}.$$

This indicates that the model may represent the results quite closely if the pocket material is a 'quasi-viscous' substance of the type which G. W. Scott Blair[3] has investigated. Thus it is only necessary to represent the stress-strain-time relationship of the 'viscous' substance as $St^{0{\cdot}126} = \eta^*\sigma$, where $\eta^*$ is a constant. This corresponds with Scott Blair's expression

$$S\beta t^{\varkappa} = \psi\sigma$$

in which $\beta = 1$ and $\varkappa = 0{\cdot}12$. These values of $\beta$ and $\varkappa$ would represent a substance of high 'viscosity' approaching the elastic condition, which is not entirely unexpected since the material with which we are dealing is a silicate.

It should be noted that the equation derived from the 'viscous pocket' theory represents the experimental results over a very long range of time, namely, $10^7 : 1$, which may be taken as a very good quantitative support to the theory. It is of special interest that the theory accounts for the difference between ductile and brittle materials as a difference in relations between the elastic and 'viscous' portions. A ductile body may be regarded as one which is constituted of a viscous material with inclusions of elastic pockets, whereas a brittle material is one which is predominantly an elastic substance containing inclusions of viscous pockets. In between these

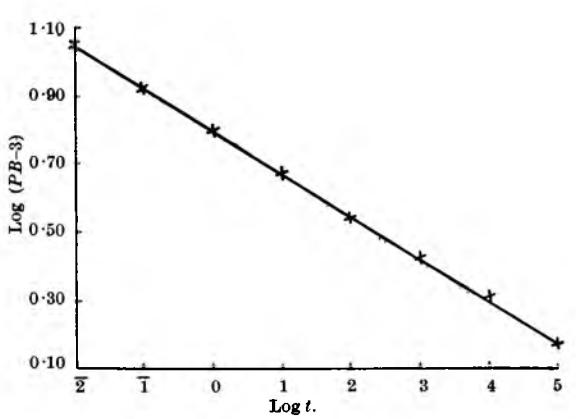

FIG. 2.

extremes there may be bodies which contain both these features to varying extents, and which may therefore be either 'brittle' or 'ductile' according to circumstances of the test.

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[1] Griffith, A. A., *Phil. Trans. Roy. Soc.*, A, **221**, 163 (1920).
[2] Preston, F. W., *J. Appl. Phys.*, **13**, 623 (1942).
[3] Scott Blair, G. W., *Nature*, **152**, 412 (1943).

## Place-Exchange Theory of Plastic Flow, as Applied to Polymers

THE place-exchange theory of plastic flow was originally developed by Becker[1], to account for the flow of metals. More recently a somewhat similar theory has been advanced by Eyring[2] to account for flow in polymeric materials. In the latter theory the flow process is regarded as the movement of a molecule, or segment of a molecule, from one position in the plastic to a neighbouring one, under the influence of thermal energy. If $E$ be the potential barrier separating two positions, and $f$ the stress, then the activation energy for the process is written as $E-bf$, where $b$ is a constant involving the dimensions of the 'unit of flow'. The rate of flow $\theta$ may then be written

$$\theta = \text{const. } e^{-(E-bf)/RT} \quad . \quad . \quad . \quad (1)$$

It can be shown from (1) that for very low stresses the system will show Newtonian behaviour, that is, for $bf << RT$, $\theta \propto f$, and Eyring has treated simple liquids along these lines[3]. For $bf > RT$ the following behaviour is predicted

$$\ln \theta = a + b'f \quad . \quad . \quad . \quad . \quad . \quad (2)$$

(The equations are given in their simplest form.)

We have recently completed an extensive series of measurements on a plasticized cellulose derivative over a stress range 2–160 kgm./cm.$^2$ and temperature range 16–100° C. The methods used were compression of cylinders and extension of rods, care being taken to analyse the total strain into its plastic (non-recoverable) and elastic components. In this note we are concerned solely with the plastic flow.

The important result of our work is that equation 2 is followed only at the lower stresses, that is, up to a certain stress value $f_0$ which is itself a function of temperature. In this range, $f < f_0$, we have further checked, in a qualitative way, the main assumption of the theory; thus we have found that the 'activation energy' for flow falls from *c.* 30 kcal. at 4·6 kgm. cm.$^{-2}$ to *c.* 11 kcal. at $f \geqslant f_0$. For values of the applied stress above $f_0$ we find that the activation energy is independent of stress. In fact, the flow may be described by the equation originally used by Bingham to describe the flow of solid–liquid dispersions through capillary tubes.

$$f \geqslant f_0, \quad \theta = A(f - f_0) \quad . \quad . \quad . \quad . \quad (3)$$

This equation could not have been predicted by the place-exchange theory as it stands. Its application gives hope for a simpler analysis of flow problems in industrial processes than could be achieved by equation 2. We should mention that similar results were obtained by Dillon and Johnston[4] for the extrusion of compounded rubber. Their work, however, by itself, is not directly comparable with ours owing to the presence of 'fillers' in many of their rubbers (that is, they are not dealing with a simple polymer system), and the possibility of 'plug-flow' at the lower stresses. In fact, it might be argued that their rubber-filler systems were analogous to the Bingham solid–liquid paste systems. However, our results would suggest that rubber without fillers may follow equation 3 at high stresses, and there are indications, in the paper quoted, that this may well be so.

It is of interest that we found no indication of a true yield-value, and we may hazard the opinion that in our system, whether or not a yield-value is observed is purely a question of duration of experiment and sensitivity of observation. In fact, it is possible to observe flow in our sensitive extension apparatus at stresses much below the apparent yield-value obtained in our compression plastometer. It is, of course, possible that if the plasticizer content were reduced, a true-yield value would appear. It is of interest that to a reasonable approximation, over a temperature interval of 40° C., the 'mobility constant' $A$ has the same temperature dependence as the intercept $f_0$, namely,

$$A = A_0\, e^{-11000/RT} \qquad f_0 = f_{00}\, e^{11000/RT}.$$

A further feature of our results was that at the very low stresses, in extension, the material showed strain-hardening, $\theta$ falling 20–30 fold over the initial 3–4 per cent extension, reaching an apparently steady value, very similar to the behaviour reported by Andrade for metal wires[5]. At the high stresses used in compression, we could not detect any such behaviour. Whether this was due to instrumental limitations we cannot at present say. It does, however, seem likely that any strain-hardened structure which may be formed initially cannot withstand the large shearing forces produced by the high stresses operative in the compression measurements.

It would seem that a critical attitude is required to the application of place-exchange theories in their present form, not only to the flow of plastics at high stresses, but also to the normal viscosity phenomena in liquids. Granting the application of the theory to plastics at relatively low stresses, it might be surmised that at the higher stresses the flowing molecules may pass over several energy barriers, and that the rate of flow is then determined by the rate of exchange of momentum, as visualized by Van der Waals' and Andrade's theories of liquid viscosity[6]. If this is so, it would argue for the possible application of the momentum exchange theory to the behaviour of simple liquids. It is hoped in the future to make experimental and theoretical investigations of this question.

Approval for publication has been granted by the Director-General of Scientific Research and Development, Ministry of Supply.

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[1] Becker, *Phys. Z.*, **26**, 919 (1925).
[2] Tobolsky, Powell and Eyring, "Chemistry of Large Molecules", 125 (Interscience, 1943).
[3] Eyring, *J. Chem. Phys.*, **4**, 283 (1936).
[4] Dillon and Johnston, *Physics*, **4**, 225 (1933). Also Houwink, "Physikalische Eigenschaften und Feinbau von Natur- und Kunstharzen" (Akad. Verlag. Leipzig, 1934).
[5] Andrade, *Proc. Roy. Soc.*, A, **84**, 1 (1910); **90**, 329 (1914); **138**, 348 (1932).
[6] Van der Waals, *Proc. Acad. Amsterdam*, **21**, 743 (1918). Andrade, *Phil. Mag.*, **17**, 497, 705 (1934).

## Displacement of X-Ray Reflexions

A SMALL displacement of the X-ray diffraction maxima from the position determined by Bragg's equation $n\lambda = 2d\sin\theta$ may be caused by experimental conditions, such as the absorption of X-rays in the specimen, or it may be caused by imperfections in the crystal structure, as several authors have shown by theoretical considerations, starting from different assumptions[1,2,3]. It seems, however, that in the latter case no experimental evidence has been produced.

