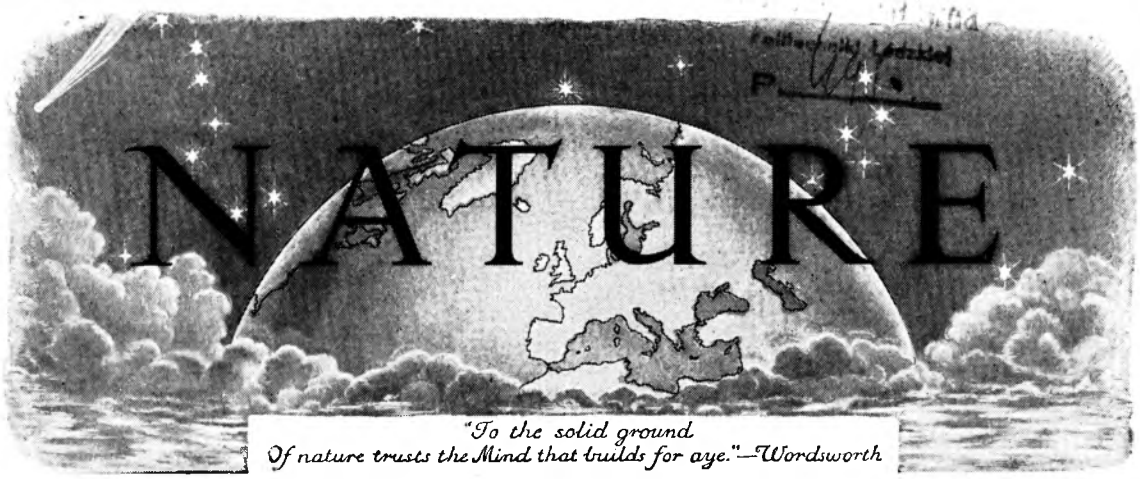

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NATURE

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UTILIZATION OF SCIENTIFIC AND TECHNICAL RESOURCES

IN the past few weeks, the movement for making fuller use of the scientific and technical man-power of Great Britain in the war effort has been increasingly to the fore. The question was raised in the House of Lords on July 29 by Lord Strabolgi, who expressed the belief that the work of the scientific men attached to various Ministries is departmentalized ; the remedy he suggested is a scientific general staff, with wide powers. The Government reply, by Lord Snell, pointed out the difficulty of arranging for an advisory or executive body which would not be responsible to a Minister, although Ministers are expected to assume full responsibility for decisions taken. He said, however, that the Government is continually considering methods of improving the present organization for utilizing the scientific and technical resources of the country. Since then, Captain L. F. Plugge, secretary of the Parliamentary and Scientific Committee, and nineteen other members of Parliament of all parties, have tabled a motion for discussion in the House of Commons urging "the early establishment of a whole-time Central Scientific and Technical Board to co-ordinate research and development in relation to the war effort and to ensure that the experience, knowledge and creative genius of British technicians and scientists exert a more effective influence over the conduct of a highly mechanized war".

The present position with regard to this thorny subject was outlined in NATURE of July 15, p. 65, following upon a spirited letter in *The Times* from Prof. A. V. Hill. The Government's attitude was defined in more detail in the debate in the House of Commons on July 14, when Mr. Oliver Lyttelton, Minister of Production, made a statement on the work of his department. In reading that statement, it is important to realize that the question at issue is not the merit of the scientific work being done, which is indeed of a high order. The crux of the situation is not the standard of work in the departments, but what is happening strategically in the use of the work of all the departments together. It is the old charge of departmentalism and the need for some properly constituted authority, with technical knowledge, centrally placed, that can insist on getting the information that it wants.

The central issue is simple enough, and it was not confused in the two days' debate. Would a central scientific direction in place of the present scattered and unrelated efforts better enable the country to convert its brain-power into the methods and the physical instruments which, as the product of ideas, win wars ? The general trend of the debate was to give an affirmative answer. At present, scientific and technical control is entirely departmental and not central, and usually at a low level, subordinate to administration. For operations, as Prof. A. V. Hill pointed out, planning has been centralized in the Chiefs of Staff organization ; for supply in the Ministry of Production ; whereas research, design, development and quantitative planning of the use of tech-

nical resources are altogether unrepresented at the highest level.

Prof. Hill's contention that there is no central technical staff or individual to advise the Cabinet or the Chiefs of Staff directly on the scientific and engineering aspects either of operations or production, or to ensure, on their behalf, that design and development are efficient and far-reaching, was not disputed by the Minister of Production. Mr. Lyttelton's attempt to show that such central direction is unnecessary did not find much support, judging from the tone of subsequent speeches during the debate. The evidence of departmental overlapping, of failure to check advance or effort on wrong lines, to correlate results and make them generally available, of lack of stimulus to the right research and of means of bringing the most important issues to the Government, coupled with the conspicuous neglect to implement the recommendations of the Select Committee on National Expenditure which was repeatedly stressed, remain disturbing.

It is not merely that the main questions as to whether our scientific and technical resources are being effectively used as a homogeneous whole, whether the advice of our committees and advisers is taken, and whether they have the authority to get done the things they advise, remained unanswered. The questions raised in earlier debates in February and in March are still awaiting answers. Prof. Hill pointedly commented once more on the research and development side of work in the Admiralty, but there has been no reply to his inquiry on February 24 regarding the scientific panel which had then been sitting for nine months to examine the scientific and technical departments of the Admiralty. Nothing further was said as to the appointment of three of the ablest scientific people in Great Britain to undertake operational research at the Admiralty, and the suggestion of a director of operational research in the combined operational or general staff has been quietly ignored. "If statesmanship and strategy are not properly provided all the time with accurate knowledge of weapons and equipment, their functions, their limitations, their cost in man-power and material for production, and their availability, we are heading straight for destruction. An expert knowledge of modern arms and their interaction with one another in operations against the enemy is an essential part of the directing brain centre in modern, world-wide technical conflict." These words, with which Prof. Hill in his speech on February 24 built up his case for a General Staff with executive functions, including a technical section of young and able officers, proved prophetic in the light of disasters in Libya. That alone sufficiently endorses the plea for providing on the qualitative side some high-level central body to see that the scientific and technical resources of our departments and the country are properly and effectively used, and that all technical activities of the departments are critically examined and their defects rectified.

The uneasiness on this point will persist while there is such studied indifference to the critical examination of many aspects of production which is contained in the fifty or so reports of the Select Committee on National Expenditure. The work of that Committee has been one of the most striking vindications of the Parliamentary system that has come out of the War, and yet, as Mr. A. Edwards pointed out on March 25, scant attention has been given to its reports, either by the House of Commons or by departments. The same point was made repeatedly in the debate on July 15. Sir Herbert Williams reminded the House that the vital importance of close contact at all stages between those engaged in design and those engaged in production was emphasized in the Committee's Second Report presented on April 18, 1940. His emphatic protest against the failure of Governments and Ministers to give effect to recommendations carefully thought out and based on full evidence was strongly supported by Mr. Price as well as by Sir George Schuster, who quoted from the Prime Minister's own Romanes Lecture at Oxford in 1930 on the functions of Parliament in dealing with economic problems: "Economic problems . . . cannot be solved by any expression, however vehement, of the national will, but only by taking the right action. You cannot cure cancer by a majority."

That is equally true of production, and it is no use pressing for a central scientific directing council unless there is in the Government the will, the vision and the determination to compel action on the ascertained facts, no matter what departmental privileges or other vested interests and private considerations must be overruled. A great Minister must to-day be more than the great advocate of which Bagehot writes. We have to secure that everywhere in control of policy and action there are alert and creative minds alive to the inherent possibilities in technical advance and competent not merely to match and counter, but also to surpass the developments and innovations of the enemy. Those are the standards, not social status, by which we must measure the competence, efficiency and dynamic qualities of an individual or a department, and while we may welcome the Minister of Production's assurance that an investigation is being made into scientific organization, and that of the Minister of Supply regarding the equipment for scientific research under the Tank Board, as well as for development and for practical knowledge of all kinds, the latest developments in the organization of the Ministry of Production will by themselves not meet the situation, though they are welcomed and will be followed with a lively interest.

There is no evidence of any desire to insist on the precise form in which the need for central scientific direction should be met. Since the debate an important deputation from the Parliamentary and Scientific Committee has waited on Mr. R. A. Butler, chairman of the Scientific Advisory Committee and president of the Board of Education, and asked the Government to set up a full-time Scientific and Technical Board (NATURE, July 25, p. 116), which would bring together all the essential information that is available, to link up the scientific and technical direction of the departments connected with the War and to influence the War Cabinet and the Chiefs of Staff as necessary.

On a further point also Prof. Hill has clearly won support for his views. He has directed attention to the contrast between our own haphazard system and what is being done in the United States to ensure that the best scientific ability works with the high command. The growing importance of linking our production and resources as closely as possible with those in the United States, the very account of the formation and work of the Combined Production and Resources Board which Mr. Lyttelton gave in his own speech, emphasize the importance of improving organization and relations at this point. But there is no properly organized central agency for bringing together the work of all the missions to the United States. We cannot wisely allow the departments to continue individually to send their missions, not in contact with one another and not co-ordinated with each other's activities. With central technical direction, it would be easy to establish a central information bureau from which scientific and technical liaison could be conducted so as to ensure that departmental missions are at least in touch with one another and that people at the centre know what all of them are doing.

The latest report of the Select Committee on National Expenditure heavily underlines all that has been said in these debates about our lack of full use of scientific knowledge, our tendency to use it as a last resource instead of in the earliest stages, and of the need for what Mr. P. L. Horabin described as a Ministry of Efficiency. If in such matters the Select Committee can advance such a damning indictment of the neglect by the Ministry of Supply of the elementary technique, tools and principles of scientific management few will be so far reassured by the Minister's statements in the debate on production as to cease to press for further co-ordination in matters affecting the use of scientific or technical knowledge.

It is true indeed that we need to become as a nation more achievement-minded, and that the wise use of industrial psychology and effective personnel management in the factory might do much to see better results from the labour force already deployed in the factories. That, however, is only a special aspect of scientific management which industry has long been accustomed to employ, although as the Select Committee observes, only within the last twelve months has there been in the ordnance factories any organized labour management as it is understood in well-run private industry. What is in fact required in the whole field of production, in its qualitative and in its quantitative aspects, is the thorough-going application of exactly those principles of administration which private industry is accustomed to apply unceasingly: far-sighted planning; effective co-ordination and sound organization; effective machinery to ensure that action is taken in accordance with decisions and policy determined; systematic control of efficiency; and the clear delegation of responsibility and the endowment with and use of adequate authority at every point in the chain. Flexibility, decision and purposeful action, co-ordinated and inspired by wise leadership, these are the essentials in war production, and great as have been many of our achievements in the last three years, our effort halts of its maximum until their influence is felt in every phase of our war production and every corner of the national economy.

The attention now rightly being directed to the place of scientific and technical men in the war effort, and the scrutiny of our own organization to that end in the light of American experience, should not lead us to overlook the fact that failure to implement the suggestions or to utilize effectively the knowledge or experience of men of science are only one aspect of a general failing. The memorandum presented to the Minister of Production last March by the Council of the Institution of Production Engineers on "Increasing Production without Increasing Facilities", like the reports of the Select Committee on National Expenditure, testifies to this. Its suggestions for increasing machine activity, regarding the simplification of design, rationalization by standardizing on fewer types or by sub-dividing production between fewer firms, and the introduction of improved manufacturing methods, have for the most part already been advanced by the Select Committee or elsewhere, but it is clear that inadequate use is still being made of the services of the members of the Institution although their availability has long been brought to the notice of the Ministry.

Very clearly, matters cannot and will not be allowed to rest as they are. However capable the president of the Board of Education may be, he ought not to be asked to combine with his departmental duties and responsibilities those which the chairmanship of the Scientific Advisory Committee should involve if that body is to make the maximum contribution towards resolving the present hiatus between expert knowledge and effective action. Whether or not the plan of a joint Technical Board is adopted, it is essential that those responsible for effecting the necessary co-ordination should be freed from other duties and able to devote their full time to the work. The second essential condition is that, individually and collectively, the members of the co-ordinating body should possess the scope and the authority to exercise leadership, and not merely advisory functions. They must be able to compel attention to the scientific and technical issues that come before them, and to override any attempt at departmental delay or frustration.

The establishment of some such small body is the surest way of ensuring that the best use is made of the scientific and technical resources of Great Britain in all branches of the war effort. That establishment, and the steady functioning of such a board when established, will call for unceasing pressure and vigilance from the general body of scientific workers, as well as from that increasing section of the general public which is now becoming aware of the dangerous consequences which have flowed from the Government's failure to deal with departmentalism and to heed the repeated warnings of disinterested and expert opinion of all kinds in matters affecting the efficiency of production and the utilization of expert knowledge.

THE STUDY OF RACE

Race, Reason and Rubbish

By Dr. Gunnar Dahlberg. Translated from the Swedish by Prof. Lancelot Hogben. Pp. 240. (London : George Allen and Unwin, Ltd., 1942.) 8*s*. 6*d*. net.

Race and Racism

By Ruth Benedict. Pp. viii+175. (London : George Routledge and Sons, Ltd., 1942.) 7*s*. 6*d*. net.

NEARLY all proposed solutions of problems of zoological classification have been of provisional value only. Of all such problems, the discrimination of natural subgroups of modern man and the evaluation of their interrelationships must have been the most discussed and the most controversial. The relevant evidence is far more extensive for *Homo sapiens* than for any other species, but no agreement regarding its racial classification has yet been reached. Darwinism altered the course of the study, but it did not provide a solution. More recently, reconsideration has been necessitated by the rapid increase of knowledge regarding heredity.

Prof. Dahlberg's book provides a lucid discussion of those aspects of genetical fact and theory which have a bearing on the racial problem. It is not assumed that the reader has any acquaintance with the subject. The first half of the volume, dealing with the mechanism of individual inheritance in general, is followed by chapters on differences between human populations. Finally, the "rubbish" referred to in the title is discussed : this is the Nazi racial doctrine and its application to Jews in particular.

There is no other account of modern genetics which has the same scope, and it will be welcomed especially by anthropologists. While appreciating that the evidence in question is relevant, they may reflect that it serves rather to emphasize the complexity of their racial problem than to provide a solution of it. In common with many other geneticists who have recently discussed problems of group heredity in man, Prof. Dahlberg considers populations as "isolates", though it is admitted that "species are the smallest groups which have sharp boundaries". In fact, there is no evidence that any subgroup of the existing species of man was detached from all other subgroups at any period. The general rule is that the geographical distributions of anthropological characters show gradations, and they fail to make any abrupt distinctions between populations. The records relating to series of living people and skeletons fail to suggest that any biologically isolated communities have ever existed, and this is the peculiar difficulty of racial classification. In view of a descriptive situation of this kind, the anthropologist may feel disappointed when the geneticist remarks : "Unless a racial group constitutes an isolate, or was formerly one and is now in process of breaking up, it has obviously no special interest for us."

One kind of aid which genetical theory can give to those engaged in dealing with this involved problem is well illustrated by a discussion in "Race, Reason and Rubbish" of the stature of Swedes in modern times. As for several other European populations, the records show that there has been a secular increase in the average measurement since about 1850. This trend has often been attributed to nutritional and other improvements in the standard of living, though there are objections to such an explanation. An alternative one suggested is that the change has been a result of the breaking up of isolates. The tentative argument is :

"Stature depends on a number of genes which reinforce one another. It is reasonable to assume that different genes occur with different frequencies in different isolates. Through the break-up of isolates these genes have been spread out in single dosage. If tallness depends on dominant genes, the break-up of isolates must, therefore, bring about increase of stature." If this view is correct, then stature still fails to satisfy the ideal requirements of a character used for taxonomic purposes.

Scientific workers have been unable to reach agreement in defining the concept of race, or in deriving a particular racial classification. They have no core of established opinion regarding such questions which might have been incorporated in the educational tradition. This failure left the way open to those who supposed that group relationships may be inferred not from biological facts, but from the cultural evidence of early historical records and language distinctions. It was discovered later that the idea of race may be used (or misused) to serve the political purposes of national propaganda.

"Race and Racism" is concerned primarily with this last question. It is divided into two parts. The first gives a popular account of the facts regarding racial differences which are commonly set forth by teachers of anthropology. It deals with such questions as the physical characters used, their genetical interpretation, group differences in mental traits, and the effects of the migrations and minglings of peoples. The treatment of these topics adequately refutes certain misconceptions and falsifications of the evidence, but it leaves the impression that the concept of race is still ill-defined.