Some years ago, the indexing of the X-ray diffraction pattern of chrysotile caused considerable difficulties, which were ultimately solved by making allowances for a displacement of certain reflexions. In this case, of the thirty-four reflexions observed on the equator and on the second layer line, twenty-two were of the $\{00l\}$ and $\{20l\}$ type (crystal reflected copper $K\alpha$ radiation). These were comparatively sharp reflexions, and the agreement between calculation and measurements was so good as to exclude the possibility of any measurable displacement due to experimental conditions. Still, the remaining third could not be indexed, unless a variable axial length was used for the $b$-axis. Only then could the first layer line also be indexed. Such 'apparent' $b$ values, when plotted against the corresponding index $k$, lie on a smooth curve (Fig. 1), with a few exceptions. These exceptions are, apparently, the reflexions for which the indices $k$ and $l$ are both multiples of three, including zero. Furthermore, all these exceptional reflexions yield the same $b$ value. (More spots have been measured on photographs taken with molybdenum $K\alpha$ radiation, which give a similar picture to Fig. 1, though the measurements are less accurate.)

It is only putting the statement another way round to write that in the X-ray pattern of chrysotile some reflexions are displaced away from the central ordinate in a manner implicitly dependent on the crystal structure. The displacement may be between 0·15 mm. (for 110 reflexion) and 1 mm. (for 190 reflexion), in a camera of 60 mm. diameter, using copper $K\alpha$ radiation.

Quantitatively, the displacement has not yet been fully accounted for. The key to the solution lies in the fact that all the fuzzy spots, and only these, are displaced from the Bragg reflexion position. It is hoped to discuss this matter elsewhere in more detail.

Another interesting error of psychological origin was observed in this connexion. It was found that the distances from the central ordinate of the peaks of the reflexions 020, 110 and 130 on the microphotometer curves are 0·06, 0·05 and 0·11 mm.

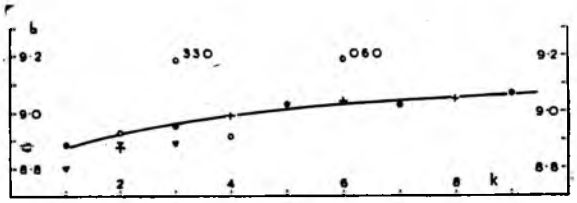


FIG. 1.

Fig. 1. 'APPARENT' LENGTH OF THE $b$-AXIS OF CHRYSOTILE PLOTTED AGAINST THE INDEX $k$. CAMERA 60 MM. IN DIAMETER, COPPER $K$ RADIATION.
○, reflexions $0k0$, on the equator; ●, $1k0$'s on the first layer line; +, $2k0$'s on the second layer line. ▼, microphotometer readings of the 110, 020 and 130 reflexions. Reflexion 040 is a very weak one.

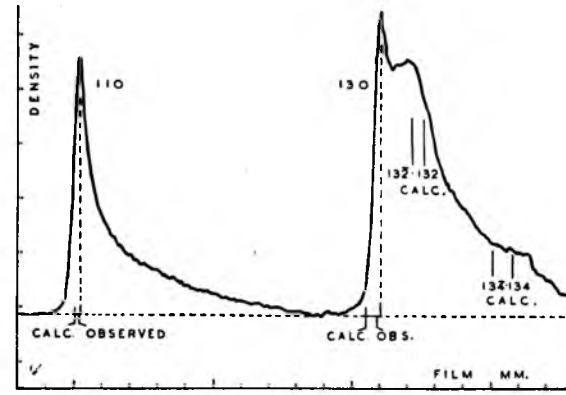


FIG. 2.

Fig. 2. MICROPHOTOMETER CURVE OF THE FIRST LAYER LINE OF CHRYSOTILE.
[$a = 5·32$, $b = 9·2$, and $c = 14·62$ kX., and $\beta = 93·2°$]. Crystal reflected copper $K\alpha$ radiation. The positions of the reflexions as calculated, and as measured by a travelling microscope are also indicated.

respectively larger than the same distances obtained with a travelling microscope. (A difference two or three times larger was obtained from photographs taken with a camera of 19 cm. in diameter for the 020 reflexion.) It seems that in the case of an unsymmetrical density distribution in reflexions such as those measured (Fig. 2), the eye tends to estimate the position of the middle of the line towards the steeper fall of the density. Such an error of judgment will be of importance when measuring unsymmetrical lines, such as partly overlapping reflexions, incompletely resolved $K\alpha$ doublets, or lines of considerable broadening.

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[1] Laue, M. v., *Z. Kristallogr.*, A, **82**, 127 (1932).
[2] Landau, L., *Phys. Z. Sovietunion*, **12**, 579 (1937).
[3] Warren, B. E., *Phys. Rev.*, **59**, 693 (1941).

## Age of the Saline Series in the Salt Range of the Punjab

WITH regard to recent letters on this subject[1], I would recall in addition that Mr. R. V. Anderson reported finding Quercus in the Punjab Saline Series[2]; while Foraminifera said to be from the same were referred by me to Ranikot species. Commenting on my report, Sir Lewis Fermor remarked that: "The discovery of these fossils indicates a Ranikot or post-Ranikot age for the Salt Marl Series, and appears to set at rest the long controversy about the age of the Salt Marl. We appear now to know that the age of this series is Tertiary and not Cambrian"[3].

Mr. Wadia and I had previously referred the Kohat salt to the Eocene[4]; and my later opinion is that all the salt of the region (Kohat and Punjab) is of basal Khirthar age. I have shown[5] that the Kohat-Potwar marine basin was isolated, at the close of Laki times, by a Waziristan ridge on the west, by the initial rise of the Salt Range axis on the south, and by the advance of the Himalayan axis on the north-east. The consequent desiccation of the basin produced Pinfold's 'passage beds' in its north-eastern parts, with salt to south and west;

and the succeeding Lower Chharat (early Khirthar) beds mark a fluviatile interlude before the extensive mid-Eocene transgression brought marine beds (Upper Chharats, Kohat Limestones, etc.) again over that region.

Thus the presence of Tertiary forms in the Punjab Salt Marl proves a Tertiary age for the associated salt, while the stratigraphy of the region more precisely indicates a basal Khirthar age for both the Punjab and the Kohat salt. Prof. Sahni's abundant confirmation of the first point goes far to clinch an increasingly strong case.

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[1] *Nature*, **153**, 462 and 654 (1944).
[2] *Bull. Geol. Soc. Amer.*, **38**, 665 (1927).
[3] *Rec. Geol. Surv. Ind.*, **66**, 117 (1933). Mr. Pinfold and I have since shown that Ranikot beds are well represented on the Salt Range, *vide Nature*, **139**, 414 (1937); *Pal. Indica* (N.S.), **24**, Mem. 1 (1937).
[4] *Trans. Min. Geol. Inst. Ind.*, **24**, 202 (1929); *Rec. Geol. Surv. Ind.*, **65**, 112 (1932).
[5] "Geographical Changes in North-West India during Late Cretaceous and Early Tertiary Times", *Proc. Sixth Pac. Sci. Congress*, 1939, **2**, 483 (1940).

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IN a letter dated February 10, one of us directed attention to the discovery of microscopic angiosperm, gymnosperm and insect remains in the Saline Series as exposed in the salt mines at Khewra and Warchha in the Punjab. The situations from which our samples were taken, in the body of a closely bedded series, placed it beyond doubt that the fossils were truly *in situ*; and their affinities make it obvious that the beds cannot possibly be as old as Cambrian.

These fossils were obtained by dissolving two kinds of samples: (*a*) lumps of rock-salt in which thin interbedded layers of saline earth ('kallar') were enclosed, and (*b*) portions of the 'kallar' bands alone, after scraping off the pure salt from both faces. We have now dissolved (*c*) lumps of the massive transparent rock-salt alone, taken from the same spots as before in the two mines. The Warchha salt has revealed shreds of carbonized pitted wood, and thick-walled tracheids with large circular separate bordered pits of the coniferous type. The Khewra salt has yielded, *inter alia*, felt-like masses of fibres of several different kinds; a fragment of wood with pitted cells; a cuticle recalling that of grasses, with a beautifully preserved stoma in an epidermis of elongated cells; and the chitinous coat of a small arthropod with paired jointed legs and traces of mouth parts.

Thus the rock-salt itself seems to be as rich in organic remains as the interbedded laminæ of saline earth. The indications are that the entire salt- and -'kallar' series in these mines is teeming with microfossils. For anyone now to claim that these fossils are 'derived' would be to claim that the whole series, even in the depths of these mines, has been churned up with extraneous matter. We cannot, of course, say whether the fossils reported by others were truly *in situ*. Ours certainly are; and although their exact age-value still needs to be critically assessed, there can obviously be no question of an age as ancient as Cambrian. On present evidence the only alternative seems to be that the Salt Marl is Tertiary.

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## Preparation of a Stable and Active Pancreatin from Commercial Samples

THE problem of a pancreas protease preparation of a constant activity can be solved by the following preparative process:

1 gm. of the commercial sample of 'Pancreatin' (Parke, Davis and Co.) is mixed with 10 ml. distilled water and kept under toluene for about 24 hours at 37°. The mixture is then centrifuged, filtered and 50 ml. absolute alcohol are added. The centrifuged precipitate obtained may be washed with ether and is dried in a vacuum desiccator over sulphuric acid.

The yield of the dried substance is about 10 per cent of the original commercial product. It dissolves easily in water and is about five times as active as the original water extract (casein as substrate).

The preparation retains also the lipase (of weak activity) and the amylase of the mother substance.

While the water extracts or even the generally used glycerol extracts are not stable and their activity diminishes gradually on standing, even when kept under toluene (water extracts) in an ice box, the dry preparation seems to retain its original activity indefinitely.

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## A Basic Principle Governing the Changes in Organisms under the Action of External Factors

THE present communication describes a general method of making a quantitative estimation of the response to external factors shown by biological systems of different order (individuals, taxonomic categories, populations or communities).

In studying the effect of training and learning, psychologists were the first to raise the question concerning the relationship of a change in the character to its original value[1]. In my recent work published in collaboration with my associate Dr. Gause[2] we gave three examples of "a negative relation between acquired and inherent characters of the organism".

My method consists in calculating the regression coefficients of positive or negative increments ($\Delta x$) of the character on their original values ($x$), both variables being expressed in the original units of measurement.

Four types of such a regression under the influence of an external factor can be established:

TABLE 1.

| Change in size of character | Relation of increase $\Delta x$ to character | Type |
|---|---|---|
| Increase | Positive correlation | I |
| | Negative ,, | II |
| Decrease | Negative ,, | III |
| | Positive ,, | IV |

The crossing of the $x$ axis by the regression line determines the point where $\Delta x$ is equal to 0. This

point is located at a distance $A$ from the origin of the co-ordinate system. $A$ represents the asymptotic value of our character or a lower or upper limit of its expression (see below). The coefficient of regression $b$ gives a measure of increments per unit of the character. It may be used in two ways: first, in ascertaining the efficiency of different factors acting upon a series of several groups of test animals, and secondly in comparing the response of different animal groups to the influence of the same factor, which shows the reactability of each particular group. Table 1 contains the constants $b$ and $A$ calculated for different examples taken from several branches of biology, medicine and agriculture. These constants were calculated from regression lines fitted by hand to observation points plotted on millimetre paper.

What is the mechanism of such types of biological reactions? The most plausible explanation seems to consist in the assumption that individuals or taxonomic groups used in experiments represent different stages of positive or negative growth. Thus, the most common type of exponential growth can be expressed by a function $x = A(1 - e^{-Ct})$. The differential equation of such a function, $\frac{dx}{dt} = CA - Cx$, clearly shows the velocity of growth to be inversely proportional to the size of the character $x$. The negative coefficient of regression in our type II is just an approximation of the function connecting the velocity with the size of the character obtained by using $\frac{\Delta x}{\Delta t}$ instead of $\frac{dx}{dt}$. Other types can be derived in the manner described from corresponding exponential growth-curves or curves of decay. In cases when growth of decay approaches an asymptote a kind of friction seems to take place. This friction is produced by components of the system which surround the character under question. Our types II and IV represent cases with an internal friction of components, while types I and III involve systems with a self-accelerating plus or minus growth.

TABLE 2.

| Name of the organism of the system | Character studied | Factor | $b$ | $A$ | Type |
|---|---|---|---|---|---|
| *Epilachna chrisomelina* (beetle)[3] | Diffuse black pigment between spots | Temperature | +1·5 | — | I |
| Children[4] | % hæmoglobin in blood | Honey diet during two weeks | —0·7 | 6·4 | II |
| Men affected by tertian malaria[5] | Spleen size (cm.) | Acrichine + chinoline therapy | +0·2 | 6·33 | IV |
| Black and white race and sexes[6] | Expectation of life at birth | Secular changes, 1901–20 | —0·13 | 54·4 | II |
| Man[7] | % correct answers obtained with the aid of tachistoscope | 3 days training | —1·0 | 87 | II |
| Patients[8] | Mitogenic radiation of blood | Hydrotherapy at a summer resort "Tzaltubo" | —0·54 | 32·5 | II |
| Populations of different countries[9] | Birth-rate per 100,000 | Secular changes, 1871–1913 | +0·40 | 170 | IV |
| Population of different States of U.S.A.[10] | Vital index | Secular changes, 1919–21 | +0·24 | 20 | I |
| Different soil types[11] | Oat yield (centners per hectare) | Fertilizer | —1·00 | 255 | II |

A general principle of a quantitative response of elements in biological systems (and very likely in physical also) to external factors may be expressed as follows:

(*A*) Positive changes (increments) in a character are: (I) directly proportional to its original values, if the growth of the character is not limited by an upper asymptote; in such a system the component is exposed to a stimulatory action of adjacent components; and (II) inversely proportional to its original values if the character is limited by an upper asymptote; in such a system the component is exposed to the inhibitory action of adjacent components.

(*B*) Negative changes (decrements) in character are: (III) inversely proportional to its original values, if its changes are not limited by a lower asymptote; in such a system the character is exposed to a stimulative action of other components; and (IV) directly proportional to its original values, if the character is limited by a lower asymptote; in such a system the character is exposed to an inhibitory action of adjacent components.

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[1] Kincaid, M., *Psych. Rev.*, **32** (1925).
[2] Gause, G. F., and Alpatov, W. W., *C.R. Acad Sci. U.S.S.R.*, **30**, No. 3 (1941).
[3] Timofeef-Ressovsky, H. A., *Biol. Z.*, **61**, H.1/2 (1941).
[4] Root, A. J., "ABC and XYZ of Bee Culture" (1940).
[5] Raskin, A. J., *Med. Parasit. Parasit. Dis.*, **8**, No. 6 (1939).
[6] Pearl, R., in Nelson Loose Leaf "System of Public Health—Preventive Medicine" (1927).
[7] Isserlin, M., "Handbuch der Naturwiss.", **10** (1935).
[8] Rikkel, A. V., *Arch. Sci. biol.*, **35**, *B*, No. 1 (1934).
[9] Pearl, R., "Medical Biometry" (3rd edit., 1940).
[10] Pearl, R., "Studies in Human Biology" (Baltimore, 1924).
[11] Kirssanoff, A., "Mitcherlich's Theory" (Moscow, 1930).

## Densities of the Embryonic Stages of Sea-Urchins

RECENTLY the densities of the early stages in the development of the very common sea-urchin, *Psammechinus miliaris* (Gmelin), have been obtained by the displacement method. The figures are as follows:

| | Temperature | Density |
|---|---|---|
| Ova | 9·8 °C. | 1·0725 |
| Zygotes (1 hr.) | 10·4 | 1·07360 |
| Blastula (embryos, 14 hr.) | 11·0 | 1·07582 |
| Blastula (larvæ, 20 hr.) | 9·8 | 1·0793 |
| Gastrula (late, 44 hr.) | 9·8 | 1·08390 |
| Echinopluteus (early, 68 hr.) | 9·8 | 1·09626 |

Both ova and zygotes were left in large dishes of sea-water for an hour. The densities of the ova and zygotes have been twice confirmed, and similar figures were obtained for the ova and zygotes of *Echinus esculentus* L.

In *P. miliaris* there is therefore a definite and gradual increase in density; but the figure which is

of outstanding importance is that for the zygote, which exceeds that of the ovum in spite of the inclusion of a large amount of liquid of a lower density.

Within an hour of fertilization taking place the zygote 'puts out' the very familiar fertilization membrane, which is separated from what was the original ovum by a clear space containing a colourless liquid. Measurement has shown that while the diameter of the original ovum is practically unchanged, the diameter of the whole zygote, including the membrane, is considerably increased, with the result that the volume of the zygote is more than twice that of the ovum. In the past, there has been a great diversity of opinion as to the nature both of the fertilization membrane and of the liquid enclosed. From simple basic reasoning we should expect the enclosed liquid to be slightly hypertonic to sea-water and to have a similar density. The density of the Plymouth sea-water at 11·0° C. was 1·02663, and the density of the enclosed liquid could therefore scarcely exceed 1·03. Hence, taking the density of the ovum as 1·07 and that of the surrounding liquid as 1·03, we should expect the density of the whole zygote to be 1·05, or very nearly so, instead of which it is 1·0736. When, therefore, the ova are left in sea-water, there is a very definite increase in density; and it would seem that this increase can only be attributed to a great intake of calcium ions, which on reaching the cell proper, immediately begin to separate out as crypto-crystalline granules of calcite. Calcium ions would not cause any appreciable increase in density, but calcite granules would, since their density is 2·7.