The second part of the book deals with "racism", which is said to be "the dogma that one ethnic group is condemned by Nature to congenital inferiority and another group is destined to congenital superiority". This is considered as a communal belief, like a religion, which must be studied historically. Its descent is traced through classical and medieval times to the age of European expansion, and on to the culmination reached in the Third Reich. It is convenient to have a single word to denote the idea of group antagonism, but it may be questioned whether "racism" is the right word. Race did not become a political cypher until it was used in the interests of particular nations during the decades following the Napoleonic wars.

In order to counteract its misuse, Dr. Benedict urges the plea voiced by all detached students who have seriously considered the matter. The need is for widespread teaching of the biological facts of race and their bearing on the origin and development of culture. It is emphasized that such teaching by itself could not be expected to go far towards fostering racial tolerance. To serve that purpose effectively, it should be part of a syllabus concerned with the functioning and ideals of a democratic social order.

Racial dogma had been of political significance in Germany in earlier times, but it was left to the Nazi party to adopt it as the basis of the avowed national policy. The form of the doctrine was specially adapted to excuse persecution of Jews. Beyond that, in fact, no attempt was made to apply the theory : when the henchmen of the Führer were selected, no regard can have been paid to the physical qualities said to indicate pure Nordic

descent. But it must have been supposed that the ruse worked sufficiently well, for, otherwise, another would doubtless have been substituted for it. It was possible to exploit the idea of race for propaganda purposes because its scientific investigation had led to no precise and final results. By ruthlessly disregarding all inconvenient facts, it was possible to adapt the doctrine to the changing needs of the political scene. In essence it was anti-scientific and in application entirely unscrupulous. This is a question which might well be considered by those engaged in examining the social and international relations of science.

ACOUSTICAL FACTORS IN PLANNING BUILDINGS

Practical Acoustics and Planning against Noise

By Hope Bagenal. Pp. xi+146. (London: Methuen and Co., Ltd., 1942.) 7*s*. 6*d*. net.

IN buildings of almost every type acoustical problems may arise in one form or another, ranging from the avoidance of noise from neighbours in small houses and flats to the provision of good hearing conditions in concert halls and cathedrals. It cannot be repeated too often that acoustical requirements should be considered from the very beginning of planning, and should be given due weight compared with other factors which affect the general lay-out, form and construction of the building. Mr. Bagenal, writing for students, and also for builders and architects with practical problems before them, expounds this principle very effectively in the book under notice.

The avoidance of noise is often the main acoustical need. In small buildings it may only be the noise of neighbours or of the plumbing, but in larger buildings more sources of noise, such as lifts and air-conditioning plant, may have to be considered. Moreover, different types of building—hotels, offices, hospitals, etc.—present their own special problems. These and other buildings are considered in detail, and the most effective methods of avoiding noise in the initial planning, so as to minimize the need for special sound-insulating constructions, are explained. The methods of providing good sound insulation in partitions, and good insulation against impact noises in floors, are described, and details of practical forms of construction are illustrated.

The last half of the book is devoted to the other major acoustical problem, that of providing good hearing in auditoriums. Here the requirements are adequate loudness, absence of echoes (especially of concentrated echoes arising from focusing of sound by large concave surfaces), and reverberant conditions appropriate to the functions of the particular auditorium. These factors are considered both in general and with special reference to different types of auditorium ranging from the small committee room to the large concert hall.

The author is at his best in dealing with the practical aspects of his subject, and makes effective use of existing buildings in illustrating his points. The short chapter surveying the acoustical defects of modern building types is especially valuable, and could be read with advantage by all members of building committees. Acoustical requirements may conflict with other needs, but they must never be ignored in the hope that everything will turn out satisfactorily in the end. Attempting to design for a multiplicity of functions may lead to failure to provide satisfactorily for any one, and the author wisely advises against such features as suites of committee rooms with folding partitions to permit them to be thrown into one, or a greater and a lesser hall, communicating for large assemblies, but intended also for separate simultaneous use.

The weakest part of the book is that devoted to the theory of building acoustics, and the physicist will find much to criticize here. The 'phon' and the 'decibel' are old stumbling blocks, and Bagenal fails to surmount them successfully. His statement (p. 64) that "where noise measurements of the insulation of a wall or floor are made by comparing energies measured on the source side and then on the receiving side, that is, where they are *differences* between measurements, it is clear that either unit can be used" is quite wrong. At low frequencies the sound reduction in decibels may be very different from the sound reduction in phons; the former, moreover, is independent of the absolute level of the sound intensity but the latter is not. Similarly (p. 88), the reverberation period of an auditorium is the time taken for sound to decay by 60 db., and is not in general the same as that for a sound of loudness 60 phons to decay to inaudibility. In the table on p. 97 the absorption coefficients of surfaces are specified as being in foot units. The absorption coefficient of a surface is a pure number and thus independent of any units, and the same coefficients are applicable whether areas are measured in square feet or square metres. (The units are rightly stated in dealing with persons, chairs, etc., for the numbers here are the areas of totally absorbing surface which would provide the same absorption.)

These defects are unfortunate in a book intended for students, and the theoretical grounding should be sought elsewhere. Nevertheless, the student, the builder and the architect will all find the book of great assistance, not only in indicating the methods of dealing with specific cases, but also in directing their ideas generally along the lines to be followed in approaching all problems in building acoustics.

N. FLEMING.

AUTOBIOGRAPHY OF AN INDIAN CHIEF

Smoke from their Fires

The Life of a Kwakiutl Chief. By Prof. Clennan S. Ford. (Institute of Human Relations, Yale University.) Pp. xiv+248+4 plates. (New Haven, Conn.: Yale University Press; London: Oxford University Press, 1941.) 18*s*. 6*d*.

ONE of the interesting features of this book lies in the fact that it covers the period of the first impact of white civilization on the native culture. The story is told by Charley, a Kwakiutl chief, born before there was much change in the native mode of life. Owing, however, to his elder brother's admiration of the white people's civilization, Charley was sent to school where he learnt English, and was thus able to give an account of his own life-history. He must have been a man of exceptional intelligence as well as possessing the good memory which characterizes peoples who have no written language and therefore have to depend upon oral tradition.

Charley's story of his life is no mere catalogue of events, but a full and reasoned account that illustrates, as it goes on, the social and material culture of his tribe, and many of their customs appear under a new light with his explanations of their meaning. This method of presentation is interesting and gives one the feeling almost of personal contact with the tribe, but it has the disadvantages of a good deal of repetition and a sometimes cloying amount of detail. This, however, is probably unavoidable in the circumstances, as over-editing and precise arrangement would destroy its human touch.

Apart from the sequence of nurture from birth to manhood, perhaps the most interesting part of the book is that which deals with the ceremonial life of the Kwakiutl and especially with the holding of the potlach. Charley was a firm believer in these and was at great pains to describe their procedure and significance. Even after they were forbidden by law he continued to hold them, or their equivalents, and thus they are probably the last to be documented by an actual participant. The potlach was no indiscriminate distribution of gifts—usually blankets—but an ordered ceremony in which the rank of each guest was indicated by the number of blankets he received. Each important step in the life of an individual was marked by a potlach, and could scarcely be achieved without it. The more important the status of the donor, the larger the gifts, and thousands of blankets changed hands at a sitting. As a blanket represented wealth and could always be exchanged for other goods, a man's position could be estimated by the number of blankets he owned—or were owing to him, for frequently blankets had to be borrowed, at a high rate of interest, by a man who wished to give a potlach. Moreover, as a man expected, sooner or later, to receive back from each of his guests the same number of blankets that he had given them, a potlach ceremony might be regarded as a kind of investment with the goods still in active circulation instead of being hoarded uselessly. These blankets were originally of native manufacture, of woven cedar bark or of skin; but with the coming of the whites they were soon superseded by the Hudson's Bay Company's trade blankets, which could be obtained readily in exchange for pelts. Potlaches did not always involve the distribution of blankets, for money, canoes or other recognized articles might be used, and at the potlach that took place a few years after a wedding in connexion with the marriage payment by the bride's family, there was always a distribution of household articles —boxes, mats, baskets and such-like.

In spite of his association with white people which was lifelong though intermittent, Charley retained his belief in sorcery, which in his youth was widely practised. The sorcerer, as is usual, had first to obtain some samples of the personal belongings of the individual to be bewitched—such as hair or nail clippings—which were put inside a human corpse, if possible, or if not into the body of some dead animal, which was sealed up and exposed. Whatever happened thereafter to this body would affect the sorcered person, and at its decay the victim would die, unless someone found the corpse and removed the contents. Sorcery was a dangerous trade and liable to punishment by death if discovered, but it was carried on all the same, and Charley gives a good many examples of it throughout his narrative, including his own experiences when a love charm was worked on him by a woman.

Charley must have been one of the last of his tribe to undergo the rigorous initiation ceremonies then practised on boys, including the warrior's dance when twigs were inserted through his flesh and he was lifted by them and was also cut by knives. He said that he felt scarcely any pain at all; indeed the whole boyhood training involved a stoical attitude towards suffering, a trait he seems to have retained throughout his life, as when he was nearly seventy years old he insisted on undergoing two operations to his hand without an anæsthetic.

Perhaps the most important part of the book to students is the author's forty-page introduction, which gives a clear account of the Kwakiutl, their tribal customs and social fabric. Without this, Charley's narrative would lose much of its value, and it provides a concise summary of a North-western culture. As a book of reference, this volume's usefulness is impaired by the lack of an index.

K. RISHBETH.

DERIVATION OF PETROLEUM

Source Beds of Petroleum

By Parker D. Trask and H. Whitman Patnode. Report of Investigation supported jointly by the American Petroleum Institute and the Geological Survey of the United States Department of the Interior, from 1931 to 1941. Pp. xiv+566. (Tulsa, Okla.: American Association of Petroleum Geologists, 1942.) 4.50 dollars.

ALTHOUGH a great deal has been written concerning the probable origin of oil, relatively little has hitherto been published on the nature of the substances from which it is derived. This has been largely due to the scarcity of data relating to the organic constituents of sediments. In 1926 the American Petroleum Institute, recognizing the vital need for such information, instituted a comprehensive study of source beds. Afterwards, in collaboration with the United States Geological Survey, the Institute extended this study of lithified deposits to embrace all aspects of the problem of origin and environment of source beds of petroleum. Results of these investigations are fully reported in this publication and an indication is given of the lines on which further research might profitably be undertaken.

As a basis of correlation approximately 35,000 samples were examined, of which 32,000 were well samples and 3,000 were outcrop samples. Of these 14,000 were from California, 6,000 from the Mid-Continent, 500 from West Texas, 3,500 from East Texas Basin, 2,000 from the Gulf Coast and 3,000 from the Appalachian area.

The method of examination was to compare the properties of the sediments within 200 feet of the oil zones with those more than 500 feet away to ascertain if consistent differences existed. Because of the large number of samples, attention was focused on properties of sediments which could be determined rapidly and with reasonable accuracy. Eight properties studied were: organic carbon content, nitrogen content, reduction number, assay number, texture, content of bituminous substances, colour and calcium carbonate content.

It was found that the nitrogen-reduction ratio, which is the ratio of the assay number to the reduction number and is a rough measure of the degree of

volatility of the organic constituents, had a fairly definite relationship to the occurrence of oil, this ratio being generally low in sediments closely associated with known oil zones and generally high in barren beds or in sediments remote from known oil zones. The ratio ranged mainly between 3·0 and 10·0, and it was concluded that formations in which the average ratio is less than 5·0 could be considered definitely favourable for the finding of petroleum; those in which it is 6·0 were regarded as encouraging; those in which it is 7·0 not particularly encouraging; and those in which it is more than 8·0 definitely unfavourable.

The investigation is not claimed to have solved the problem of source beds, though considerable progress has been made. It is suggested that future research should be more detailed and that special attention should be given to sediments which, because of their stratigraphical relations to known oil zones, are almost certainly source beds. Investigations of this character would involve special chemical and physical methods such as X-ray and ultra-violet ray studies, chemical analyses of organic constituents and determinations of the state of reduction by more refined methods than have hitherto been employed.

PSYCHOLOGICAL STUDY OF TWINS

Twins and Super-Twins

A Study of Twins, Triplets, Quadruplets and Quintuplets. By Prof. Horatio Hackett Newman. (Advancement of Science Series, No. 1.) Pp. 164+15 plates. (London, New York and Melbourne: Hutchinson's Scientific and Technical Publications, 1942.) 10*s*. 6*d*. net.

ALTHOUGH, as the Registrar-General's recent report on fertility shows, one out of every forty-four persons born alive in England and Wales is a twin or super-twin—to use Prof. Newman's convenient term for individuals born more than two at a time—plural births usually occasion surprise and sometimes consternation. It was natural that the first quintuplets known to have been reared should attract popular interest; but it was not anticipated that the Dionne children would rival Niagara Falls as an attraction for foreign visitors to Canada. In writing a book designed to sift fancy from fact and to give a popular account of scientific knowledge about twins and super-twins, the author is sure of a wide circle of readers. It is only possible here to touch upon a few aspects of such a work.

Of the twins born in the United States during 1890–1900, 26 per cent are estimated to have been monozygotic, and the author states that 3–4 times as many dizygotic twins and 6–7 times as many monozygotic twins are born dead as is the case for singly-born children. The 1938 fertility statistics of England and Wales have shown that probably 25·4 per cent of twins born were dizygotic, and that the proportion of still-born was 83 per 1,000 for twins of like sex, 63 for twins of unlike sex and 37 for singly-born children, a very different ratio which does not, however, comprise abortions. The twin frequencies in different countries, set out in Table I, leave the reader in doubt as to the period covered, and nothing is said as to the probable effect of differing maternal age distributions, which have changed rapidly in some countries. This table and the conclusions drawn from it may be misleading, for while Norway is given a frequency of 1·45 twin maternities in each 100, and Italy 1·16, the percentage frequency of multiple maternities in 1934–36 was 1·35 in each of these countries, as a table in the Registrar-General's report indicates. A higher frequency in Scandinavia than in the British Empire (United Kingdom 1·21, Canada 1·18, New Zealand 1·17, South Africa 1·10) or in the United States (1·17) seems to be established by recent figures, but otherwise no firm conclusion can be drawn.

The summary of recent facts about monozygotic twins reared apart and about the Dionne quintuplets is, perhaps, the best part of the book. After ten years of patient search twenty pairs of monozygotic twins who had been separated in infancy and brought up in different circumstances have been found and studied. Of these, four pairs had experienced wide differences in education, and their discrepancies in intelligence quotient (Stanford-Binet) amounted to 24, 19, 17 and 12 points, whereas in the remaining sixteen pairs whose education had differed only slightly the average discrepancy was no more than that for monozygotic twins reared together. The author's conclusion that the intelligence quotient is not fixed by heredity alone but can be changed considerably by education is a useful corrective to the widely held belief that intelligence quotients are measures of innate ability which are scarcely affected by education or environment. Furthermore, it shows that some conclusions which have been drawn from comparisons between the average intelligence quotient of groups of people educated under widely different circumstances of time and place, as for example parents and their children, are invalid. Innate ability cannot respond fully to most intelligence tests unless there has been an adequate educational background. On the other hand, the maximum response to such tests obtainable by dint of education is definitely limited by capacity of genetic origin, and it is not surprising that, despite the well-nigh perfect conditions of upbringing of the monozygotic Dionne quintuplets, identical hereditary factors seem to be imposing very similar limitations of mental development upon them all.

ENGINEERING MATERIALS

Materials Handbook

An Encyclopedia for Purchasing Agents, Engineers, Executives and Foremen. By George S. Brady. Fourth edition. Pp. vii+591. (New York and London: McGraw-Hill Book Co., Inc., 1940.) 35*s*.

THE sub title of this handbook gives the clue to the mode of treatment of the subject matter, and so inactivates the critical faculty of anyone who would judge it as a strictly scientific work; but it may at once be said that the information provided, being accurate and clearly presented, will be most useful to the readers for whom it is intended. The author wisely keeps to facts and ignores opinions, and his assiduity in collecting and fashioning the information over a period of twenty years deserves high commendation.

Although errors and omissions are remarkably few, considering the magnitude of the work, attention may usefully be directed to some of them. It will be news to the modern educated engineer to learn that

oxalic acid is made by the action of nitric acid on strong alkalis (p. 349), and even a fourth-form schoolboy will smile at the statement that the specific gravity of degras (unpurified wool fat) is about 92 (p. 162). No doubt the latter is an uncorrected printer's error, as also is the formula $NaSO_4$ for saltcake (p. 472), and the statement that benzyl bromide is made by mixing bromide and toluene (p. 63). Trade buyers, executives and foremen, in particular, are unlikely to be edified by the assertion that dextrine is "a starch with a smaller value of x in the molecule"; and though, as the author states, it was clearly impracticable to give references or quote authorities, one would like to have corroboration of the statement that acetic acid occurs in citrus fruits and vegetables (p. 5).

Among the few omissions noted is the absence of any reference to synthetic acetic acid and the manufacture of nitric acid by oxidation of ammonia. There is a great wealth of data concerning metals and alloys, but chemical materials are treated somewhat cavalierly; for example, only eight lines are given to methyl alcohol, fifteen to benzene and seventeen to 'alkalis'; in fact, a better title for the book would be "Handbook of Engineering Materials". British trade names are conspicuously few, but no doubt a limit had to be set to the size of the volume; as it is, no fewer than about 4,500 substances are dealt with, and this fact alone should ensure a wide and successful appeal among those who desire a reliable and reasonably up-to-date compendium of the marketable commodities used in engineering and allied industries.

E. H. TRIPP.

MODERN STATISTICAL METHODS

The Fundamental Principles of Mathematical Statistics

With Special Reference to the Requirements of Actuaries and Vital Statisticians; and an Outline of a Course in Graduation. By Hugh H. Wolfenden. (Published for the Actuarial Society of America, New York.) Pp. xvi+379. (Toronto: The Macmillan Company of Canada, Ltd., 1942.) 5 dollars.

Sampling Methods in Forestry and Range Management

By F. X. Schumacher and R. A. Chapman. (Duke University School of Forestry, Bulletin 7.) (Durham, N.C.: Duke University Press, 1942.) 2 dollars.

THE contemporary population of the United States seems to have not only a taste but also a distinct genius for statistical research. It does not follow, however, that American mathematicians have at all uniformly shown a talent for expounding mathematical statistics. The contrast is one of the most interesting in contemporary science. Obviously it springs largely from the detachment and isolation of many mathematical departments from the fields of application; so far that expositors do not appreciate, or indeed even know of, the mathematical advances used in practice. This paradoxical situation has, of course, its lessons for other countries and for other disciplines.

Mr. Wolfenden has written an original book. It is scarcely what its title (on the cover) claims, a presentation of "The Fundamental Principles of Mathematical Statistics", but rather an introductory course of reading for actuarial students, and "an Outline of a Course in Graduation". This course, which occupies two thirds of the book, is divided into three sections: (*a*) history; (*b*) mathematics and interpretation; and (*c*) applications.

The stress laid by the author on the importance of history is most refreshing:

"I therefore believe it essential to the proper understanding of any subject to absorb the history of the mental processes which have guided its development. This study, accordingly, is framed on that conviction. It is hoped, however, that the arrangement used will enable the reader to acquire the background easily, and in a manner less destructive of imaginative interest than is so often inseparable from the teaching of history *per se*."

A text-book is often thought to be a suitable sarcophagus in which to lay undisturbed the embalmed remains of obsolete methods. One valuable use of a historical as contrasted with a mathematical section might be to separate the living from the dead. The contributions of the twentieth century have, however, suffered in Mr. Wolfenden's hands. "Student's" method is much ill treated, and I read with pain of the analysis of variance "arising from Lexis's theory, based in fact upon the 'correlation ratio'". Such comments are not historical. I venture to suggest that the first two hundred papers, at least, employing the analysis of variance do not make any use of Lexis's theory, or of the correlation ratio; and, for such part as I had in developing the method, I was at that time strongly conscious of the failure of the methods developed by Lexis and Pearson to solve even the simpler problems of this type which they discussed.

Whereas Mr. Wolfenden's title seems to invite too wide a class of readers, Schumacher and Chapman's paper-covered bulletin from the School of Forestry at Duke University, entitled "Sampling Methods in Forestry and Range Management", might properly have been addressed to a much wider audience. It constitutes an altogether excellent introduction to modern statistical methods, and its success in this respect seems to flow directly from the fact that the authors' aims are not academic, but are concerned only with a competent planning and handling of this aspect of practical forestry.

The utmost care is taken to give the reader a clear grasp of the elementary concepts which all statistical work involves; but this does not mean that only unimportant ground is covered. Degrees of freedom are introduced in the first chapter; "Student's" method and inferences of fiducial probability appear in the second. Part 2 is concerned with direct estimates by sampling, introducing the effects of the finiteness of the population sampled; stratified random sampling; the simultaneous use of several variates; sub-sampling and representative sampling. Part 3, on indirect estimates, gives a thorough account of the uses of regression, not neglecting the use of weights.

An appendix includes technical notes on mathematical points requiring further discussion than that given in the text. In respect of the factor $\left(1-\frac{n}{N}\right)$ used in the variance of samples from finite populations, I would suggest that the student can gain a clear idea of its origin from the circumstance that sampling errors only affect his estimate of that fraction of the whole which is not included in the sample. The technical note on this point thus seems unduly heavy.

R. A. FISHER.

MECHANISM OF METALLIC FRICTION*

By DR. F. P. BOWDEN and D. TABOR

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AN experimental investigation of the kinetic friction of non-lubricated metals has shown that, in general, friction cannot be regarded as a surface effect. Penetration and distortion occur to some depth beneath the surface, and the frictional force and the nature of sliding are both influenced by the bulk properties of the metals. The physical properties of the metals, such as their relative hardness and melting point, play an important part. In fact, it has been shown that the nature of the sliding and the value of the friction are largely determined by these factors, and it has been suggested[1,2,3,4] that the frictional resistance between unlubricated metals is due primarily to the shearing of the metallic junctions formed by adhesion and welding at the points of contact, and to the work of dragging or ploughing the surface irregularities of the harder metal through the softer one. Even if the metals are carefully polished and are made as flat as possible, hills and valleys which are large compared with the dimensions of a molecule will still be present on the surface, and contact will occur only locally at the summits of these surface irregularities. The formation of metallic junctions between the surfaces will, of course, take place with cold metals. It has been shown that when the speed is slow or when the surfaces are stationary, so that there is no question of temperature rise, the high pressures at the points of contact will readily cause local adhesion and welding.

If the load and speed are sufficiently great, the frictional heat may raise the local surface temperature to a high value, so that a softening or even melting may occur at the points of contact. The occurrence of these high temperatures may be demonstrated by measurements of thermal electromotive force[5] and by polishing experiments[6]. If the loads are relatively light or the sliding speeds are slow, the temperature is, of course, too small to affect sensibly the mechanical properties of the metals. This is made clear in the original papers, where the actual conditions necessary for high temperature have been determined; but it is emphasized here, since there seems to have been some misunderstanding on this point. Other workers[7,8] have reported that when the average sliding speed of the surfaces is slow, the momentary temperature rise is of the order of 30–50° C. These measurements are in sensible agreement with ours. There seems little doubt, however, that under many of the conditions of load and speed used in practice, the local temperatures reach a high value. Independent evidence for the occurrence of these high temperatures has recently been obtained by other observers[9,10,11]. These observations are of importance, since it means that, under these conditions, the frictional behaviour of the metals and of lubricant films on them will be determined not by their properties at room temperature but by their properties at the actual temperature of sliding.

The physical processes that occur during sliding are obviously very complex, but an attempt has been made to put this theory on a more quantitative basis and to make an approximate calculation of the friction in terms of the known physical properties of the metals. It is suggested[12] that we may, in general, write the frictional force F as $F = S + P$, where S is the force required to shear the metallic junctions and P the force required to displace the softer metal from the path of the slider. A simple theoretical treatment enables us to calculate, for sliders of different shapes and sizes, the values of F, S and P in terms of the shear strength s and the 'flow pressure' p of the softer metal. In general, it follows that $S = As$, where A is the real area of contact of the metals, and $P = A'p$, where A' is the cross-sectional area of the torn track. From this, $F = As + A'p$.

If the ploughing term P is negligible, we have $F = As$. When the load is applied to the surface, plastic flow of the softer metal occurs at the regions of contact until the area of contact is sufficiently great to support the load. With any particular metal, therefore, the real area of contact A is determined primarily by the load W, and $W = pA$.

Hence $F = W\frac{s}{p}$, and the coefficient of friction

$$\mu = \frac{F}{W} = \frac{s}{p} = \frac{\text{shear strength}}{\text{flow pressure}}.$$

A somewhat similar expression applied to the cutting of metals has recently been derived by Ernst and Merchant[13].

Friction of a Hard Metal on a Soft One

An experimental investigation was made of these relations for steel sliding on indium, which is a very soft metal. The experiments were made with cylindrical, hemispherical, and plane sliders, and S and P were evaluated separately. The sliding speeds were low, so that the metals were at room temperature. It was found that the experimental results were in reasonable agreement with the general theory. The relative magnitude of the two terms S and P naturally depends upon the shape of the slider and upon other factors, but it is clear, both from theory and experiment, that under many experimental conditions the ploughing term P is an appreciable fraction of the total frictional force.

Another problem that is of general interest is the relation between the frictional force, the area of contact, and the load. The early work of Coulomb and of Amontons led to the formulation of two 'laws': (i) that the frictional force is independent of the area of the sliding bodies; and (ii) that the frictional force is proportional to the applied load[14]. There has been some difficulty in explaining these laws, but experiments on the real area of contact between stationary and between moving surfaces offer a theoretical explanation of them[2]. In these experiments the area of contact between the metals was determined by measuring the electrical conductance between them, and the results showed that, in general, contact occurred only locally at the summit of the surface irregularities, so that the real area of contact was very small and was almost independent of the apparent area of contact. We should therefore expect that the frictional force would also be independent of the apparent area of contact.

The second law, which is often referred to as Amontons' Law, also presented difficulties, since it was usually assumed that when the load was applied the surfaces were deformed elastically. In this case, the area of contact and hence the frictional force would be expected to vary as the two-thirds power of the load and not as the first power[2,15]. The conductivity

* Lecture given to the Royal Society of Victoria in March 1942.

measurements, however, showed that the deformation of the surfaces is mainly *plastic*[2]. The metals flowed under the applied load until the area of contact was sufficient to support it. In the case of plastic flow, the area of contact is directly proportional to the applied load, so that the difficulty disappears and we should expect the second law (Amontons' Law) to hold.

With any particular junction or point of contact between the metals, one of two conditions may obtain :

(1) The strength of adhesion between the soft metal and the hard may be greater than the shear strength of the soft metal. In this case, the break will occur within the soft metal, and fragments will be left adhering to the surface of the hard one. If the fraction of the total area of contact over which this occurs be α, the frictional resistance due to these junctions will then be $s_1 \alpha A$, where s_1 is the shear strength of the softer metal and A is the real area of contact.

(2) The strength of adhesion at the junction is less than the shear strength of the softer metal. In this case, the break will occur between the metals, and the soft metal will not be wiped on to the harder one. The value for the shear strength of these weaker junctions will not necessarily be constant. It may vary from a value that approaches s_1 down to very small values. Let s_2 be the average value. Over the whole area of contact there will, in general, be junctions of both types, and the total shearing force S will be :

$$S = A\,(s_1 + (1 - \alpha)\, s_2).$$

This treatment has been applied to metals which differ in hardness. The same general considerations apply if the surfaces both consist of the same metal. This case is, however, more difficult experimentally, since it is not easy to evaluate separately the S and P terms. We may expect somewhat similar general conclusions to hold for non-metallic solids.

Effect of Contaminating Films

Under most experimental conditions, metal surfaces are covered with a thin oxide layer and other contaminating films. During sliding, these films are torn, many of the surface irregularities penetrate through them, and some metallic contact does occur. Nevertheless, we should expect that the adhesion and shear strength of the junctions would be less than that of the pure metal. Earlier experiments have shown that this is indeed so[16]. If the surface films are removed by outgassing in a high vacuum, the friction is increased to a high value (for example, for outgassed nickel or tungsten μ is increased from about 0·3 to 6). In the same way, we should expect that the deliberate addition of suitable lubricant films to the metals would again diminish the intimacy of contact and the strength of adhesion at the junction.

Although experiments show this, they also show that lubricant films are rarely able to prevent some metallic adhesion from taking place. The surface irregularities penetrate and tear through the surface film, and metallic seizure and damage occur. The total area over which this metallic seizure takes place is, of course, very much smaller in the presence of lubricants than in their absence. It is probable that the main effect of adding a lubricant is to decrease both α and s_2. The experiments suggest that with clean steel sliding on indium, α is very nearly equal to unity and s_1 to the shear strength of pure indium.

Intermittent Motion

It has been shown that if one part of the moving system possesses an appreciable degree of elastic freedom, the motion may not be continuous but may be intermittent and proceed by a process of 'stick-slip'. This necessarily means that the kinetic friction during the slip is less than the static friction during the stick. It was found that with any particular mechanical system the type of sliding is profoundly influenced by the nature of the metals and of the lubricant films on the surface. The nature of the motion is also, of course, controlled by the mechanical properties of the moving system. Other workers[7,8] have recently repeated some of these experiments, using similar apparatus. They find results which are similar, but they lay particular stress on the fact that the motion is determined by the elastic properties of the system. This has, however, already been emphasized by us (compare ref. 3), where it is stated that the motion "will be influenced by the mechanical properties of the system such as the natural frequency, the moment of inertia, and the damping of the moving parts. Finally, it will be influenced by the velocity of the main forward motion." Since many moving systems possess an appreciable degree of elastic freedom, and since, in the limit, the surface irregularities themselves may be capable of a small elastic deformation, this stick-slip motion is of frequent occurrence provided the surface and other conditions are suitable.

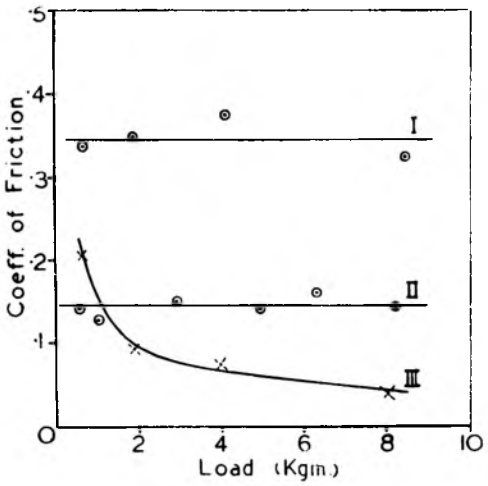
It is not suggested that the occurrence of stick-slip is in itself proof that a lubricant is a poor one, although most poor lubricants give a motion of this type if the mechanical system will permit it. The nature of the sliding, the value of the friction, the damage to the surface and other factors must all be taken into account.

Friction of Metallic Films

In the earlier experiments, Amontons' Law held true, because a variation in the load automatically produced a corresponding change in the area of contact. It was not possible to vary them independently. This may be achieved artificially by using as the lower surface a hard steel substrate on to which a thin layer of a soft metal such as indium is deposited. A hemispherical slider is placed on top of this, different loads are applied, and the friction measured[12]. When the load is applied, the spherical surface will sink through the indium layer until the weight is supported by the underlying steel surface. Since the underlying steel surfaces are deformed comparatively little by the load, further increases in load will have relatively little influence on the area of contact between the slider and the indium. Provided a very thin layer of indium still adheres to the bottom surface so that little or no steel contact occurs, we should expect the frictional force to be almost independent of the applied load. This means that the coefficient of friction as usually defined by $\mu = \frac{F}{W}$ should decrease as the load increases.

Curve I shows the results obtained with unlubricated steel, Curve II with steel lubricated with a mineral oil and Curve III with steel on the surface of which an indium film 4×10^{-4} cm. thick has been deposited. In the first two cases, Amontons' Law is obeyed and μ is constant. With the indium film Amontons' Law breaks down ; μ decreases as the

load increases and reaches a value so low as $\mu = 0{\cdot}04$. This very low value of the friction is considerably less than that frequently observed with the best boundary lubricants and is similar to that obtained on ice[17].



Friction of curved slider on flat surface. Steel on steel (I) unlubricated, (II) lubricated with mineral oil, (III) with indium film 4 × 10^{-4} cm. thick.

The frictional force was determined by the real area of contact A between the steel and the indium. The load was important mainly in so far as it affected this area. In fact, for any given track-width the friction was the same on bulk indium as it was on indium films. If, however, very heavy loads were used, the films broke down: contact occurred between the slider and the underlying metal and the friction rose. Similar results were obtained with films of lead and copper deposited on the surface of other metals. It is interesting to note that Attlee, Wilson and Filmer[18] found that the steel ball bearings in a vacuum tube could be lubricated by thin metallic films of softer metals.