Much remains to be done, but unfortunately it is too late in the season to undertake it now. We know that spicules of calcite occur in the blastula larva stage. They are definitely crystalline, and in the first stages are intracellular and cannot have come into existence suddenly. This is clearly indicated, apart from anything else, by the gradual increase in density. The recrystallization of calcite from very finely divided granules of calcium carbonate is a well-known but none the less a complicated process even when it takes place in simple inorganic solutions. The protein in the echinoderm cell would probably act as a protective colloid and complicate matters considerably. It is known that calcium ions play a most important part in the early embryology of echinoderms, and also that the presence of excess of lithium ions prevents the normal development of echinoderms, especially in the earliest stages.

This is far too big a problem to discuss here, but the fact remains that while freshly precipitated calcium carbonate recrystallizes normally from sea-water, or from a solution of sodium chloride of the same strength, it does not crystallize normally from a solution in which the sodium is replaced by lithium.

The above concept of the great intake of calcium is strongly supported by the work of Ephrussi and Rapkine, as recorded by Needham[1], on the ash of the echinoderm egg. The figures are as follows:

| Hours after fertilization | | 0 | 12 | 40 (Pluteus) |
|---|---|---|---|---|
| Total ash, % dry weight | .. | 1·5 | 9·1 | 16·8 |
| Total ash, % wet weight | .. | 0·34 | 2·06 | 3·56 |

There are, of course, slight variations in the densities and also in the volumes of ova and zygotes, but in all cases investigated so far the density of the latter exceeds that of the former, which is the really important point.

In a previous communication[2], I recorded the fact that a ripe ovum in the oviduct of *Calanus finmarchicus* may increase its volume nearly twenty-two times within a few hours of extrusion. I also pointed out that in certain cases such volume changes took place irrespective of syngamy. Clearly in all these cases a consideration of *density* must preclude the assumption that these great changes in volume can be due to an intake of water alone.

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[1] "Chemical Embryology" (Camb. Univ. Press), 1271.
[2] Lowndes, A. G., *Proc. Zoo. Soc. London*, A, **113**, 28 (1943).

## Composition of Coal

DETAILED research into the composition of coal demonstrates its intricacy. There can be no true understanding of this complicated and important substance if the results of research are confused by the use in varying senses of descriptive terms.

A recrudescence of confusion has recently arisen around the use of the word 'anthraxylon' as though it were synonymous with 'vitrain'. In their book "Geology in the Service of Man", Prof. W. G. Fearnsides and Dr. O. M. B. Bulman say (p. 108) "black, shining, bright coal ('vitrain' or 'anthraxylon') also composed of woody fragments". This is misleading: 'vitrain' and 'anthraxylon' are not equivalent, and 'vitrain' may or may not be composed of woody fragments.

I originally demonstrated and defined 'vitrain' in 1919[1]; in the following year Dr. Thiessen[2] described 'anthraxylon' as being layers which "correspond to the larger pieces of woody peat". Following my paper of 1935[3], an international agreement about coal terminology was achieved at the congress at Heerlen in the autumn of the same year[4].

It is particularly unfortunate at the present time when coal research is receiving wider recognition that confusion should be exacerbated, so that one must state emphatically that the term 'anthraxylon' cannot be used as the equivalent of 'vitrain'.

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[1] Stopes, M. C., *Proc. Roy. Soc.*, B, **90**, 469 (1919).
[2] Thiessen, R., *Bull.* 117, U.S. Bureau Mines, Washington (1920).
[3] Stopes, M. C., *Fuel*, **14** (1935).
[4] Jongmans, W. J., Agreed details of "Nomenclature of Coal Petrography", *Compt. Rend. Congres Heerlen*, Sept. 1935 (Maestricht, 1938).

## Factors in the Production of Honey

I MUST apologize for having misquoted Miss Betts in my article in *Nature* of May 13. Her optimum figure for maximum sugar intake is 56 per cent, not 40, and incidentally is nearly independent of temperature. My conclusion is not affected. It is interesting to note that for a given concentration she established that the sugar intake is roughly doubled between 15° C. and 25° C. and follows roughly a linear law over a wider temperature range. The optimum concentration is nearly independent of temperature.

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# HARDENING AND DARKENING OF THE INSECT CUTICLE

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IT has long been known that the darkening of the insect cuticle which often follows ecdysis or metamorphosis is due to enzyme action. Tyrosinase has often been shown to be present in the body, and Bhagvat and Richter[1] have found in certain soft cuticles an active polyphenol oxidase. The chromogens involved, 'dopa' and related dihydroxyphenols, have been identified in a number of insects[2,3], and it has been suggested[4] that they play an active part in hardening the cuticle, by providing on oxidation ortho-quinones which 'tan' the protein constituents by the introduction of aromatic cross-linkages.

Considerable information on this subject is therefore available, but its integration into a coherent account is still largely incomplete. In particular, the functional connexion between the secretion of the pupation hormone and the changes in the cuticle is obscure. A recent morphological and histochemical study of the larval and pupal cuticles of *Sarcophaga falculata* (Dipt.) has, however, produced significant results.

The soft cuticle of the mature larva consists of an outermost very thin resistant epicuticle, covering a thicker (4μ) layer of protein unassociated with chitin which may be termed the secondary epicuticle. Beneath these lies the endocuticle, a laminated chitin-protein complex of two distinct layers. The outer, laid down early in larval life, possesses pore-canals[5], but the inner, added later, when the chitinization of the cytoplasmic filaments of the canals is complete, has none.

The secondary epicuticle carries an oxidase, readily demonstrated by the 'Nadi' reagent, which is capable under experimental conditions of oxidizing catechol and 'dopa' rapidly, and tyrosine much more slowly. It is inhibited by cyanide, but not by sodium azide, and is resistant to drying and to treatment with alcohol, acetone, and chloroform. Moreover, at pupation the outer layer of the endocuticle gives a positive reaction to the ferric chloride test for orthodihydroxyphenols. Darkening of the cuticle begins at the epicuticle, where enzyme and substrate meet, and spreads inwards through the outer endocuticle, which is thereby converted into the hard and dark exocuticle of the puparium. The inner layer of the endocuticle does not darken, one reason for this being that it lacks the necessary phenol.

The accumulation of a dihydroxyphenol in the outer endocuticle coincides with the appearance in the blood of a similar phenol. That this phenol is not produced by tyrosinase activity after withdrawal of the blood for test is clearly shown by subjecting early pupæ to hydrogen cyanide vapour before opening, and withdrawing the blood into a small quantity of dilute hydrogen cyanide. Blood so obtained darkens on exposure, and gives faint but positive reactions to tests for dihydroxyphenols. The source of the phenol seems reasonably to be found in the oxidation *in situ* of the blood tyrosine by tyrosinase.

Larval blood, when tested at intervals with Millon's or Mörner's reagents, shows a progressive increase in its tyrosine content from the cessation of feeding to the onset of pupation, and thereafter shows a decline, and this is confirmed by the results given by a quantitative examination of the blood carried out by Dr. G. Fraenkel before this work was begun (private communication). It may be postulated that the decline in tyrosine content at pupation indicates its consumption as the blood phenol is produced and removed by oxidation in the cuticle.

Although tyrosinase is known to occur in insect blood, its source has not been shown. Drawn blood and dissected larvæ have therefore been examined after treatment with the 'Nadi' reagent, cytochrome oxidase having been inhibited by methyl alcohol. A positive reaction to this treatment, apart from that given more feebly by the secondary epicuticle, is given only by a small number of hæmocytes which closely resemble the œnocytoids described by Wigglesworth[6]. In addition to occurring free in the hæmolymph, they are found also in small clusters adhering to other tissues between the main posterior spiracular trunks. First noticeable in larvæ which are ceasing to feed, they increase in number as the crop is emptied, disappearing again shortly before pupation. On the addition of catechol to the blood, they rapidly darken ; and in blood which is allowed to stand they darken more slowly. It seems clear that they are centres of tyrosinase synthesis. In freshly drawn blood the œnocytoids give a positive 'Nadi' reaction only after treatment with methyl alcohol—a feature which will be discussed later.