Effect of Temperature

With metallic films, the friction decreases steadily as the temperature is raised and reaches a minimum when incipient melting begins. This should be contrasted with the effect of temperature on the friction of pure metals[16], where the change in friction is very much less marked. This is to be expected, since with pure metals the shear strength decreases with temperature; but this is accompanied by a corresponding increase in the area of contact. With metallic films, however, the area of contact remains essentially constant since the load is taken primarily by the hard underlying metal. The decrease in shear strength of the film, therefore, leads to a decrease in friction. Once melting is complete, there is a rise in the friction, the magnitude of which depends upon the extent to which the molten metal wets the underlying surface.

In some ways, the behaviour of thin metallic films closely resembles that of lubricant films. They produce a substantial reduction in the friction, they can cause smooth sliding, and they protect the underlying metal surfaces. In addition, metallic films are worn off the surfaces by successive sliding over the same track in a manner similar to that of a lubricant film, except that the metallic films are worn away at a greater rate than the hydrocarbon films. A further point of similarity is the effect of melting. The transition from smooth sliding to stick-slips when the metallic films are melted is closely analogous to the change observed when solid hydrocarbon films are heated through their melting point[4].

There are, however, several marked differences between metallic films and lubricant films. The earlier experiments[4] showed that even on rough surfaces a lubricant film need only be one molecule thick to be effective as a boundary lubricant (see also Langmuir[19]). A metallic film must be appreciably thicker (*ca.* 10^{-6} cm.) if it is to be effective. A further striking difference is that lubricant films obey Amontons' Law whereas metallic films of this thickness do not. It is possible that with very smooth surfaces considerably thinner metallic films would be effective, and in this case Amontons' Law would be more nearly applicable.

The fact that under suitable conditions metallic films may act as effective lubricants is of some practical interest. It is suggested that the smearing of a thin film over the surface of a hard one plays an essential part in reducing the friction of many bearing alloys. Experiments which have been carried out on some of the copper lead alloys and on silver lead indium alloys lend support to this suggestion.

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TEA LEAVES AS A MAINTENANCE FOOD FOR ANIMALS

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IN these days, when the conservation and utilization of vegetable waste of all kinds is so urgently necessary, it is desirable that the possibilities of feeding spent tea leaves, which are produced in such large quantities, should not be overlooked.

Tea drinking has greatly increased in the United Kingdom in the past century; consumption rose from 1·4 lb. per head a century ago to 9·2 lb. before the War. The next highest rate of consumption per head of population was in the British Commonwealth, namely, Eire 8·2, Australia 7·0, New Zealand 6·7, Canada 3·6. Although total consumption in the United States was high, the rate was only 0·7,

in the Soviet Union 0·2 and in Germany 0·2 per person.

It is obvious that in Great Britain the spent tea leaves provide a considerable bulk (roughly 200,000 tons before the War) of waste material which is available in most households and might be utilized, with other waste foodstuffs, for domestic animals.

An idea of the chemical composition of spent tea leaves is given by the following results of analysis of a sample taken from the urn and pots in the kitchen of Harper Adams College. The sample was found to contain 84·2 per cent of water and 15·8 per cent of dry substance, so that a pound of these wet leaves was equivalent to nearly 3 oz. of air-dry meal. The dry matter was found to contain 26·1 per cent crude protein, 14·2 per cent fibre, 1·2 per cent oil, and 4·6 per cent mineral matter. The high percentage of crude protein is probably deceptive since much of it is almost certainly in an indigestible form owing to the rather high tannin content of the leaves. In a test by the method of artificial digestion the dry substance was found to yield only 3·7 per cent of digestible protein. It is probable also that the tannin will tend to reduce the digestibility of the protein in other foods with which tea leaves may be mixed, and this point must be kept in mind in making up rations containing tea leaves. Broadly speaking, from the point of view of composition tea leaves may be regarded as a rough substitute for bran, though rather higher in fibre and lower in digestible protein.

There is a conspicuous absence of data on the use of waste tea leaves in animal rations, although it was indicated that they could be utilized as a result of feeding two small rabbits for very short periods (for five and ten days respectively) with 50 and 33 per cent of meal and bran replaced by an equal weight (30 and 25 gm.) of dried tea leaves. Another one was fed for two periods of ten days each with 33 and 50 per cent (20 and 30 gm.) of the meal and bran replaced by tea leaves. The same rabbit was fed for three days on powdered tea leaves without diminution of weight[1].

The use of spent tea leaves is no novelty to small-scale rabbit-keepers, but definite evidence as to their worth seems, however, to be very scanty, and therefore in view of the present emergency it was thought worth while to make some controlled tests in the Rabbit Section of the National Institute of Poultry Husbandry. The tea leaves were taken daily straight from the drainer and fed as soon as possible since they quickly go mouldy, especially in hot weather. They were readily taken by the rabbits, and their consumption reduced the intake of drinking water and stimulated the consumption of hay.

Tea Leaves in Growers' Rations

The first trial, of which a preliminary report has been given in the technical press, was carried out with thirty young rabbits, divided into three groups of similar weight (average 3 lb.). The control group were fed on green food, dry meals and rough hay. The other two groups were fed high proportions of tea leaves, 25 and 50 per cent of the concentrates being replaced on the basis of 4 oz. of tea leaves replacing 1 oz. of meal. It was found necessary to reduce the quantity of green food owing to undue laxativeness when used with high proportions of tea leaves. After one week on these diets the average weight gains per head were 4·5, 2·8 and 0·2 oz., but as the 50 per cent group had also dropped badly in condition the proportion of tea leaves for this group was reduced to a 12½ per cent replacement level, after which they soon recovered and then made satisfactory progress. By the end of the fourth week it was clear that even 25 per cent substitution was excessive, whereas those on 12·5 per cent replacement were doing well, with glossy fur and good bodily condition, and by the end of six weeks their average live weight had practically caught up with those of the controls, namely, 12·2 and 12·6 oz. respectively.

TABLE 1. AVERAGE DAILY FOOD CONSUMPTION (OZ.)

	Control			10 per cent concentrates replaced				20 per cent concentrates replaced			
	Concentrates	Green and roots	Hay	Concentrates	Tea leaves	Green and roots	Hay	Concentrates	Tea leaves	Green and roots	Hay
1st month	3·57	6·65	1·76	3·21	1·43	6·65	1·76	2·86	2·86	6·65	1·76
2nd ,, ...	3·29	7·71	1·60	2·96	1·31	7·71	1·60	2·63	2·63	7·71	1·60
3rd ,, ...	2·43	8·20	1·71	2·19	0·97	8·20	1·71	1·94	1·94	8·20	1·71
4th ,, ...	2·32	8·29	1·71	2·09	0·93	8·29	1·71	1·86	1·86	8·29	1·71
5th ,, ...	2·14	11·20	1·77	1·93	0·86	11·20	1·77	1·71	1·71	11·20	1·77
6th ,, ...	2·05	11·20	1·71	1·85	0·82	11·20	1·71	1·64	1·64	11·20	1·71
7th ,, ...	2·05	11·20	1·71	1·85	0·82	11·20	1·71	1·64	1·64	11·20	1·71
Average ..	2·55	9·21	1·71	2·30	1·02	9·21	1·71	2·04	2·04	9·21	1·71

Briefly summarized, therefore, the first experiment with growers indicated that 12·5 per cent of the concentrates could be replaced by fresh spent tea leaves, but a 25 per cent level proved unsuitable between two and four weeks, and at 50 per cent it proved unsatisfactory within one week.

A second experiment was made with thirty more young rabbits, divided again into three groups of similar live weight and fed thus: group (4) on the control diet, (5) with 12·5 per cent of the concentrates replaced by fresh spent tea leaves, and (6) also with 12·5 per cent concentrates replaced by tea leaves but supplemented with fish meal in the ratio of 16 to 1 by weight to raise the protein level to that of the controls. The latter produced softer fæces than groups (4) and (5). Body condition and fur growth appeared to be similar 4–6 weeks later but, when handled, group (5) was not so good as the control or the supplemented tea leaves group; the latter were in good, firm condition. At the end of the sixth week of the experiment the average weight increments per head for the three groups were 12·3, 11·8 and 12·6 oz. respectively.

These results thus confirm the conclusion from the first experiment carried out that for growers, up to 12·5 per cent of the concentrates could be replaced by tea leaves.

Tea Leaves in Maintenance Rations

In a third experiment the object aimed at was to ascertain the extent to which this substitute foodstuff could be utilized in winter maintenance rations when other feeding-stuffs were in short supply. After a preliminary feeding period of two lunar months thirty adults, of average weight 7 lb. 7·6 oz., were divided into three comparable groups. Lot (7), the control group, was given a daily allowance per head of green food 7–11 oz., coarse hay 1·7 oz. and concentrates 3·6–2 oz., varied according to their condition and appetites ; lots (8) and (9) were similarly fed except that 10 and 20 per cent, respectively, of the concentrates were replaced by tea leaves (on the 4 : 1 basis) supplemented by 6 per cent of fish meal. The concentrates were fed generously in the early periods, when practically all stock was heavy in the moult, and were later reduced, more greenstuff or roots then being fed. The average daily food consumption in each lunar month is shown in Table 1. Owing to shortage in the supply of tea leaves during the College vacation, there was a break of three weeks in the feeding between the second and third months.

TABLE 2. AVERAGE LIVE WEIGHTS

	Control		Concentrates replaced by tea leaves			
			10 per cent		20 per cent	
	lb.	oz.	lb.	oz.	lb.	oz.
Initial live weight	7	7·60	7	7·50	7	7·70
1st month ..	7	8·20	7	3·60	7	6·80
2nd ,, ..	8	0·50	7	9·00	7	9·40
Resumed weights	8	2·20	7	10·30	7	9·50
3rd month ..	8	6·50	7	13·50	7	10·90
4th ,, ..	8	2·90	7	10·50	7	8·80
5th ,, ..	8	1·20	7	12·00	7	8·10
6th ,, ..	8	8·70	8	0·00	7	10·10
7th ,, ..	8	11·20	8	2·40	7	14·50
Actual aver. gain	1	1·90		9·60		6·70

From the live weight data summarized in Table 2 it will be seen that during the first two months the average gains in live weight per head in the three groups were 8·9, 1·5 and 1·7 oz. respectively, which suggests that the control ration was more than adequate for maintenance and produced a certain amount of fattening, while the two tea-leaves groups seemed little more than bare maintenance. After the experimental feeding was resumed at the beginning of the third month the differences over the remaining five months were much less (9·0, 8·1, 5·0 oz.), there being in fact little difference between the control group and the 10 per cent tea-leaves group, although the 20 per cent group was still substantially behind the others. Over the whole experiment the average weight gains of the groups with concentrates replaced by tea leaves were 53–63 and 37–43 per cent respectively of that of the control group.

The condition of the groups was mainly good to very good. The fur underwent great change, from heavy moult in all groups at the start, to a good, even, glossy fur in each group by 3–4 months later without any noticeable difference between different rations. The full winter bloom later faded as the breeding season came round. In the last month the does were mated and the feeding of tea leaves ended before the birth of the young. The numbers of fertile does in each group in this round of matings were eight, seven and nine respectively, so that the tea leaves would not seem to have exercised any specific effect, either good or bad, on fertility. There were strong indications that the infertile does in all groups were associated more with strain than feeding.

As was to be expected, a much higher proportion of water was drunk by the control animals, with their somewhat larger quantity of dry food, than by those eating fresh moist tea leaves. The average daily amounts of water taken were 5·19, 3·26 and 3·26 oz. respectively. The water intake was also influenced by the quantity of roots and greenstuff which was fed. The animals on the tea leaves had damper floors, especially on the 20 per cent replacement, and required more hutch cleaning and caused some coat stain on the lower part of the body fur.

Briefly summarized, this experiment indicated that adult rabbits could be maintained in body condition on a ration in which 10–20 per cent of the concentrates were replaced by spent tea leaves (on the 4 : 1 basis). There was an increase of live weight in all groups, being greatest on the control diet, and lowest on 20 per cent replacement of concentrates by the tea leaves mixture. In neither case was there any adverse effect on subsequent fertility.

Acknowledgment is made of the helpful advice received from Dr. Charles Crowther in connexion with these experiments.

[1] Aruch, E., *L'Italia Agricola*, **57**, 17 (1920).
[2] King Wilson, W., *Fur and Feather*, **103**, 759 (1940).

BRITISH ASSOCIATION CONFERENCE ON MINERAL RESOURCES*

THE second day of the Conference convened by the British Association Division for the Social and Industrial Relations of Science on July 24–25 was marked by the presence of Sir Stafford Cripps as chairman of the afternoon session. In his opening remarks Sir Stafford alluded to his own experience of chemical research under Sir William Ramsay and to his contacts with scientific problems in the course of legal practice. It had been said that technical invention had outstripped social and political invention and means had still to be found by which the knowledge of the technical experts could be fully utilized in a democratic organization. It was not desirable that Parliament should be composed of specialists, the 'common jury' mind, capable of forming a general judgment on wide problems, being of great value, but that judgment had often to be formed on a basis of scientific evidence or technical knowledge. The Atlantic Charter was an attempt to express in easily understood terms the direction in which the political leaders of the democracies were looking for progress after the War had been won. It was clear that in its application a multitude of questions would be raised, requiring the best brains for their solution.

However perfect the planning of the future by experts might be, it would be of no avail without the determination of the peoples of all nations that it should succeed. It could be destroyed by a return to the old competitive struggle between nations or corporations in an attempt to win monopolies, and it would be necessary for the United Nations to undertake international regulation of the production and

* Continued from p. 173.

distribution of raw materials, in the interest of the devastated countries as well as with the object of attaining a rising standard of living throughout the world. The proposed international organization for the mobilization of all available knowledge of natural resources would be a valuable factor. The pooling of knowledge, already long customary in the field of research, must now be translated into co-operative action. The co-ordinated and planned action which had been essential during the War would be no less so after it, and the step from economic warfare to economic welfare would have to be taken. Science had shown the way to an economy of plenty, and its possibility had been made clearer by the events of the War.

At the morning session the chairman Dr. C. H. Desch, spoke of new metals and new methods. The importance of the influence of small additions of special elements to metals on their properties was illustrated, not only by the example of the alloy steels but also by such applications as the hardening of copper by beryllium and the strengthening of lead by so little as 0·05 per cent of tellurium. Novel combinations of metals led to such remarkable products as the newer permanent magnet steels, containing nickel, aluminium, cobalt and copper, giving such a high concentration of magnetic energy that a bar could be made to float in air in consequence of repulsion by another magnet, and revolutionizing the design of loud-speakers and measuring-instruments. The growing importance of metals of high melting-point, especially tungsten, had led to new techniques, such as 'powder metallurgy', and to the development of the high-frequency induction furnace and of refractory materials far superior to those in general use. Vacuum melting and also the use of exceedingly high pressures would become progressively more important, and called for new materials and new methods of construction.

The substitution of one metal for another, as of a light alloy for steel in the building of ships or bridges, usually involved new problems of design on account of differences in elastic and other properties. Chile saltpetre had been replaced by synthetic nitrogen compounds, and the rapid development of the plastics industry had made possible the replacement of metals for a number of purposes, but such substitutions did not necessarily lessen our dependence on mineral resources. Electric power for nitrate synthesis might be obtained from water, but in some highly industrialized countries had to come from coal, while many of the plastics were derived from coal or petroleum, although, being organic substances, there was always the possibility of preparing them from vegetable sources, for example, through alcohol.

Two papers dealt with sea-water as a source of minerals. Dr. E. F. Armstrong reviewed the problem generally. Salt had long been prepared by the evaporation of sea-water, but more recently the demand for bromine for the manufacture of 'Ethyl' for addition to petrol had led to the recovery of that element, especially in America, where it was blown out of the sea-water by a current of air after displacement by chlorine. Magnesia was recovered in large quantities by precipitation by lime or by calcined dolomite, and the industry had assumed large proportions in Great Britain as well as in the United States. Magnesium, although very abundant in the earth's crust, had only lately assumed great economic importance. It was extracted either by electrolysis of the anhydrous chloride or by thermal reduction of magnesia by calcium carbide, ferro-silicon, or carbon, the last of these presenting special difficulties on account of the high temperature required and the reversibility of the reaction with carbon monoxide.

Since the products of the disintegration of all rocks ultimately reached the sea, most elements must occur in sea-water, although in a state of high dilution. Phosphates, the deposits of which were limited in amount and likely to become exhausted, were wasted in present methods of sewage disposal, Great Britain alone discarding the equivalent of 150,000 tons of rock phosphate a year. Some means might be found of recovering a part of this. Selective absorption of specific elements was now utilized in the various processes depending on base exchange, and a method of recovery of phosphates might possibly be based upon that principle.

Dr. Ernst Bergmann spoke of the Dead Sea, in which the concentration of salts was much higher than in oceanic waters, while the relative proportions of the several elements were very different. The concentration increased from the surface downwards, and for industrial purposes water was taken from the lower levels. At present only potassium chloride and bromine were extracted, Palestine being now the largest producer of bromine, but the high concentration of magnesium salts suggested the use of this source for the production of the metal, provided that electric power were made available. Deposits of phosphates were found on the Transjordanian shore of the Dead Sea.

Means of economizing in the rarer metals used in alloy steels were discussed by Dr. W. H. Hatfield. Since the principal steel-making countries were dependent on imported ores for such metals as tungsten, molybdenum, nickel and vanadium, the conditions of restricted supply in war-time made measures of economy necessary. From May 1940 onwards this problem had been dealt with by a Technical Advisory Committee, and the alloy steels covered by between two and three thousand specifications had been reduced to eighty-five categories, greatly simplifying the choice of steels. It was not always necessary to use the more highly alloyed steels, which could usually be restricted to the heavier masses, for which they were essential to complete hardening.

Another aspect of economy was dealt with by Sir Harold Hartley in a paper on the recovery of metals from scrap. While process scrap, re-used in the plants in which it originated, presented no difficulty, old scrap, from disused or worn-out material, was of a mixed character, and offered many problems of collection and classification. Changes in methods of manufacture and use, such as the repair of parts by welding and improved protection against corrosion, affected the quantities of scrap returning to the furnaces, and the importance of the careful segregation of scrap from alloys containing valuable elements was stressed, as it was by the previous speaker. The great difficulty of securing statistics of scrap and secondary metal was emphasized, the present statistical knowledge of this important question being very unsatisfactory.

The session concluded with a paper by Dr. David Williams on the mineral resources of the Soviet Union. The detailed survey, illustrated by a remarkable series of maps, does not lend itself to abstracting, but both the bulk of the estimated reserves and their wide distribution must have surprised many hearers. Potash salts and phosphates, besides the metallic minerals, were present in very large deposits.

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(*Continued in next column*)

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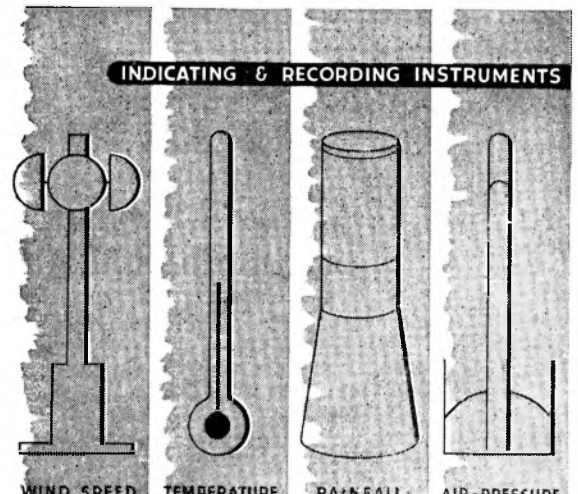

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The development of these resources within the last fifteen years had been exceptionally rapid, and although doubt might be expressed as to the validity of some of the Russian estimates of reserves, it should be recalled that there were still vast areas awaiting investigation. Tin and tungsten were deficient, but it seemed likely that the U.S.S.R. would become self-supporting in and even able to export large quantities of coal, iron, petroleum, manganese, platinum, magnesite, phosphates, asbestos, potash and sulphur.

The afternoon session was devoted to economic questions. After the opening address by Sir Stafford Cripps, Prof. J. G. Smith, speaking of international trade in raw materials, said that the arrangement by which certain countries only manufactured goods and exchanged them with other countries producing only raw materials had sometimes been regarded as permanent, but had shown signs of breaking down as old capitalist countries found themselves obliged to extend their agricultural basis, while countries rich in raw materials exported less and worked up more of those materials at home. It was argued that the tendency was for industries to become less dependent on the localization of raw materials, thus admitting considerations other than purely economic ones in the choice of a country's economic policy. The factors were, however, very complex.

Dr. W. A. Lewis, in a striking paper on some aspects of mining finance, confined his remarks in the main to mining in Africa. The ordinary investor regarded mining ventures as highly speculative, owing to the uncertainty of the quantity of ore in a given mine, the fluctuations of price of most metals, and also to the prevalence of fraud. Greater legal control of company promotion would be of service in increasing confidence. The financing of mining had fallen mainly into the hands of large corporations, which could spread the risk and also provide the necessary technical guidance. This 'grouping' system, paralleled by the 'managing agency' system of the Eastern colonies, was good from the investor's point of view, but had the disadvantage that an entire colony might find itself in the hands of one or two corporations, dominated by one or two rich men, since the capital of such corporations came only in small part from the private investor, and mainly from banks and large finance organizations. The Governments of Southern Rhodesia and Tanganyika had set up special funds for financing small mines, which still had a future, and this policy might be extended.

The large corporations, by eliminating competition, were able to make excessive profits, from which the colony derived little benefit. In 1937 the Trinidad mines earned in profits three times what they paid to their native employees in wages, the Gold Coast mines two and a half times, and the Northern Rhodesian mines twenty times, and when dividends of 100 per cent were announced, colonial peoples asked why European capitalists should take out the principal wealth of the country and leave so little. Sooner or later awakening nationalism would compel the colonial peoples to assume control of their own resources, and in the meantime taxation might be increased, or experiments made with joint control, as in the Belgian Congo and Dutch East Indies, where the capital was provided in part by the Government and in part by private enterprise.

Mr. Arthur Notman, taking aluminium as his text, suggested that there was no more fruitful source of international friction than a system of tariffs, exchange controls, and other arbitrary restrictions on freedom of trade. The existence of a great internal free trade market had been an important factor in the prosperity of the United States. Aluminium would play a leading part in the future improvement of communications, and reference was made to a possible policing of the world by an international air force.

The general question of planning and the mineral industries was dealt with by Mr. O. W. Roskill, who concluded that there must be a central international authority which would correlate the plan for the mineral industries with the requirements of other industries, and could be built up out of existing bodies. All nations must be included. Planning of production was meaningless unless accompanied by planning of distribution and consumption. The determination of prices by the free interplay of supply and demand was incompatible with such planning, and it seemed likely that prices would be increasingly related to costs. If such stabilization occurred, producers and manufacturers would not need to protect themselves against fluctuations. Organizations for each group of commodities and manufactured goods would have to control both exports and imports.

The last communication was from Dr. L. Dudley Stamp, who spoke on the exploitation of minerals in relation to national and world planning. It was necessary to distinguish between those minerals which were in limited supply and were removed as completely as possible in mining, such as coal, oil and most metalliferous ores, and those which were so abundant that only parts of the available deposits were likely to be worked, such as limestone, clay, sand and gravel. In international planning it was the first which was important. There was in general a cycle in the development of such deposits—exploration, exploitation and exhaustion. In the early stages there might be a mining boom, with a very rapid development, great increase of population, and sometimes much extravagant building. The period of steady exploitation might be short, as with alluvial gold or tin, or might last a century or more as in a coal-field. Towns might be built and the fact that their prosperity depended on the exploitation of a deposit forgotten. The period of exhaustion could cause great maladjustments and much human suffering. The recognition of the right of the nations of the world to share its mineral resources carried with it an obligation to accept responsibility and to share the burden of such readjustments as might be needed. Examples taken from the British Isles included the decay of the Cornish tin mines, the destruction of vegetation and fisheries by lead mining and smelting, the formation of a stony desert in Northamptonshire after the removal of iron ore from good agricultural land, and the familiar instance of derelict coal-fields. It would appear that mineral exploitation inevitably resulted in a need for restoration, whether of land or of the social structure of the community; that this restoration should be obligatory on those who derived benefit from the working of minerals, and that as the stage of exhaustion was unprofitable, there should be some provision, comparable with an amortization assurance, made while the work was in the flourishing stage.

The Conference closed with the passing of the resolution proposed by Sir Richard Gregory and quoted in the first article (p. 171).

C. H. DESCH.

OBITUARY

Sir William Flinders Petrie, F.R.S., F.B.A.

IN NATURE of July 18, p. 84, the respective claims of Sir Flinders Petrie and the late Prof. Reisner to have been the greatest of all Egyptian excavators were here being discussed, and satisfaction was being expressed that the former was still in the land of the living. Now, so shortly afterwards, he has passed from us at the advanced age of eighty-nine, and the mournful duty has arisen of reviewing his achievements and of discussing the influence he exerted upon archæology in England and in the world generally. One outstanding merit must be emphasized at the outset: it would be difficult to recall a life so wholeheartedly devoted to the task its owner set before himself; no hardship, no lack of monetary resources could make him swerve from the purpose he pursued with an energy for which few have the physical endowment, and none could better have deserved the fame and the honours showered upon him, the latter culminating in the knighthood of 1923.

His was a distinctively British career, exhibiting both the strength and the weakness of an intense individualism, enhanced by a private education and (if the truth be told) undisciplined by academic training. All the more brightly shone forth his undoubted genius. Few have possessed so high a degree of flair, or have obtained such accurate results by such unorthodox means. The writer has been told he sometimes made his plans with the help of an old walking-stick, from the original length of which deduction was made for wear and tear. Be this truth or mere fable, certain it is that his plans display a very high degree of accuracy, as was discovered when one of his rivals thought fit to uncover afresh some of the Royal Tombs of the First Dynasty at Abydos, an undertaking which both in its scientific results and in the material finds proved sheer waste of the rival's time.

The trouble is that the cavalier methods Petrie pursued required the hand of the master, and could not so profitably be adopted by pupils. This suggests another point. No one in England has ever excited so much interest in Egyptology, or has introduced so many fresh workers into the field; some of them, like the papyrologists Grenfell and Hunt, were destined to win great fame, while others, as little academically trained as himself, drifted into field work as a sport and drifted out again a few years later.

There was one regrettable side to Petrie's attitude to his science which must not be passed over in silence. No philologist himself, he tended to discount the importance of philology and to foster in his assistants the belief in some sort of antithesis between philology and archæology. This was ill-judged, and resulted in a certain amateurishness with which some of his work, for example, his "History of Egypt", and many articles in his periodical *Ancient Egypt*, is stamped. Obviously the Egyptian archæologist should possess at least a competent acquaintance with the hieroglyphs, just as the most learned decipherer of papyri and inscriptions would be but a poor Egyptologist could he not claim a sufficient working knowledge of archæology. But this having been said, let us hasten to add that almost any defect could be pardoned in one who owned even three quarters of the skill, the devotion and the driving-power of this greatest of all the British excavators.

It has been thought the more excusable here to offer a personal assessment of Petrie's merits since the facts of his career are so well known, have received such wide publicity in the Press, and are also set forth in his "Seventy Years in Archæology" and his much earlier summary "Ten Years' Digging in Egypt" (1892).

For this reason also the rest of this account shall be confined to enumerating the greatest of his discoveries and to stressing the most important of his innovations in archæological method. He had been engaged but four years in the field when, with his work on the Pyramids of Gizah and on the city of Tanis behind him, he started digging on the site of what proved to be the Greek colony of Naucratis (1884). Already he had set new standards in archæology by his attention to the minutest details, by his recognition of the outstanding importance of pottery, and by his personal and sympathetic supervision of his native work-people. His striking presence and personality could not fail to imbue the latter with respect, while at the same time he possessed some of the quick-wittedness with which Kitchener proved more than a match for Oriental cunning.

The work in the Fayyum in 1888–90 brought much fresh knowledge of the Middle Kingdom, but was transcended in importance by the discoveries at El-Amarnah in 1891 and at Nakadah in 1894. On the former site Petrie unearthed the palace of Akhenaten, the heretic king, finding very valuable frescoes and smaller objects, while in the latter he came upon an entirely new culture not at first recognized by him for what it really was, namely, a prehistoric cemetery of vast extent and wealth. In connexion with these prehistoric remains he inaugurated one of his most valuable contributions to archæological method, a classification styled by him "sequence-dating". This consisted in segregating the main groups of pottery, ivory, etc., in superimposed layers, and since no inscriptions were present to supply definite dates, in placing them in sequence with numbers theoretically ranging from 1 upwards, but actually starting at 30 for the oldest known remains, and ending at 80 for the First Dynasty.

As regards the tombs of the Kings of the First Dynasty at Abydos, investigated with great skill and care during 1899–1900, Petrie was not the original discoverer, but the previous excavations by Amelineau had been disgracefully conducted, and Petrie's systematic clearing was salvage of the highest order. A comparatively small dig at Thebes in 1895–96 had brought to light a stela of the reign of Merenptah with the first and only hieroglyphic mention of Israel. In 1911–12 at El-Lahun, Petrie's assistant Brunton came upon a great treasure of Middle Kingdom jewellery, later unfortunately disposed of to New York instead of finding a place, as it should have done, in the British Museum.

The above enumeration of the most outstanding finds shows that it was not given to Petrie to chance upon such sensational discoveries as Carter's tomb of Tutankhamun or Reisner's reburial of Queen Hetepheres. Cumulatively, however, his contribution has been considerably greater, for the number of sites and the variety of the objects found are almost incredible as the outcome of a single lifetime. This inadequate statement would contain an unpardonable omission were not reference made to the constant and unfailing help rendered by Lady Petrie ever since their marriage in 1897.

ALAN H. GARDINER.

NEWS and VIEWS

Imperial Institute of Entomology

IN the early part of the century the importance of entomology to the health services and to agriculture in the Overseas Empire was at last beginning to be realized. In 1909 the Entomological Research Committee of the Colonial Office was formed, with Sir Guy Marshall as scientific secretary. In 1913, when the Committee extended its outlook and became the Imperial Bureau, and later the Imperial Institute of Entomology, Sir Guy became director, and he has just retired; he has thus guided the fortunes of entomologists in the Government Services abroad for more than thirty years, ably supported by Dr. S. A. Neave, who has been assistant director since 1913. The period has seen great changes in the position of entomology in the Empire. From a few isolated workers, largely unaware of each other's work, or even of each other's existence, there has developed a small army of several hundred field workers; and much of this progress has been due to the Imperial Institute of Entomology. Instead of being completely out of touch with work elsewhere, the field entomologists have had the invaluable *Review of Applied Entomology*, which has summarized progress in agricultural and medical entomology for the past thirty years. It is difficult to-day to imagine how one got on without this journal.

Another great difficulty of the entomologist abroad was that of getting specimens identified. This problem was one of the first to be tackled by the Bureau, and for many years now the words "kindly identified by the Imperial Institute of Entomology", so frequent in entomological papers from all over the Empire, are a testimony of the great value of this work. No appreciation of the work of the Institute would be complete without mention of the Parasite Laboratory at Farnham Royal, from which useful parasites and predatory insects have been distributed to all parts of the world. Sir Guy Marshall has built up his organization with energy, with vision and with a sympathetic understanding of the difficulties of the man in the field; and now, on his retirement, he hands on the reins of government to his assistant director. Dr. Neave has succeeded to a difficult task in difficult times, but the work he has already done with the *Review*, with the *Zoological Record*, with the "Nomenclator Zoologicus" and in many other ways, leaves no doubt that the Imperial Institute of Entomology is still in capable hands.

Prof. William Peddie

THE retirement is announced of Prof. W. Peddie from the Harris chair of physics at University College, Dundee, in the University of St. Andrews. Born in Orkney in 1861, Prof. Peddie was educated in Orkney and Edinburgh, and graduated in that University in mathematics and natural philosophy. A student of Prof. P. G. Tait and a lecturer in the Department of Natural Philosophy, Prof. Peddie obtained the degree of D.Sc. from Edinburgh. He has always taken a keen interest in the work of the Royal Society of Edinburgh, and has served on the Council and as vice-president. In 1907 he was appointed as Harris professor in Dundee in succession to Prof. J. P. Kuenen, the first occupant of the chair, and for thirty-five years has carried on the work of the Department of Physics. In addition to text-books on elementary dynamics and physics he has written works on colour vision (1922) and on molecular magnetism (1929), two subjects on which he has specialized, and he has frequently contributed the results of his work to NATURE.