In late larval life, therefore, both tyrosine and tyrosinase are present in the blood, which darkens on exposure but not *in situ*. The reason for the inability of the blood to darken within the body seems due to the reducing properties of the hæmolymph. Kuwana[7] has distinguished clearly between a stable reducing fraction of the blood of silkworms, due to uric acid and glucose, and an unstable fraction, which increases greatly before ecdysis and pupation, falling sharply as these changes proceed. The unstable fraction decreases on exposure of the blood. In the present work the unstable fraction is provisionally regarded as being stabilized *in situ* by the action of an unidentified dehydrogenase, a view supported by the fact that the blood of late Sarcophaga larvæ will reduce tolylene blue almost completely, and phenol-indo-2 : 6-dibromophenol completely. Allowing the blood to stand, or treating it with methyl alcohol or chloroform, however, causes full return of colour to the dye solution. The same treatment greatly accelerates the darkening of exposed blood, due possibly to destruction of dehydrogenase and release of tyrosinase activity. In agreement with these observations, Graubard[8] obtained a higher effective tyrosinase yield from Drosophila larvæ after treatment with chloroform water.

Tyrosinase activity in the blood, prior to pupation, may therefore provisionally be regarded as being held in check by the reducing power of a dehydrogenase, tyrosine being reduced as rapidly as it is oxidized. This is further indicated by the inability of the œnocytoids to give an immediate 'Nadi' reaction without previous alcohol treatment, and by the darkening, first pointed out to me by Dr. G. Fraenkel, which is caused in intact larvæ by immersion for 24 hours or more in methyl alcohol. Larvæ which are ceasing to feed darken slightly at each end, and older larvæ and young pupæ blacken completely. On the other hand, young larvæ undergo no change, and isolated pieces of cuticle are not darkened under the same conditions. Similar results

are given, but more slowly, owing perhaps to slower penetration, by solutions of phenyl-urethane, phenylurea, and other narcotics known to inhibit dehydrogenases. Sections reveal that this induced darkening proceeds inwards from the epicuticle and closely simulates the natural process, although unaccompanied by normal hardening. Clearly a phenol, derived from the blood, is oxidized by the polyphenol oxidase of the epicuticle.

The significance of the increase in the unstable reducing fraction of the blood before pupation noted by Kuwana may therefore be explained by the simultaneous accumulation of tyrosine and tyrosinase, although the meaning of the increase before ecdysis, which is followed in the silkworm by cuticle growth but no darkening, is less clear. However, the speculation is inevitable that one effect of the liberation of a pupation hormone may be to modify the reducing properties of the blood by dehydrogenase inhibition, so leading to the release of tyrosinase activity, the production of a polyphenol, and the ultimate hardening and darkening of the cuticle.

A full account of this work, together with observations on the structure and growth of the cuticle, will be published in due course.

[1] Bhagvat and Richter, *Biochem. J.*, **32**, 1397 (1938).
[2] Schmalfuss and Müller, *Biochem. Z.*, **183**, 362 (1927).
[3] Schmalfuss, Heider and Winkelmann, *Biochem. Z.*, **257**, 188 (1933).
[4] Prior, *Proc. Roy. Soc.*, B, **128**, 393 (1940).
[5] Dennell, *Nature*, **152**, 50 (1943).
[6] Wigglesworth, "The Principles of Insect Physiology" (London, 1939).
[7] Kuwana, *Jap. J. Zool.*, **7**, 273 (1937).
[8] Graubard, *J. Genetics*, **27**, 199 (1933).

# CHARCOAL BRIQUETTES AS LOCOMOTIVE FUEL

By DR. H. GREENE and T. N. JEWITT
Agricultural Research Institute, Anglo-Egyptian Sudan

A. F. JOSEPH and B. W. Whitfield[1] described in 1921 the production of charcoal briquettes made from Sudan woods. They used as binder gum arabic or sorghum flour, both of which are available locally. Such briquettes are satisfactory for firing a stationary boiler, but are quite unsuitable as locomotive fuel. For this use 20–25 per cent volatile matter is needed; furthermore, the briquettes have to withstand the severe conditions within the locomotive fire-box where, if the briquettes are weakly bound, forced draught and shaking may cause loss of fuel and where high temperature may produce clinker. On the instructions of Dr. J. D. Tothill, director of agriculture and forests, Sudan Government, work was resumed with the war-time object of finding a locally produced substitute for coal needed by the Sudan railways.

The previous workers had used a falling weight to compress their material. Lacking normal briquetting equipment we devised a hand-operated drop stamp mounted on wooden baulks. This drop stamp produces briquettes 7 in. × 6 in. × 3 in. at a rate exceeding one ton per working day, and enabled us to prepare the rather large amounts needed for full-scale locomotive fuel trials.

Pitch (Mexphalte *D.H.* 75/85) was incorporated with the charcoal (1 : 9 parts) and is considered essential. We had no means of steam-heating the mix as in normal briquetting practice, and therefore added gum arabic as primary binder. Ground charcoal and pitch, well mixed with water and gum solution, was stamped into briquettes by three impacts from a 75 lb. weight having 6 ft. fall. The freshly made briquettes can be handled with care and, in this hot climate, harden on drying to withstand crushing loads up to 2,000 lb. per sq. in. Strongest briquettes are obtained from a mixture containing about 60 parts water to 100 parts dry matter. Strength also depends upon a number of other factors, notably gum content, number of impacts, method of grinding, etc.

Charcoals available in the central Sudan are made from three kinds of acacia: *A. arabica* Wild., ash content 3–5 per cent; *A. seyal* Del., ash content 5–11 per cent; *A. mellifera* Benth., ash content 6–15 per cent; *A. arabica* Wild., which forms riverside forests within the 400–600 mm. rainfall belt, is of value as rough timber and also as fuel. *A. seyal* Del. is a prominent member of the thorn grassland association found on moderately alkaline clay soils receiving summer rainfall of about 600 mm. This acacia produces a marketable gum, but is otherwise useless, since when cut it is severely attacked by boring beetles (Sinoxylon spp., Bostrychidæ). The shrub-like *A. mellifera* Benth. is of use only as a source of charcoal. It is found in almost pure stands on clay soils receiving about 500 mm. summer rainfall. The charcoal used in Trials 3 and 8 (see below) was reputed to be mainly *A. seyal* Del., which is perhaps the most promising source. A consignment of *A. mellifera* Benth. charcoal was briquetted and burned in Trials 5, 6 and 7, the failure of which was due to causes not associated with the variety of charcoal used. The charcoal used in Trials 9, 10 and 11 was a well-mixed consignment believed to consist for the most part of *A. arabica* Wild. Reliable comparison of these three charcoals as constituents of locomotive fuel is not yet available, since other factors enter into the trial data. As another possible source of supply, some cotton-stalk charcoal was prepared, but owing to its high ash content (17 per cent) and low density was considered unsuitable as locomotive fuel.

It is extremely difficult to reproduce on a small scale conditions inside the fire-box of a locomotive steaming with full load. For this reason, the full-scale trial is the only valid test of a proposed coal substitute. Data obtained in such trials by inspectors of the Sudan Railways are tabulated below.

A locomotive with a 200-ton load steamed fairly well with charcoal-pitch briquettes made as described above, but it was seen that more volatile matter was needed. This was provided by dipping the air-dry briquettes in furnace fuel-oil. The mechanical strength of the briquettes is somewhat reduced by dipping in oil, but their resistance to rain is notably enhanced. In this way considerable quantities were made conforming fairly closely to the following percentage composition: charcoal, 75; pitch, 8; oil, 8; gum, 4; water (lost at 105° C.), 4. Of these constituents water is the most variable, since the charcoal absorbs 2–8 per cent water at relative humidities of 20–80 per cent. Oil content decreases with time owing to slow volatilization.

Briquettes of this type were used in a number of full-scale fuel trials using Prairie type locomotives of 33·1 sq. ft. grate area. The accompanying table gives details of successful runs which were made with service trains running to schedule at the moderate speeds customary in the Sudan. Normal

steam pressures (170–175 lb. per sq. in.) were maintained except in Trial 11.

| Trial | Load (tons) | Run (km.) | Running time (hr. min.) | Av. steam pressure (lb./sq. in.) | Fuel used (kgm.) | Equiv. evap. | Cal. value (B.T.U.) |
|---|---|---|---|---|---|---|---|
| 3 | 753 | 313 | 7 14 | 175 | 4970 | 8·06 | 12830 |
| 8 | 539 | 313 | 6 54 | 170 | 4920 | 7·33 | 12140 |
| 9 | 750 | 266 | 6 02 | 175 | 6037 | 6·17 | 13690 |
| 10 | 733 | 313 | 7 12 | 175 | 5611 | 6·88 | 13220 |
| 11 | 634 | 313 | 7 48 | 160 | 6580* | 7·23* | mixed fuel |

Representative figures for 'equiv. evap.' of coals under conditions of these trials are: Welsh or American coal, 9·4; South African, 8·7; Indian, 8·2.