Prof. Peddie reached the conclusion that the Young-Helmholtz theory of colour vision is the simplest, but the mechanism proposed by them is not an essential part of the theory. The formal laws of action, and these alone, constitute the essence of the theory. A paper published in the *Philosophical Magazine* in September 1941 gives a summary of six years' work on magnetization in crystalline media. The results in general sustain Weber's theory, which originated almost a century ago. An appreciative reviewer of his book called the modern presentation "Peddie's theory". The theoretical aspects of physics have always aroused his interest, and in discussing in 1931 the philosophy of "As If" in physical science he wrote: "The idealist, if he is an investigator in physical science, cannot avoid acting upon the postulate of realism. Nothing else gives him a foothold for work. He has to regard the universe 'as if' it were real. All our philosophies are necessarily based upon postulate; all our science is founded upon faith."

Biology and Human Welfare

SPEAKING at a conference at Newnham College, Cambridge, under the chairmanship of Mr. L. J. F. Brimble on August 8, Sir John Orr outlined his conception of the place of science in the post-war era. Pleading for a clearer vision of the great new world, he said: "What we need to go for in the new world is not the application of physical science for the production of goods to get money-power, but the application of biological science to build better men and a better society." The first step in the new world must be the abolition of poverty, and we must concentrate on building men and women before we build new cities. Sir John expressed the view that the age which is now passing away is largely the age of physical science, with its inventions and discoveries, which have given us power over the forces of Nature. It is to be hoped that when this War is over the age of physical science will be replaced by an age of biological science—the study of life in all its manifestations. Reviewing some of the results of the age of physical science he pointed out that in spite of the new inventions and discoveries the standard of life up to 1840 or 1850 actually fell below what it was before. The reason was that instead of applying the new machines wisely men had applied them to produce goods to sell to get money. "It was not that men were individually bad," he said, "but their whole background was bad. The fundamental ideal of the age was bad and, not only that, men did not even have the vision to see that this system must inevitably collapse, as it did during the War of 1914–1918."

One could have predicted a few years ago that the present War was inevitable. Now it has come it is destroying the age of the application of physical science to the production of money-wealth. Money is losing its power. The age of physical science is being destroyed by the machines which the system itself created. The old ideas are going with it, and to talk of reconstruction in the sense of getting back to 1938 is to talk sheer nonsense. In spite of the fact, however, that they have been driven by the

wrong ideal, the people of England are people with an extraordinary sense of justice and kindness. They still retain a grasp on their old religious and ethical ideals. It is because we realize that these ideals cannot exist with the type of world domination sought by Germany that the War is being fought. Sir John emphasized the fact that a first step in the new world must be the abolition of poverty in feeding, clothing and housing, and declared that in the future biological science will be applied much faster than it has been applied in the past. We must concentrate first on building men and women—particularly women. That is more important than building new cities. That can be done by the purposeful teaching of biological science, and if we apply the ideals of biological science in our teaching we shall find we are not very far off the Christian ideal.

Industrial Pest Control Association

A MEETING of representatives of firms in all branches of the industrial pest control industry other than agriculture was held in London on June 9. The firms represented included those interested in natural insecticide raw materials such as Pyrethrum and Derris of Lonchocarpus, manufacturers of basic chemicals such as ethylene oxide and cyanides, manufacturers of speciality products for insect and rodent control, and contracting firms primarily concerned in the application of insecticides, fumigants and rodent killers on industrial premises. After consideration of the growing need for industrial pest control measures, particularly in relation to food storage and the war effort generally, it was unanimously decided to set up a fully representative body to be known as the Industrial Pest Control Association. In the past two months the new Association, with forty members, has set up a strong executive committee consisting of: Mr. C. S. Kroger of W. Edmonds and Co., Ltd. (chairman), Mr. R. G. Berchem of Jeyes Sanitary Compounds Co., Ltd., Mr. F. H. Braybrook of Technical Products, Ltd., Dr. F. P. Coyne of Imperial Chemical Industries, Ltd., Mr. A. F. McIntosh of Thos. Harley, Ltd., Mr. S. F. Sprange of London Fumigation Co., Ltd., Mr. J. B. Wilton of Fumigation Services, Ltd., Dr. E. Holmes of Plant Protection, Ltd. (hon. secretary). In addition, a small technical sub-committee has been set up, with powers to co-opt other representatives with special knowledge, to advise the Association on technical matters and to collaborate with Government departments and other bodies on matters of mutual interest. Inquiries should be addressed to the honorary secretary of the Association at Jealott's Hill, Bracknell, Berks.

Sir William Tilden, F.R.S. (1842-1926)

SIR WILLIAM AUGUSTUS TILDEN, the centenary of whose birth falls on August 15, is best remembered as an inspiring teacher and for his pioneering work in connexion with scientific teaching in the younger universities of Great Britain. At twenty-two he became a demonstrator in chemistry at the Pharmaceutical Society, at thirty science master at Clifton College, at thirty-six professor of chemistry and metallurgy in Mason College, Birmingham, and at fifty-two he succeeded Sir Edward Thorpe in the chair of chemistry at the Royal College of Science, London. He retired in 1909. Tilden himself wrote some autobiographical notes on his school days and his efforts to qualify as a teacher of science in an article entitled "Progress in Science Teaching", published in the Jubilee issue of NATURE (Nov. 6, 1919); while in his biography of Sir William Ramsay (1918) are to be found accounts of the movement by which Ramsay, Tilden and others in 1889 secured a Government grant of £15,000 for the university colleges of Great Britain. Tilden's books were mainly for the use of teachers and students, but he also wrote some on the history of chemistry. He published some sixty scientific papers. So early as 1884, in his study of the terpenes, he obtained a liquid isoprene which by contact with gaseous hydrochloric acid was partly converted to rubber.

Tilden was president of the Institute of Chemistry during 1891–94 and president of the Chemical Society during 1903–5. He delivered the Bakerian Lecture to the Royal Society in 1900 and eight years later received the Davy Medal. When presented with the Medal he remarked that "In the life of every true scientific man there came sooner of later a time when if he had the smallest amount of success he felt disposed like Archimedes to rush into the street and shout Eureka! Eureka! Those were the moments of real triumph, the moments when one felt that life held something that was very sweet". Tilden, who was born in London and was the son of a Bank of England official, was twice married, and died on December 11, 1926, at Northwood, Middlesex, in his eighty-fourth year.

A Founder of the Royal Horticultural Society

THE Royal Horticultural Society was founded at a meeting on March 7, 1804, at Mr. Hatchard's house in Piccadilly. First among the names of those present was the Right Hon. Charles Greville, whose biography forms the subject of a paper by the present assistant secretary of the Society (*J. Roy. Hort. Soc.*, 67, Pt. 7; July, 1942). Born in 1749, he was a friend of Emma Lyon, later the Lady Hamilton who was associated with Nelson, had a distinguished career in Parliament, built harbour works at Milford Haven, became a fellow of the Royal Society for his work in geology, and practised such wide cultural graces as are denoted by membership of the Society of Dilettanti. Among all this extensive interest he managed to make a specialist contribution to horticulture, being responsible for the introduction of *Lilium concolor*, *Pæonia suffruticosa rosea*, *Camellia japonica*, *Clinogyne dichotoma*, two varieties of Magnolia, and others. Greville's garden near Paddington is said to be the place where American blight first appeared, but its owner overcame this doubtful distinction by suggesting the spraying of fruit trees with lime-wash. The genus Grevillea was named in honour of this horticultural pioneer by Robert Brown.

Prevention of Heart Disease

IN a recent paper (*Bol. Of. San. Panamericana*, 21, 231; 1942), Dr. Hugo J. D'Amato, secretary of the National Department of Hygiene at Buenos Aires, states that diseases of the heart and circulatory system were responsible for 24 per cent of the deaths in Buenos Aires in 1939. A fourfold programme has therefore been devised involving respectively medical prophylaxis and care, influence on specific groups, and economic losses, social assistance and State action. As regards the first point, medical examinations are to be made in such centres as factories, government offices and schools, so that

persons suffering from heart diseases may receive early treatment. These diseases produce their worst effects during the most productive period (generally after the age of forty), and it is calculated that 100 million pesos represents the social cost of early death and forced retirement of such persons. Social assistance should be given not only to the actual patients but also to needy persons who are burdened with their maintenance. As regards State action, the Argentine Government has provided for a compulsory State examination, and legal restrictions have been made on the work done by persons suffering from cardio-vascular diseases.

Endocrinology in Montevideo

THE June issue of the *Boletín de la Oficina Sanitaria Panamericana* contains an interesting account of the Institute of Endocrinology at Montevideo, which was founded in 1937 and serves as a teaching, preventive, therapeutical and research centre. It is under the direction of Dr. J. C. Mussio Fournier, professor of endocrinology in the Montevideo School of Medicine, who was recently president of the Second Panamerican Congress of Endocrinology held at Montevideo. The Institute possesses a staff of visiting nurses who regularly inspect the schools at Montevideo, and under the guidance of a school doctor select for observation and treatment children suffering from endocrine disorders. A hospital is attached to the Institute, consisting of three wards, for men, women and surgical cases respectively. The majority of the patients are suffering from endocrine diseases, but other complaints in adults and children are also treated.

A 1,000-kw. Wind-driven Electric Generator

A PLANT which is said to represent the first serious attempt to study the generation of electricity by wind power on such a scale that its practical and economic possibilities may be judged, is described in *Engineering* of July 31. The plant consists of a two-bladed wind-turbine and a 1,000-kw. alternator mounted on a pintle girder on the top of a lattice steel tower 110 ft. high, and it has been erected on the summit of a 2,000-ft. mountain known as Grandpa's Knob, near Rutland, in the State of Vermont. Though in a sense the plant is experimental, the current generated will be used by the Central Vermont Public Service Corporation. It has been estimated that it will be possible to use the power of the wind for 4,000 hours a year. The blades of the turbine are each 65 ft. long and 11 ft. wide and weigh 15,300 lb. The circle described by the ends of the blades is 175 ft. in diameter and at 28·7 r.p.m. the tip speed is 15·785 ft. per minute. The alternator is driven through gearing and generates three-phase current at 60 cycles and 2,300 volts. The designer of the wind turbine, Mr. P. C. Putnam, has had the assistance of others, and model tests of his turbine were made in the wind tunnel of Stanford University. There are many interesting features in the plant, and so that an exhaustive study of wind variations can be made an anemometer tower 180 ft. high has been erected close by and fitted with three types of anemometers.

Recent Earthquakes

THE United States Coast and Geodetic Survey, in co-operation with Science Service and the Jesuit Seismological Association, has found the provisional epicentre of the earthquake of June 29, which occurred at about 6h. 26·4m. U.T. From instrumental reports from eleven observatories, the epicentre turned out to be near latitude 34·5° S., longitude 70·5° W., which is south-east of Rancagua in Chile. This is definitely in a seismic district, and the depth of focus of slightly greater than normal is not without precedent near the Andes.

ON August 6 a severe earthquake began recording at 23h. 49m. 04s. U.T. A maximum ground amplitude of 800 μ was recorded at Kew on the vertical component seismograph on August 7 at *ca.* 00h. 25m. U.T. According to a tentative interpretation, the first impulse is a P wave, the S wave following at 23h. 59m. 15s. U.T on August 6, and according to the tables in use at Kew the epicentral distance would then be approximately 9,000 km.

Announcements

PROF. JAMES GRAY, professor of zoology in the University of Cambridge, and Prof. F. L. Engledow, Drapers professor of agriculture in the University of Cambridge, have been appointed members of the Agricultural Research Council in succession to Sir Merrik Burrell and Prof. D. M. S. Watson, whose terms of office as members of the Council have expired.

PRESIDENT ROOSEVELT has appointed the following committee to examine the whole field of synthetic rubber production and to report as quickly as possible: Mr. Bernard Baruch (chairman), who was the head of the War Industries Board during 1917–18; Dr. James Conant, president of Harvard University, and Dr. Karl Compton, president of the Massachusetts Institute of Technology.

A PANEL has been set up to inquire into the possibility of improving the ventilation of tanks either by use of refrigeration or by air conditioning. It is constituted as follows: Mr. S. A. Wood, senior scientific officer, Scientific Research Department, Ministry of Supply; Dr. Dorey, chief engineer surveyor, Lloyd's Register; and Dr. Ezer Griffiths, principal scientific officer, Physics Department, National Physical Laboratory.

THE Honorary Medal of the Royal College of Surgeons of England has been awarded to Lord Nuffield in recognition of his conspicuous service in assisting the improvement of natural knowledge and of the healing art and of his many liberal acts and distinguished labours inspired by the desire to advance the science and practice of medicine and surgery. The Honorary Medal was instituted a hundred and forty years ago, and this is the nineteenth occasion on which it has been awarded.

THE following appointments, promotions and transfers in the Colonial Service have recently been made: D. E. MacGregor, veterinary officer, Nigeria; F. Davidson, rubber production officer, Gold Coast; C. W. Lynn (agricultural superintendent), senior agricultural superintendent, Gold Coast; J. D. Kennedy (senior assistant conservator of forests), conservator of forests, Nigeria; C. R. Petty (senior surveyor), deputy director of surveys, Gold Coast; H. R. Binns (veterinary research officer), senior veterinary research officer, Palestine.

LETTERS TO THE EDITORS

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

Onset of Reproductive Phase in Grasses and Cereals

IN the Gramineæ inflorescence production commences suddenly: the new primordia arising at the apex remain small but their axillary buds appear precociously and rapidly begin to develop into spikelets or groups of spikelets, according to the species. The abruptness with which vegetative growth changes over to inflorescence production suggests that there is a sort of minimum condition in the internal economy of the shoot apex which must be reached, and that once the point of balance is passed the vegetative type of growth ceases. The obvious suggestion is that the onset of the reproductive phase only occurs when a certain carbohydrate/nitrogen (C/N) ratio is reached. If this is the case, it should be possible to alter markedly the number of leaves produced before inflorescence production by altering the nutriment in which the plants are growing. Purvis[1], however, has shown that the amount of nitrogen supplied to rye seedlings has little effect. Plants grown under long days (16 hours) and manured with a full culture solution and 1/10 *N* culture solution produced 13·3 and 12·4 leaves respectively if germinated at 1° C. and 21 and 20·59 leaves respectively if germinated at 18° C.

I thought that the successive removal of the laminæ as they appeared might either lower the C/N ratio in the plant by cutting down the photosynthesis, or at least greatly lower the amount of food available for transport to the apex, using the term 'food' in its widest sense. It was thought that, as a consequence, the seedling might have to produce an increased number of leaves before inflorescence production commenced. As a test, grains from a single head of a pure line of wheat, *Triticum vulgare* var. *ferrugineum* Al. 'April Bearded', were sown in a large pot of good garden soil in mid-January in a cool greenhouse. (Thanks are due to Prof. Percival for original material from which the line was derived.) As the plants grew, those on one side of the pot had each successive lamina removed just above the ligular region immediately it was fully exposed. These plants could thus only photosynthesize by each developing lamina and by the sheaths left on the plant. As would be expected, the experimental plants were much smaller than the controls, as shown in the photograph taken on May 3, when most of the plants were gathered.

Although the two sets of plants differ so markedly in size, it will be seen from the results tabled below that the removal of the laminæ does not greatly influence the number of leaves produced before inflorescence initiation commences. Furthermore, if anything, removal of the laminæ slightly reduces the number of leaves rather than increasing them as was expected. The treated plants grew more slowly, and when collected, about a fortnight before the controls would have headed, were even then about three weeks behind. The reduction in the number of spikelets from 22 to 13–14 is clearly another indication of the starvation of the plants. It may be that this last effect is not merely due to a reduction in carbohydrate production, but at least partly to a decrease in the amino compounds available to the apex from the leaves. It may easily be that the removal of the leaves has not altered the C/N ratio of the apex itself but only reduced the amount of food present.

		Number of Vegetative leaves	Number of Spikelets	Highest internode with basal Bud	Highest internode with basal Root initials
Control	1	12	21	8	8
	2	12	22	8	8
	3	12	22	8	8
	4	12	23	8	8
Average		12	22	8	8
Laminæ removed	1	11	12	7	6
	2	11	13	–	–
	3	11	14	8	8
	4	12	14	9	8
	5	12	15	8	8
Average		11·4	13·6	8	7·5

From these results, in conjunction with the observations quoted from Purvis[1], it would seem that it is impossible to make much alteration in the number of leaves which must be produced at the apex of a growing cereal like rye or wheat, either by altering the amount of nitrogen supplied to its roots or by greatly reducing its photosynthesis by the removal of large areas of assimilating tissue.

The stability of the leaf number at maturity in spite of drastic treatment is also apparent in Nutman's[2] study of plants grown from dwarf embryos of rye, where grains weighing only 2·3 mgm., obtained by early harvesting of the heads, gave plants with about the same final number of leaves as those grown from normal grains (about 36 mgm.).

Workers investigating the biology of cereals and grasses might well use the number of leaves on the main stem as an index of the maturity of the individual at any stage, since it seems to be more or less independent of maltreatment suffered by the plant.

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Relative Toxicity of Insecticides

THE mode of action of insecticides is still very obscure, and it often happens that their relative toxicity is largely dependent on the method of testing employed. Consequently it is difficult to compare the results of one worker with those of another.

Carefully planned standard methods are necessary, and we welcome the publication by Dr. Parkin of the technique adopted by the Pest Infestation Laboratory of the Department of Scientific and Industrial Research[1].

One point, however, might be criticized: it would seem unwise to rely on only one species of test insect. I have found that the relative resistance of insect species changes very much with different types of poison[2]. Therefore any one insect may not give a true indication of the effectiveness of a new insecticide.

In the Pest Control Laboratories of Messrs. Imperial Chemical Industries the difficulty is met by testing new samples on several pest species. Some interesting results emerged from testing even well-known poisons with a range of insects. Table 1 shows the relative toxicity to seven insect types of a variety of fumigants and vapour poisons.

TABLE 1. RELATIVE RESISTANCE OF PEST INSECTS*

Species	Stage	Median lethal dose (mgm. litre)										
		5 hr. exposure at 20° C.								1 hr. 25° C.		1 hr. 20° C.
		Benzene	Toluene	Trichlorethylene	Perchlorethylene	Carbon tetrachloride	Chloroform	Methyl acetate	Ethyl acetate	Ammonia	Hydrogen cyanide	Ethylene oxide	Sulphur dioxide
Ephestia kühniella	Pupa	243	>Sat.	299	>Sat.	>Sat.	387	—	—	—	1·6	37	—
Calandra granaria	Adult	213	90	251	101	592	359	70	99	8·9	22	17	10
Calandra oryzæ	Adult	183	76	219	90	473	254	38	36	7·3	24	12	31
Ephestia kühniella	Larva	152	62	204	91	448	255	44	50	7·7	0·4	26	16
Tineola biselliella	Larva	137	55	176	86	352	215	—	69	—	6·5	18	24
Tribolium castaneum	Adult	64	33	103	50	137	181	65	68	5·9	0·6	41	17
Cimex lectularius	Adult	62	25	67	42	113	106	16	25	12	0·14	26	6·7
		Group 1						2		3			

*Experiments done in Pest Control Laboratories, I.C.I. Ltd. in 1939.

When this table is examined it is seen that the insects show the same order of resistance towards the various fat-solvent vapours (Group 1) but entirely different orders to the gaseous fumigants (Group 3). The explanation seems to be that an order of resistance is characteristic of a type of toxic action. The action of the fat-solvent vapours is mainly physical, whereas the highly toxic fumigants like cyanide undergo specific chemical reaction in the tissues. The two esters in group 2 would be expected to act like group 1 but are likely to be more readily hydrolysed in the tissues. It is interesting to find that the order of resistance to asphyxiation by carbon dioxide is the same as that towards the fat-solvent vapours (Table 2). (The exposures were made in glass phials, flushed through with carbon dioxide from a cylinder for five minutes and then sealed.)

TABLE 2. RESISTANCE TO ASPHYXIATION BY CARBON DIOXIDE

Species	Stage	Median lethal exposure (hr.)
Calandra granaria	Adult	213
Calandra oryzæ	Adult	68
Ephestia kühniella	Larva	54
Tribolium castaneum	Adult	30
Cimex lectularius	Adult	15

Returning to the general point, we see that *Tribolium castaneum* (Dr. Parkin's test insect) is relatively susceptible to the fat-solvent vapours and to hydrogen cyanide. But it is highly resistant to ethylene oxide, which would not appear to be a very promising fumigant judged by this species only. On the other hand ethylene oxide is more toxic to the *Calandra* spp. than hydrogen cyanide.

Contact poisons show the same specificity as fumigants. Thus, it has been shown that the house-fly[3] and the Aphids *Rhopalosiphum pseudobrassicæ*, *Aphis spiræcola*[4], *A. pomi* and *A. sorbi*[5] are more resistant to pyrethrins than to rotenone; while the reverse is true for the honey bee[5], the beetles *Epilachna corrupta* and *Diabrotica duodecimpunctata*[4] and the tick *Ornithodorus moubata*[6].

If the insecticides to be tested are merely pyrethrum solutions of different strengths, it is satisfactory to rely on one species, carefully reared as Dr. Parkin specifies. But if toxic principles other than pyrethrum are to be investigated, it would seem advisable to use more than one test species.

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[1] Parkin, E. A., NATURE, **149**, 720 (1942).
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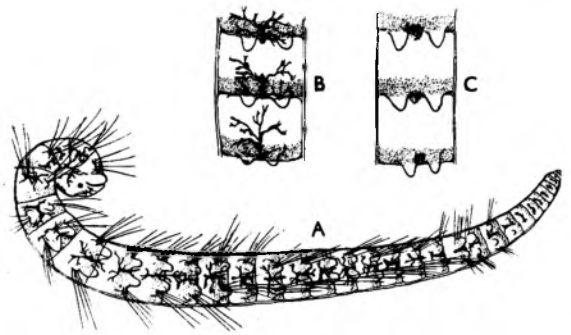
Stellate Chromatophore in the Polychæta

THE stellate chromatophore has been chiefly studied in the Crustacea and Vertebrata, to which groups it was supposed at one time to be confined[1]. It is, however, present in leeches[2,3,4,5] and has been proved experimentally to contract in the dark and expand in the light. The purpose of this note is to show that the stellate chromatophore also occurs in polychæte larvæ. It may have an extensive distribution in the annelid phylum.

On the suggestion of Mr. G. P. Wells, who has kindly helped with this note and supplied details of literature, I made rough experiments at Plymouth with the larvæ of *Pœcilochætus serpens* Allen, which

possesses stellate chromatophores noted first by Dr. E. J. Allen[6].

Structures resembling the vertebrate stellate chromatophore in appearance occur in many, but not all, polychæte larvæ. Wilson[7] found, in Polydora larvæ, that the chromatophores were sometimes expanded and sometimes contracted, but he made no experiments to determine the cause of pigment migration.



A. Pœcilochætus larva, 1·5 mm. long, from plankton, Plymouth Sound. Alive.
B. Chromatophores of same enlarged.
C. Chromatophores of another specimen kept in dark overnight.

I have been able to show that, in Pœcilochætus larvæ and in the larvæ of an unidentified Spionid, the chromatophores, which normally are expanded in the light, can be made to contract by keeping in darkness.

The worms taken direct from the plankton samples and showing branching chromatophores were kept in a cupboard in a finger bowl overnight. The next morning they were quite active and their chromatophores were contracted. The chromatophores appear to show "primary reactivity" of Hogben and Slome[8], as those of leeches do[5]. The worms were fixed in picric and mounted in euparol. The pigment in the chromatophores is almost black and shows no sign of dissolving in the permanent preparation. It is probably melanin.

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[1] Parker, G. H., *Biol. Reviews*, **5**, 59 (1930).
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Tracing Plane Spiral Coiling

LIEUT. A. T. J. DOLLAR'S letter on optical projection as an aid in studying plane spiral coiling of small fossil lamellibranchs[1] prompts me to point out a variation in technique which in the investigation of brachiopods gave superior results.

The study of a number of Lower Carboniferous brachiopods has forcibly suggested that the median or venter profile of the ventral valve is so constant as to be diagnostic of a given species. In arriving at this conclusion many accurately drawn venter profiles were compared. In the case of *Airtonia hudsoni* Cope[2], experiment on various methods of obtaining profiles, including that described by Lieut. Dollar, was made. The most satisfactory method was found in the use of an enlarging camera. The brachiopod valve was placed with the venter profile parallel to the surface of the bench, being held in position with a small block of 'Plasticine'. By careful adjustment on the vertical racking, a sharp image was obtained upon the ground-glass focusing screen of the camera. A small sheet of tracing-paper was secured in position in apposition with the screen and the venter profile traced with a pencil. Best results were obtained in a dark room using artificial illumination. Comparison of profiles was facilitated by having a separate small sheet of tracing-paper for each individual. The profile of the holotype for any given species was traced in coloured ink and taken as the standard profile.

By this method the position of the umbo can always be marked. Employment of the technique described by Lieut. Dollar frequently means that this important character is lost in the body of the silhouette.

In dealing with massive brachiopod valves such as those of *Daviesiella llangollensis* (Dav.), a different technique, which can be used when a laboratory is not at hand, was adopted[3]. An optical method could not be employed owing to the presence in many specimens of a ventral sinus. A piece of fairly stout lead-covered cable was obtained, the wire core with its cotton and rubber covering was withdrawn, and the lead tube slightly flattened. A mark near one end of the tube was brought into juxtaposition with the tip of the umbo of the brachiopod valve. The tube was then bent around the venter, care being taken that it was in contact with the valve throughout its length; the anterior margin of the valve was indicated by the production of a sharp bend. The curve so produced was laid upon tracing-paper and secured firmly on a drawing-board. A pencil line was then drawn along the inner periphery of the curve.

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[1] Dollar, A. T. J., NATURE, **150**, 57 (1942).
[2] Cope, F. W., *Ann. Mag. Nat. Hist.*, **14**, 273 (1934).
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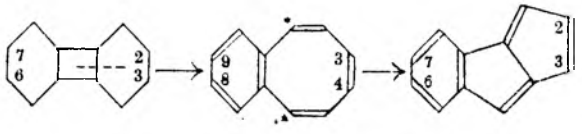
Structure of 'Diphenylene'

THE preparation of diphenylene (I) by the action of sodium on 2 : 2′-dibromodiphenyl was described in 1911[1], but later workers have been unable to confirm this claim[2]. W. C. Lothrop[3] has recently described a different compound, $C_{12}H_8$, m.p. 110°, believed to be diphenylene (I), prepared by distilling either 2 : 2′-dibromodiphenyl, or, better, diphenylene-2 : 2′-iodonium iodide, $\{C_{12}H_8I\}$ I, with cuprous oxide. By the latter reaction he also prepared 2 : 7- and 3 : 6-dimethyldiphenylenes and found that the two products were identical; this was accepted as proof of the symmetrical structure (I).

The highly strained diphenylene molecule (I) is unlikely to exist, and consideration of the most probable course of the synthetical process employed by Lothrop leads to the conclusion that 'diphenylene' is the comparatively strainless tricyclic compound (III). The removal of the two halogen atoms will

first give a diphenyl with free valencies in positions 2 and 2′. On the natural assumption that these valencies can only unite with simultaneous rupture of the potential *cyclo*butadiene ring (*cyclo*butadiene does not exist), see (I), the result will be to give a diradical of benzo-*cyclo*-octatetraene (II) (trivalent C atoms marked with *), which will rearrange into the least strained structure (III). This view of the structure of 'diphenylene' is in harmony with the identity of the two dimethyl derivatives, since both isomeric dimethyl-diphenylene-iodonium iodides must yield the same intermediate, the 4 : 8-(3 : 9)-dimethyl derivative of (II), and, therefore, the same final product, which may be either the 2 : 7- or the 3 : 6-dimethyl derivative of (III).



(I) (II) (III)

The preparation of 'diphenylene' by Lothrop's method has been confirmed. Catalytic reduction results in absorption of nearly three molecules of hydrogen, and thus it does not readily yield diphenyl as (I) would be expected to do. Moreover, it does not show the properties of an acetylene or an allene.

'Diphenylene' is the first known derivative of the partially aromatic system consisting of two fused 5-membered rings possessing four double bonds, a system first postulated by J. W. Armit and R. Robinson[4], and the preparation of which was attempted by J. W. Barratt and R. P. Linstead[5]. The double bonds in formulæ (II) and (III) are not fixed, and three uncharged forms of (III) may be written.

A full account of this work will be published elsewhere.

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[2] Mascarelli, L., and Gatti, D., *Gazz. chim. italiana*, **63**, 661 (1933). Rapson, W. S., and Shuttleworth, R. G., *J. Chem. Soc.*, 487 (1941). Lothrop, W. C., *J. Amer. Chem. Soc.*, **63**, 1187 (1941).
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Simplification of Musical Notation

As a result of a mess argument, in which two music lovers protested that the existing system of notation is too complicated, I endeavoured to produce a simpler method. The result was a 12-note arrangement instead of the customary 8-note one; therefore it would require 1½ times the space, using six lines per octave and a thick line for each *C*. The scale of *C* is shown, the arrow indicating the key note. In addition to doing away with sharps, flats and key signatures, when this method is used for keyboard instruments, the music is read in exactly the same way for both hands.

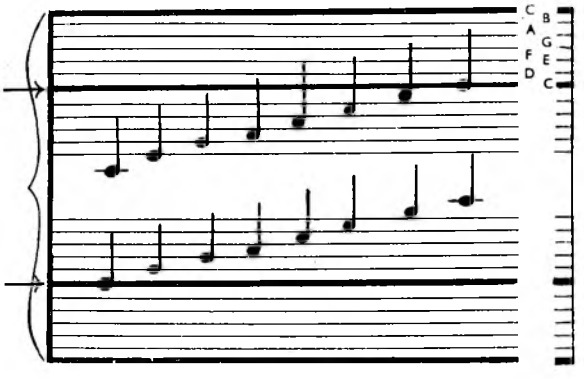
I see no reason why this system should not be applicable to all other instruments and lead to the abolition of special clefs for the instruments of the orchestra.

Some days later, I saw the interesting letters from Mr. Ll. S. Lloyd and Mr. K. B. Wood in NATURE of June 6, p. 640.

Like all readers of music, Mr. Lloyd reads a group of notes, not each individual note; this facility has been acquired by practice and experience. But what about the beginner? Which is the easier to grasp and eventually to understand and read—the 8-note plus accidentals method, or the plain 12-note method.

Mr. Wood's spacing takes even more room, but is splendid for keyboard use. I wonder if that can be dispensed with so as to make the system universal for all instruments.

Finally, I should like to point out, in defence of the extra lines required, the great steps that have been taken since plainsong was written on four lines. The extra line, sharps, flats and all the rest were added to the existing system, until it emerged in its present form. For equally tempered instruments we have had a 12-note scale for two centuries. For such free instruments as the violin and even the



voice, the adjustment of each individual note depends entirely on the player or singer, who plays or sings to the pattern of the music, adjusting the pitch as dictated by his own ear. He could read this pattern from a 12-note stave and produce the key as harmonically correct as he could from the 8-note stave.

ALAN G. SMALLEY.

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Preparation of Deoxycholic Acid

THE problem of obtaining deoxycholic acid (3, 12-dihydroxy cholanic acid) in quantity has been rendered acute by present conditions, implying the closure of the sources (largely German) of pure bile acids. Isolation from bile is laborious and yields are uncertain. Since the acid is now widely used in bacteriological media, its preparation from cholic acid (itself easily obtained from bile) has been successfully undertaken. Cholic acid (3, 7, 12-trihydroxy cholanic acid) has been directly oxidized by chromium trioxide under controlled conditions to a mixture giving the semicarbazone (m.p. 250°) of 7-keto, 3, 12-dihydroxy cholanic acid in approximately 45 per cent yield. Reduction of this substance gives a 70 per cent yield of deoxycholic acid of high purity, identified by chemical and physical properties and oxidized to the well-known dehydrodeoxycholic acid (3, 12-diketo cholanic acid).

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THE ROYAL OBSERVATORY, GREENWICH

THIS year's Report of the Astronomer Royal refers to the work of the Royal Observatory during the period May 1, 1941–April 30, 1942. London suffered few air attacks during this time, and no further damage to the Observatory has occurred. Daylight observing is still carried on at Greenwich, but the larger instruments will, of course, remain dismantled for the duration of the War.