In all these trials the charcoal was ground in edge-runner mills. For material used in Trials 3 and 8, the following is a specimen sieve analysis.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Less than | | 8 | 16 | 30 | 60 | 100 | 200 | I.M.M. |
| Greater than | 8 | 16 | 30 | 60 | 100 | 200 | | I.M.M. |
| | 15 | 15 | 12 | 16 | 9 | 13 | 19 | per cent |

Coarser material (less than $\frac{5}{8}$ in.) was used in Trials 9 and 11, while that used in Trial 10 was intermediate (less than $\frac{1}{4}$ in.). The trial results fell off accordingly, Trial 9 being inferior to Trial 10, which is inferior to Trials 3 and 8. With these coarser materials it was observed that a larger proportion of fuel was carried away unburned and accumulated in the smoke-box. In Trial 11 we remedied this by burning the briquettes in 50/50 mixture with an American coal, but this and other similar trials were unsatisfactory for, although no data are available as to the performance of the American coal used in Trial 11, if the average figure of 9·4 for equiv. evap. is taken, it indicates that the briquettes were burned inefficiently. The failure of such trials is due to troublesome clinker formation caused, it is thought[2], by admixture of the siliceous ash of the coal with the basic ash of the charcoal. A similar formation of clinker occurs with charcoal-pitch briquettes to which 5 per cent of siliceous fine soil has been added.

Owing to the large demand for pitch for various war purposes, we tried to do without this constituent. The briquettes, however, disintegrated in use and gave poor results (equiv. evap. 5·08 and 4·62 in Trials 5 and 7). These failures occurred although the briquettes, which had been given a higher proportion of oil, resembled the successful ones in calorific value (12310 B.T.U.) and ash content (about 10 per cent). Considerable quantities of briquettes rejected owing to mechanical weakness, damage by rain, etc., were remade and satisfactorily disposed of in shunting engines or used to fire a stationary boiler, for which purpose they roughly equalled coal.

It became clear at an early stage of our work that the grinding of charcoal to a suitable powder was the most difficult part of the whole process. The product obtained from edge-runner mills is satisfactory, but much difficulty was experienced with charcoal pulverized in beater type mills which continually produced weak or badly cracked briquettes. Internal strains are gradually released when charcoal is moistened, and we have some reason to think that this difference in behaviour depends in part on the fact that charcoal was moistened before being fed to edge-runner mills but was fed dry to beater type mills. Neither sieve analysis nor microscopical examination of the fine particles revealed any notable feature other than the rather less rounded shape of particles obtained from a beater type mill.

One satisfactory full-scale trial was carried out using briquettes made from charcoal which was wetted and then crushed by an ordinary garden roller and stirred by rakes to prevent packing of the fragments into a resistant bed. In this trial the briquettes were burned in 50/50 mixture with American coal, some steam pressure being lost owing to formation of clinker. (Trial 12. Load 777 tons; run 313 km.; running time 9 hr. 34 min.; av. steam pressure 150 lb./sq. in.; fuel used 4,938 kgm.; equiv. evap. 8·26.) Since edge-runner mills were not available for production of briquettes on a larger scale, we have devised a type of bull-drawn roller in which twin rollers are set at an angle so as to combine the shearing and crushing action such as occurs in an edge-runner mill. Strong, mechanically sound briquettes have been consistently produced by this simple means.

The experiments described above were carried out in 1942 and concluded the first part of our inquiry. We have since been filling in the gaps with a long series of fairly obvious multi-factor experiments of which the results will be published later. In 1943 some 1,000 tons of charcoal-pitch briquettes were produced, under the direction of Mr. J. Smith, chief conservator of forests, in a first attempt to use the process on a larger scale, but the briquettes disintegrated when used in main-line locomotives and had to be burned in less severe conditions. With extemporized equipment, unskilled labour and limited supervision it is difficult to turn out large amounts of a good and uniform product. Charcoal burning is now being increased, and a small briquetting factory, embodying normal industrial equipment, is in operation. In this a mixture of charcoal (85 parts) and Mexphalte *DH* 75/85 (15 parts) is steam-heated and pressed between rollers, gum and oil being omitted. The product is strong and waterproof and does not disintegrate in the fire-box. Owing to formation of clinker, however, locomotive fuel trial results have been poor (equiv. evap. 5·08, 4·95). This difficulty probably arose from use of dirty charcoal and therefore should soon be eliminated or reduced.

Our thanks are due to the General Manager, Sudan Railways, for help in the well-equipped Atbara workshops and for the skilled and willing co-operation of his staff. We are also indebted to Dr. A. J. Henry, Government analyst, for determinations of calorific value.

[1] Joseph, A. W., and Whitfield, B. W., *J. Soc. Chem. Ind.*, **15**, 190 (1921).
[2] Searle, A. B., "Refractory Materials" (C. Griffin and Co., Ltd., 1917), 48.

## RESEARCH PROGRAMME FOR SOUTH WALES

IN an inaugural address to the South Wales Institute of Engineers at Cardiff on January 20, on "Industrial Planning and Research: Catchwords or Realities?", Dr. F. J. North emphasized that our plans for the expansion of industry and for the betterment of social conditions will be useless unless the availability of the means for giving effect to them has been assured. What is technically possible is not necessarily economically profitable; the success of a venture depends on a market as well as upon raw materials, and the value of one industry is related to its effect upon others. The single-track approach to many of our problems, Dr. North said, is largely due to the gap which exists between scientific knowledge and popular comprehension of it, a gap which will only be permanently bridged when a new attitude towards science is adopted by those responsible for

the educational system of Great Britain. Discussing particular proposals such as coal and its hydrogenation, the Severn Barrage scheme and the like as contributions to Welsh reconstruction, he pointed out that such questions cannot be considered solely in terms of regional standards or local expediency. The first step in giving effect to plans for social betterment in all its aspects is to make the nation realize the extent to which its welfare depends upon coal, upon those who make it available for use, and upon those who attempt to discover how best to use it.

After reviewing the position of coal in the economic picture, Dr. North discussed the aims and objects of research. He deprecated the distinction between fundamental and industrial research as helpful neither to science nor to industry, and emphasized that research is a continuous process in which one step prepares the way for another. In the past, largely because of the abundance of the world's natural wealth to which Great Britain has access, industry in general prospered without much recourse to the results of research, but now as a nation we have to recognize the desirability of doing willingly in peace-time some of the things we are doing under compulsion in war-time. The only way to ensure a future adequacy of research is to create conditions affecting remuneration, prestige and equipment, in which research will be an attractive career, while those concerned with the commercial side of industry must be encouraged to develop a scientific outlook which will enable them better to appreciate and to respond to changes in the availability of raw materials, in public taste, and in technical possibilities. Dr. North urged that the right line of advance is to extend the existing facilities by more generous appropriations to the Department of Scientific and Industrial Research, more generous grants to the universities and more generous support from firms and industries that have not yet accepted their full share of the burden. Closer collaboration between research organizations is also required, and while there are in South Wales all the necessary elements for concerted research in the interest of local industry, there are few signs of general co-ordination. He believes that regional commissioners for the co-ordination of research might help those concerned in the industries of such a well-defined area to know what has been done or is contemplated, and at the same time keep the appropriate government department aware of the collective needs of the area.

In regard to a research programme for South Wales, Dr. North considers that a prime necessity is the vigorous prosecution of the survey of the chemical and physical properties of all the coal seams, and the completion of the geological re-survey of the coal-field. The chemical information would indicate the nature and distribution of the various kinds of coal present, and the geological survey would indicate where and under what conditions they can be mined. Given a fair idea of the trend of industrial development, it would be possible to pay special attention to mining methods appropriate to the kinds of coal likely to be in greatest demand, and to the size and degree of purity of the coal. Co-ordinated work of this kind would help the mines to meet the increasingly exacting demands of industry ; but mining research should also be encouraged to indicate the coals which can be most safely and cheaply won, leaving to industry the onus of finding efficient ways of using them. Knowledge of the varieties of coal and their potentialities must be the basis of any attempt to explore the possibilities of the underground gasification of coal, as well as of decisions concerning the kinds of new industry that can be developed and the localities in which they should be founded. Such decisions, in turn, afford guidance to those concerned in determining the position and character of new housing schemes, the facilities for access to them and the amenities required. Again, South Wales cannot afford to be unconcerned at the general lack of official interest in geological exploration, since its industries require minerals and ores not locally available.

Dr. North suggested that the basic principles should be to develop industries in which there is the greatest possible difference between the value of the raw materials used and that of the commodity or article produced, and in which the largest possible part of that difference is represented by payments to those whose services have effected the difference. Scientific and technical workers must be the guides and not the tools of the politician and financier, and the industries selected for foundation or expansion should be those which can be self-supporting at least within a reasonably short time. We should think along the lines of organic evolution, in which there is a continual reaction to changing environment by organisms which possess, in some degree, the capacity to modify or control it. An important function of the South Wales Institute of Engineers is to help create public awareness in matters appertaining to the industrial future of the region.

## INDUSTRIAL FATIGUE AND ABSENTEEISM

THE Industrial Health Research Board has issued a pamphlet (London : H.M. Stationery Office. 3*d*.) giving a survey in non-technical language of the problems of absence from work and prevention of fatigue. Merely vague statements about the excessive amount of absenteeism are valueless. It is necessary to know how much there is, to what extent it is greater than in peace-time and the conditions leading to it.

The Industrial Health Research Board has been studying the problem throughout the war years in numbers of factories of varying size and kind, and the records have been analysed. In normal times, it was usually estimated that absence should not exceed five per cent of the possible hours of work a year. During the war years, this amount has increased and is now between six and eight per cent for men and between ten and fifteen per cent for women. There are considerable variations from factory to factory. Factories of recent growth, situated far from the homes of those who work in them, employing women unused to factory work, show an absence-rate almost twice as high as some of the old-established works within easy travelling distance of the workers' homes.

In most factories it was found that the women lost about twice as much time as the men, and married women lost up to three times as much as single women. The conditions conducive to absence include excessive hours of work, bad working conditions, unexplained idle time, wages problems, lack of co-operation between managers and workers. The factory, however, is not the whole environment of the worker ; conditions outside the factory also play a part. Some of these refer to transport difficulties,

shopping, housework and children, as well as the presence on leave of husband or son. There must also be considered the less obvious but important conditions that affect the body and the mind of the individual worker; for example, boredom, lack of understanding of the value of his work, anxiety, ill-health. As much care should be taken of the health of the industrial worker as is taken of the health of the men and women in the Fighting Forces.

The accumulated effects of war-time conditions have caused in many workers a state vaguely labelled industrial fatigue, of which one expression is in absenteeism.

During a war it is impossible to avoid making heavy demands on people's energy; but it should have been possible, if adequate use had been made of the available knowledge, to have prevented some of the worst effects. Unfortunately, for diagnostic purposes the effects of fatigue and those of boredom are similar, namely, lowered output, inferior quality of work, increase of accidents, discontent, and some physical symptoms of ill-health. Fatigue and boredom also affect one's attitude to the work and to the War. The over-tired or very bored worker becomes despondent or indifferent, and tends to lose his sense of proportion in regard to himself and his surroundings, as well as to the course of the War. The remedies are not really difficult to deduce or to make effective.

The weekly hours should not exceed 60 for men and 55 for women, and even these are too high for certain classes of work. The week-end break is important. There should be adequate rest pauses within each spell of work. Attention should be given to the design and speed of machines, and to the selection and training of people for the jobs they are best fitted to undertake. Good working conditions including canteens, and rest and recreation rooms, help to decrease fatigue and boredom, and music is a very popular antidote.

The pamphlet is most attractively printed, produced and illustrated.

## NATURAL HISTORY OF THE MINNOW

MISS WINIFRED FROST has done good work on the biology and natural history of the minnow *Phoxinus phoxinus* (*J. Animal Ecol.*, **12**, No. 2; Nov. 1943). Taking Lake Windermere and one of its affluent streams, the River Brathay, as headquarters, the minnow has been studied in detail for two years. The investigation deals with its habits, growth, food and reproduction. Minnows are active and pelagic in both lake and stream from April until October, and migrate into deeper water where they are relatively passive and hidden under stones from November to March. They breed from May until July, sexual maturity in a few being reached at the end of the first year: the majority of those in their second year and all older fish are mature.

Length frequency curves supported by scale examination indicate that there are certainly three-year classes, and suggest the possibility of a fourth. The feeding habits have been studied intensively and it is found that in the lake, although a variety of food is taken, planktonic Crustacea, particularly Cladocera, form the chief food and these are also much eaten by the other fish. The supply of these organisms is, however, so large that it seems unlikely that the minnow is a serious competitor for food in this community, especially because of its inshore habits. In the river, Algæ are eaten, a much larger proportion of insect larvæ and less Cladocera and copepods. Much of the food here is similar to that of the young brown trout, and competition is likely. As to enemies, there are many, for the minnow is eaten by a few trout and many perch but not much by the pike. Eels also eat it and it forms part of the diet of the brown trout.

In Windermere and similar large lakes the conclusion is that it is unlikely that the minnow is a serious competitor for food, and it is of itself an appreciable source of food for larger fish. In running water inhabited primarily by salmon and trout the possibility of serious competition is great. So far as fishery conservation is concerned it is concluded that in general, provided the fish population is balanced with active predators to keep their numbers in check, it may be said that minnows are not inimical to a fishery. If, however, the balance is disturbed in favour of fish such as salmon and trout to the exclusion of the more active predatory fish, the minnow may multiply and become a menace.

## JUTE STUDIES

RECENTLY there have been several Indian publications upon the anatomy of jute (*Corchorus*) with special reference to the fibre production and development. Such studies are to be welcomed as affording a basis for the practical improvement of varieties and for modification of extraction and preparation methods.

An earlier paper by Prof. B. C. Kundu (*J. Indian Bot. Soc.*, **21**, 93; 1942) has been followed by Agricultural Research Memoir No. 1 from the Indian Central Jute Committee. This confirms the work of Kundu in the main particulars, though the authors, S. S. Ghosh, K. R. Rao and J. S. Patel do not agree that the original protophloem of jute is secondary in origin. Discrepancies here may be associated with the age of the shoot apex examined; certainly Kundu's figures of the early procambial strands are striking in their demonstration of the early growth being entirely by longitudinal divisions, though it may not necessarily be solely with radial seriation as in the case of cambial activity.

In *C. capsularis* these authors record the presence of a distinct periderm, not seen by Kundu, much of whose material was grown under greenhouse conditions in England; the authors note how this periderm, as also the free development of adventitious roots at the base of plants frequently flooded during growth, may prove a deleterious influence upon the ready separation of the fibre during retting.

As Agricultural Research Memoir No. 2, Messrs. J. S. Patel and S. S. Ghosh have published a preliminary study of the anatomy of retted jute. These studies have shown how progressive the isolation of the fibre strands may be; thus they may be free in the top portion of the stem in five-six days, in the middle of the stem in nine-twelve days and at the base only after fifteen-twenty days. Heavily lignified fibres resist retting, while near nodes, injuries, etc., retting is usually delayed (this was exemplified, in the case of nodes, in some photographs communicated by J. H. Priestley to the late Dr. S. G. Barker, *J. Textile Inst.*, **30**, 273; 1939). These retting studies contain some preliminary notes on retting organisms; but these need extension by isolation and culture of the organisms by the usual methods.

# FORTHCOMING EVENTS

## Thursday, July 6—Sunday, July 9

BRITISH RHEOLOGISTS' CLUB (at St. Hilda's College, Oxford).—Conference.

**Friday, July 7**

10 a.m.—"Rheology of Large Deformations and Plastic Flow", (*a*) Plasticity of Metals; (*b*) Polymers; (*c*) The Liquid State.

2.15 p.m.—"Relations between Shear, Tension and Compression in Complex Bodies (The pi-problem)".

5 p.m.—"Some Rheological Applications to Medical Science".

**Saturday, July 8**

10 a.m.—"Rheological Nomenclature and Symbols Metallurgical and Non-Metallurgical".

8.30 p.m.—"Future Organisation of Rheology".

## Tuesday, July 11

QUEKETT MICROSCOPICAL CLUB (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 7 p.m.—Exhibition of specimens and discussion.

## Thursday, July 13

SOCIETY OF CHEMICAL INDUSTRY (joint meeting of the LONDON SECTION and the INSTITUTE OF METALS) (at the Institution of Mechanical Engineers, Storey's Gate, St. James's Park, London, S.W.1), at 7.30 p.m.

## Friday, July 14

SOCIETY OF CHEMICAL INDUSTRY (at the Royal Institution, Albemarle Street, London, W.1).—Sixty-third Annual Meeting. At 11.30 a.m.—Presidential Address. At 2.45 p.m.—Prof. A. V. Hill, F.R.S.: Messel Medal Address.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Prof. J. Proudman, F.R.S.: "The Tides of the Atlantic Ocean" (George Darwin Lecture).

# APPOINTMENTS VACANT

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

ASSISTANT LECTURER or LECTURER IN PHYSIOLOGY—The Secretary, King's College, Strand, London, W.C.2 (July 11).

MISTRESS or MASTER to teach MATHEMATICS in the Junior Technical School of the Selby Art School and Technical Institute—The Secretary to the Managers, Education Office, Garforth, near Leeds (July 11).

CITY ELECTRICAL ENGINEER AND MANAGER of the Carlisle Electricity Undertaking—The Town Clerk, Town Hall, Carlisle (July 12).

ASSISTANT MASTER to teach ENGINEERING DRAWING, ENGINEERING SCIENCE, and WORKSHOP TECHNOLOGY up to the standard of the Ordinary National Certificate in Mechanical Engineering, in the Redditch Technical School—Mr. G. Brodrick, Education Office, Church Green West, Redditch (July 12).

DEPUTY BOROUGH ENGINEER AND SURVEYOR AND DEPUTY PLANNING OFFICER—The Borough Engineer and Surveyor, Town Hall, Barking, Essex (July 13).

ASSISTANT MASTER (temporary) to teach SCIENCE SUBJECTS, principally CHEMISTRY and MECHANICS, in the Junior Technical School—The Director of Education, City Education Offices, 33 St. David's Hill, Exeter (July 14).

ASSISTANT VETERINARY INVESTIGATION OFFICER at the University of Bristol Agricultural Advisory Centre—The Secretary and Registrar, The University, Bristol (July 14).

ELECTRICAL ENGINEER (temporary)—The Clerk to the East Grinstead Urban District Council, Norton House, London Road, East Grinstead, Sussex (endorsed 'Temporary Electrical Engineer') (July 14).

BURSAR to the Queen's College, Oxford—The Provost, Queen's College, Oxford (July 15).

SPEECH THERAPIST—The Director of Education, Shire Hall, Nottingham (July 15).

ASSISTANT LECTURER AND DEMONSTRATOR (woman) IN ZOOLOGY—The Principal, Royal Holloway College, Englefield Green, Surrey (July 15).

MAN or WOMAN to teach GEOGRAPHY and ELEMENTARY MATHEMATICS in the Mexborough Schofield Technical College—Mr. E. B. Stockdale, Education Office, Mexborough, Yorks. (July 15).

LECTURER (temporary) IN MINING, a LECTURER (temporary) IN MINERAL DRESSING, and a LECTURER (temporary) IN ENGINEERING—The Professor of Mining, Royal School of Mines, Prince Consort Road, London, S.W.7 (July 15).

LECTURER IN GEOGRAPHY—The Principal, Borough Road College, Isleworth, Middlesex (July 17).

DEMONSTRATOR (man or woman) in the Department of Inorganic and Physical Chemistry—The Secretary, Bedford College for Women, Regent's Park, London, N.W.1 (July 17).

GRADUATE or equivalent in MECHANICAL and/or ELECTRICAL ENGINEERING, and a GRADUATE IN SCIENCE to teach Science in Lower Forms, together with some General Subjects, in the Bridgend Mining and Technical Institute—The Director of Education, County Hall, Cardiff (July 17).

MASTER or MISTRESS (temporary, full-time) to teach MATHEMATICS and SCIENCE to Junior Technical students, ARITHMETIC to Junior Commercial students, and SCIENCE to Catering students in the Harrogate Technical Institute—Mr. W. E. C. Jalland, Secretary to the Managers, Municipal Offices, Harrogate (July 17).

ENGINEER to the Eden Catchment Board—The Acting Clerk to the Eden Catchment Board, The Courts, Carlisle (July 19).

GRADUATE LECTURER IN ELECTRICAL ENGINEERING at the Lincoln Technical College—The Director of Education, City Education Office, 4 Lindum Road, Lincoln (July 19).

DIRECTOR OF THE OTAGO SCHOOL OF MINES (University of Otago)—The High Commissioner for New Zealand, 415 Strand, London, W.C.2 (July 21).

LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Sheffield (July 28).

JOHN RANKIN CHAIR OF GEOGRAPHY—The Registrar, The University, Liverpool (July 31).

W. H. COLLINS PROFESSORSHIP OF HUMAN AND COMPARATIVE PATHOLOGY—The Secretary, Royal College of Surgeons of England, Lincoln's Inn Fields, London, W.C.2 (July 31).

SENIOR LECTURESHIP IN THE DEPARTMENT OF METALLURGY of the University of the Witwatersrand—Dr. W. Cullen, 4 Broad Street Place, London, E.C.2 (July 31).

FOREST ENGINEER for the Sierra Leone Government Forestry Department—The Secretary, Overseas Manpower Committee, Ministry of Labour and National Service, Alexandra House, Kingsway, London, W.C.2 (quoting Reference No. 1114).

DAIRY CHEMIST (University Honours Graduate, with Bacteriology training)—The Technical Office, Milk Marketing Board, Thames Ditton, Surrey.

LECTURER (woman) IN EDUCATIONAL PSYCHOLOGY—The Principal, St. Katharine's College (Liverpool), at Queen's Hotel, Keswick, Cumberland.

GRADUATE ASSISTANTS (two) qualified to teach MATHEMATICS, SCIENCE and ENGINEERING DRAWING in the Junior Technical School and National Certificate classes, at the Ashton-under-Lyne Technical School—The Director of Education, 8 Warrington Street, Ashton-under-Lyne, Lancs.

MASTER or MISTRESS for MATHEMATICS, and a MASTER for ENGINEERING SUBJECTS—The Principal, Erith Technical College, Belvedere, Kent.

# REPORTS and other PUBLICATIONS

*(not included in the monthly Books Supplement)*

## Great Britain and Ireland

Post-War Development in Radio Engineering, Part 1. Pp. 16. (London: British Institution of Radio Engineers.) [136

Natural Lighting: General Considerations for those concerned with Lighting Problems of Reconstruction. (Lighting Reconstruction Pamphlet, No. 4.) Pp. 12. (London: Illuminating Engineering Society.) 1*s*. [136

Souvenir of the Columbus Quincentenary Exhibition. Being a Descriptive Guide to the Exhibition of Rare Books relating to America, opened in the Wigan Library, May 30, 1944, by Dr. Richard Heindel. Compiled by Arthur J. Hawkes. Pp. 12. (Wigan: Public Library.) 2*d*. [136

British Rubber Producers' Research Association. Publication No. 45: The Statistical Length of Rubber Molecules. By L. R. G. Treloar. Pp. 8. (London: British Rubber Producers' Research Association.) [136

Imperial Bureau of Plant Breeding and Genetics. Bibliography on Insect Pest Resistance in Plants (with a Supplement on Resistance to Nematodes). Pp. 40. (Cambridge: School of Agriculture.) 1*s*. 6*d*. [136

## Other Countries

Educational Yearbook of the International Institute of Teachers College, Columbia University, 1943. Edited by Prof. I. L. Kandel. Pp. xi+297. (New York: Teachers College, Columbia University.) 3.70 dollars. [56

Punjab Irrigation Research Committee. Report for the Year ending April 1941. Pp. vii+234. (Lahore: Government Printing Office.) [86

Imperial College of Tropical Agriculture. Report of the Governing Body and the Principal's Report to December 31st, 1943, and the Accounts for the Year ended August 31st, 1943. Pp. 24. (Trinidad and London: Imperial College of Tropical Agriculture.) [136

Carnegie Institution of Washington. Year Book No. 42, July 1, 1942–June 30, 1943; with Administrative Reports through December 7, 1943. Pp. xxxii+208. (Washington, D.C.: Carnegie Institution.) [136

Bulletin of the American Museum of Natural History. Vol. 82, Art. 7: New England Annelida, Part 2, including the Unpublished Plates by Verrill with Reconstructed Captions. By Olga Hartman. Pp. 327-344+plates 45-60. (New York: American Museum of Natural History.) [136

University of California Publications in American Archeology and Ethnology. Vol. 35, No. 10: Observations on the Yurok; Childhood and World Image. By Erik Homburger Erikson. Pp. vi+257-302. 50 cents. Vol. 39, No. 3: Concerning the Middle Chimú Style. By Jorge C. Muelle. Pp. 203-222+plates 6-7. 35 cents. Vol. 40, No. 1: Studies in Plains Indian Folklore. By Robert H. Lowie. Pp. 28. 35 cents. Vol. 40, No. 2: Notes on Pomo Ethnogeography. By Omer C. Stewart. Pp. 29-62. 35 cents. Vol. 40, No. 3: Washo-Northern Paiute Peyotism; a Study in Acculturation. By Omer C. Stewart. Pp. vi+63-142+plates 1-2. 1 dollar. (Berkeley and Los Angeles, Calif.: University of California Press; London: Cambridge University Press.) [136

## Catalogues

Books and Prints relating to Mexico, South America, Central America, the West Indies, Bermuda, the Antarctic, with a Selection of Old Atlases and Maps. (Catalogue No. 671.) Pp. 58. (London: Francis Edwards, Ltd.)