The public time service continues to function from two out-stations, each maintaining, in case of breakdown at the other, a complete time service involving transit observations, clock maintenance, and transmission of time signals to the Post Office and the B.B.C. The Rugby vernier signals, which are the precision British time signals, have up to the present normally been transmitted from Station *B*, since the clocks at station *A* are mounted in temporary fashion and suffer from serious mutual interference. During the year, however, the three free-pendulum clocks and a quartz clock at station *A* have been remounted in a specially constructed building, and it is hoped that their behaviour will now be sufficiently improved to allow this station to share regularly in the transmission of the rhythmic signals. The published corrections to the Rugby signals and to foreign signals are now based on some or all of nine clocks—seven Shortt clocks and two quartz oscillators—mounted in various parts of the country. By working on a "mean clock" and by making certain changes in the routine of signal transmission, a distinct advance has been made in the precision of the Rugby signals, the value of which as a day-to-day frequency standard has thereby been increased. Accurate allowance for land-line lag is now made before each signal is transmitted. Comparison of the signals against the clocks, or of one clock against another, is now facilitated by the use of thermionic panel units which eliminate the variation of lag inevitable with mechanical relays. Intercomparison of the clocks has shown that in the matter of small erratic changes of rate even the best free-pendulum clocks are inferior to quartz clocks.

The Chronometer Depot has settled down into its new quarters, and repair, rating and issue of chronometers and watches to the Royal Navy have continued without interruption. A vibration machine constructed in the Observatory workshop has been brought into use for testing aircraft watches under service conditions. Tests of the effect of magnetic fields of strengths up to 8·5 gauss on the rates of chronometers and watches have been instituted, no doubt with war conditions in mind, and are now nearing completion.

The last report of the Observatory stated that work with the Airy transit circle had been terminated after ninety years continuous observation. Since then, news has been received of the destruction of Poulkovo Observatory during the bombardment of Leningrad. This will be such a serious loss to fundamental positional astronomy that observations are to be resumed with the old Greenwich instrument on a restricted programme, including particularly transits of the sun. Minor damage to the housing of the instrument has therefore been made good, the instrument has been overhauled, and work will be resumed shortly. Analysis of previous observations with this instrument arranged according to wind direction shows that declinations south of the zenith are measured larger by about 0·10″ when the wind is north-east than when it is south-west. The observations of latitude variation had already given a similar result. This agreement shows the advisability in positional astronomy of applying locally determined latitude variations so as to eliminate spurious annual terms due to systematic seasonal fluctuations in wind direction. The division errors of the fixed circle of the new reversible transit instrument show on analysis a cyclic error, recurrent every $2\frac{1}{2}°$, which may reach 0·19″; thus emphasizing the need of determining the division error of each graduation.

The photoheliograph observations show that the expected decline in solar activity continues, though there have been four notable periods of resuscitated activity. Of the four big spot groups the area of which exceeded 1,000 millionths of the hemisphere, two exhibited bright eruptions in Hα light which were later followed by great magnetic storms on the earth. Assuming that the magnetic storms were caused by solar corpuscles emitted at the time of maximum intensity of the chromospheric eruptions, the mean time of travel of the particles is calculated as 20 hours.

The Nautical Almanac Office continues its essential work. Last year's report referred to the destruction by fire of the type and plates for most of its publications: during the early part of the year under review printing delays due to this circumstance and to a change of printing contract caused a dangerous accumulation of arrears. The Nautical Almanac for 1942 was in fact not published until November 3, less than two months before the date to which it refers, but the arrears are being wiped off so satisfactorily that the 1943 edition appeared on April 3. The failure of communications with many of the other ephemeris offices has led to a small increase of computational work; but duplication is avoided so far as possible by interchanging information with such of the offices as are still free to collaborate. The War has hastened a decision which would have been reached in any event, namely, to abandon the indiscriminate provision of occultation reduction elements. The observations for 1938 and 1939 show that the majority of the computed reduction elements are never in fact used, owing to the particular occultation not being observed; and of the remainder most are used once only. In future the Office will do the individual reductions for all observations actually made, provided that observers will do that portion of the reduction depending solely on their position and that of the star. A revision of the Air Almanac has recently been planned in conjunction with the Air Ministry: the effect will be to redistribute the data on the two pages allotted to each day, one of which now becomes a "night" page and the other a "day" page. The change should result in greater simplicity in use, at the expense of a slightly larger page. The present R.A.F. Star Charts are based on a recent investigation carried out by the Office on the optimum method of identification of the stars used in aerial navigation.

The Magnetic Department of the Observatory, in addition to the regular daily observations of the magnetic elements, is at present engaged in preparing charts for the Admiralty showing the iso-magnetic lines in declination, horizontal intensity, inclination and vertical intensity. The declination charts, of which the previous edition was published in 1937, are now ready; those for *H* and dip, for which the

previous editions are dated 1922, are well advanced. Vertical-intensity charts are a novelty.

Features of the year's weather observed at Greenwich include a very wet August (4·146 in.) followed by an unprecedented lack of rain in September and October, during which only 1·41 in. fell. The winter was conspicuous for cloudiness, the sunshine recorded being only 55 per cent of the average, and for consistently low temperatures in January and especially in February, which had a record number of days (twenty-six) on which temperatures below freezing were recorded.

Visitors to Greenwich Park will miss the famous 24-hour clock dial at the shattered main gates of the Observatory, and the daily fall of the time ball; but the familiar domes are still there, though somewhat perforated, and the Wren building still stands guard over the all too characteristic bend in the river. Meanwhile, as the familiar, never-failing "six-pips" testify, the work of the Royal Observatory goes on.

RELICT VEGETATION OF THE SHILLONG PLATEAU, ASSAM

AN account has been given by Dr. N. L. Bor, forest research botanist at the Dehra Dun Institute (*Ind. For. Rec.*, vol. 3, No. 6, Govt. of India Press, New Delhi, 1942), of the vegetation of the Shillong plateau. The broad divisions are evergreen forest, pine forest and grassland. The status of each type is discussed. An analysis of the evergreen species in three widely separated groves shows that floristically they are related. The conclusion reached is that the climax is the evergreen forest, while the pine forest and the grassland are seral in status. This is a bald summary by the author; for there is much that is fascinating, and some important lessons to be learnt from the record.

Shillong, the summer capital of the Province, is situated in the Khasi and Jaintia Hills district. The portion here dealt with is the elevated tableland stretching from Cherrapunji, reputed the rainiest spot in the world (900 in. have fallen in a single year), in the south to Shillong in the north; it consists of a wide plateau of rolling downs intersected here and there with narrow gorges and some 4,000–6,400 ft. in elevation, the latter near Shillong.

The three great divisions of the vegetation are grassland, pine forest and evergreen forest, and here as in so many other parts of the world their distribution or survival has been due to man and his actions. Thirty years ago, the *Imperial Gazeteer of India* stated of the Khasi and Jaintia Hills: "At an elevation of 3,000 ft. the indigenous pine (*Pinus Khasya*) predominates over all other vegetation and forms almost pure pine forests. The highest peaks are clothed with clumps of oak, chestnut, magnolia, beech and other trees, which superstition has preserved from the wood-cutter". Both Hooker, 1849 ("Himalayan Journals") and Griffith (1837) recorded their impressions of the scenery, and both were struck with the bareness of the country, the great expanse of grassland on the rolling downs. Bor states that after the lapse of a century they have very much the same appearance to-day. The clumps of evergreen forest mentioned in the *Gazeteer* of thirty years ago also still exist, solely because they are regarded as sacred. Hooker has recorded that the flora of the Shillong plateau, in comparison with the area it occupies, is probably richer in the number of flowering plants than any other area similar in size in the whole of Asia.

The inhabitants of the plateau are of Mongolian stock and have maintained themselves intact for many centuries. By nature and practice they are shifting cultivators, termed Jhuming in Assam and Bengal. All the hill tribes in Assam live in this way, the most wasteful of all forms of cultivation. As Bor correctly points out, in the distant past when populations were small and forest areas extensive, little harm was done, but he writes: "it is a very different tale when the cultivators live in stationary settlements and their numbers continue to increase. What one may call 'saturation point' has now been reached by most of the hill tribes and one of their most urgent problems is that of the exhausted soil which must produce more at more frequent intervals. Some tribes solve this question by having permanent fields which they can irrigate, others manure their fields, while the Khasis go to the trouble of growing forests [of pine] which can be cut down and the area occupied by them cultivated".

Since the evergreen groves are sacred, it is the pine forest areas which are selected for cultivation. It is impossible to follow the author in his interesting descriptions of the methods used; he mentions that the introduction of the potato in 1830 has greatly increased the pine forest cultivation. Immigration by Nepali graziers, encouraged by the chiefs for the revenue they bring, has taken place for many years past and the graziers, says Bor, "are undoubtedly responsible for the devastation of forest over very large areas. In areas which were covered with forest a century ago, nothing but grassland remains, and on the whole it is very poor grassland. This grassland is composed of rather coarse species and it is fired by the graziers as soon as it is dry enough in order to obtain the new flush, which is eaten by cattle. Under treatment of this kind grassland degenerates rapidly and loss of soil by erosion is very considerable". This might equally be written of Africa.

From the forest-botanical point of view the interesting part of Bor's paper is his investigations into the evergreen forest or groves. It is stated that the pagan Khasi regards these groves as the abode of his tribal gods and is forbidden by tribal custom to fell, lop or damage a tree in any way; no flower may be plucked, no fires lit, no cattle grazed. He believes that the deity inhabiting the grove deals out punishment to those who break the tribal custom in this respect. This punishment is usually sudden death. Bor expresses the fear that with the conversion work of the missionaries—he might have added the inevitable arrival of Western civilization, so-called—there will result the loss of tribal veneration for the sacred groves, which will then fall to the evils of the axe, fire and so forth; a regrettable loss of what in his opinion are the remnants of the former forest which spread over much of the region. For Bor's reasons the paper must be consulted, but he shows quite definitely that the climate of the region is a 'forest' one as opposed to a 'grass' one. But surely it should not be beyond the power of a present-day administration to protect by other means what the uncivilized tribesman has for so long safely protected, even when that strict guardianship was due to what the Western peoples regard as purely pagan faith. A study of the depreciated grassland and pine

forest areas sufficiently indicate how strict for a long period of time this careful protection has proved; nor should it be beyond the powers of the Indian sylviculturist to extend the areas still occupied by this old indigenous evergreen forest.

Bor's investigations, as he says, are by no means complete; they "represent the gatherings of one rainy season in Shillong on the few occasions when holidays or Sundays afforded a release from the pressure of other work. Great as is the similarity of the floristic of the three areas based on these collections, it is believed that further work will make the similarity even closer". The tallest trees, says the author, in these dark and gloomy evergreen woods, are perhaps 60 ft. tall. The dominant stems have smooth, cylindrical boles and thick crowns which touch. The trunks and branches of the trees on the margins are loaded with lichens, mosses, orchids and other epiphytes. A small-tree layer can at times be distinguished, but it is not at all distinct. The shrubby and herbaceous layers are in places well marked and in others almost non-existent. The soil is covered with mosses and Selaginellas and is deeply stained with humus. Whenever a gap occurs in the canopy owing to the disappearance of a giant, natural regeneration of the dominant species is satisfactory. In his list of species, Bor enumerates 32 canopy trees, 66 small trees, 80 shrubs, 120 herbs, 30 ferns, 20 grasses and sedges, 8 parasites and 44 climbers, which endorses Hooker's remark on the richness of the flora of the region.

The author writes: "It is realized that a far larger number of the groves would have to be examined before reliable details of fidelity and constancy for the species could be obtained, but the object of this paper is not a statistical examination of the groves but an inquiry into the ecological status of the groves based upon the available data".

MANUFACTURE OF OPTICAL GLASS

THE production of optical glass is one of the most difficult as well as one of the most interesting of manufacturing processes. Fraunhofer was the first to realize the necessity for improvement in the manufacture of glass in order to bring it to the necessary degree of homogeneity and to make it free from internal strain, essential requirements for optical glass. It may be said that it has taken more than a hundred and fifty years to bring the art of optical glass manufacture to its present state. Messrs. Chance Bros. have been engaged on the task for nearly a hundred and twenty years and the Chance-Parsons optical glass embodies their experience, together with the newer research work in their laboratories as well as that of the firm owned by the late Sir Charles Parsons, under whom notable advances were made.

It is a cause for satisfaction to record the high quality of the glass produced by a British firm, even under war conditions. In homogeneity and freedom from strain and mechanical defects, Chance-Parsons optical glass can compare favourably with that of any other maker. The publication by Messrs. Chance-Parsons of a new catalogue of optical glass is thus something of an event for the optical designer and manufacturer, as well as for the physicist, as here is found exact data about glass for condensers, ophthalmic lenses, optical instruments and colour filters.

To measure the advance in the last thirty years it may be recalled that on the outbreak of the War of 1914–18 the British maker listed some dozen types of glass with refractive indexes given for four lines of the spectrum from C to G'. Now there are nearly one hundred types, and the data cover nine lines fairly evenly spaced over the visual spectrum from helium b to mercury h. Refractometry in the infra-red and the ultra-violet is still in the laboratory stage. When it is recalled that the same state of affairs existed with respect to the measurements in the visual spectrum until Abbe introduced exact measurements and published the data in a manufacturer's catalogue, it is possible to hope that an extension of the data to include the infra-red and ultra-violet will be a possibility before long. This would be a really useful advance as these regions are becoming of increasing importance in industry as well as in pure science. At present, when information is wanted as to the refractive indexes of any glass in the invisible regions, resort must be had to the inaccurate methods of extrapolation, or to the laboratory.

An innovation in the present catalogue is the introduction of a new system of classifying glasses in order of their stability, based on a thermodyne test devised by Chance Bros. which is said to conform well to the results of atmospheric action. Stability is assessed in terms of the period of time during which the glass may reasonably be expected to show no signs of surface tarnish. It is to be hoped that this classification will in time be extended to all the glasses on the list.

A useful feature of the catalogue is the distinguishing, by heavy type, of those glasses which are made regularly and so can be supplied with a minimum of delay. Furthermore, particular care is paid to the maintenance of a stock of certain glasses which are in very general demand, and these are indicated by an asterisk. These can be repeated, in successive melts, within very close limits of optical properties. The designer and manufacturer are therefore advised to use these wherever possible as a change to a new melt can be looked forward to without misgiving, calling for minimum alteration of the data of the system.

There are no fresh glasses recorded in the present catalogue nor any having the extreme properties claimed recently in patent literature, yet the range is wide and covers the normal requirements of the optician; British optical instrument manufacturers have no cause to complain of the lack of variety of material offered them.

Considerable advance is to be noted in the section relating to colour filters, which should be of particular value in laboratory work and in colorimetry, which is becoming of increasing industrial importance.

Glass filters naturally have not so wide a range as those made from coloured gelatin but have certain advantages. They are usually more stable; are more robust and can be more easily handled in the unprepared state; are cheaper when required to be of optical quality since the working of only one parallel flat is involved instead of two; for the same reason they can be made thinner and lighter; and they have a certain adaptability as the transmission can be varied by suitable choice of thickness.

The filters now offered provide a range of colours from infra-red to ultra-violet, as well as neutral and heat absorbing glass. There is also one (didymium) showing sharp absorption in a narrow region in the neighbourhood of the D line.

Transmission curves are given for each glass on a separate chart. This supersedes the previous method of plotting densities and is in conformity with other makers' lists. The integrated visible transmission, for a standard lamp and thickness of filter, is also supplied, and a formula given by which the transmission can be calculated for any other thickness. It is believed that there are only two other makers of coloured glass of optical quality in the world, and the English list compares favourably in range with any other.

The makers are to be congratulated on the publication of the new catalogue under present conditions.

H. W. LEE.

MOTION AND FORMATION OF THE PLANETS

TWO papers under the title "Gravitational Theory of Planetary Rotation", and "A New Theory of Planetary Formation", by J. Miller, have just appeared (*J. Brit. Astro. Assoc.*, **52**, 5 and 6, June and July 1942). Miller shows that a spherical body or a loose agglomeration of particles, held together by gravitational force or cohesion, which is describing an orbit around a central body, will acquire a rotation in a sense opposite to that of revolution. This rotation is produced by the unequal attractions of the central body or centre of force on the near and remote sides of the smaller body, and the axis of rotation will be perpendicular to the orbital plane. The linear velocity of rotation will vary as the diameter of the body, and will also be a function of the distance between the body and the central force. Owing to the fact that a second order term appears in certain computations, the linear velocity will not be exactly proportional to the diameter, and in addition, internal friction between the different strata has an important effect.

A relation between increments of time in rotation rates and increments in diameters is deduced by Miller, and the theoretical times of rotation for the different planets are computed. Some of these agree well with the actual times of rotation, and, where discrepancies occur, it is suggested that the internal frictions of the planets, for which it is difficult to calculate exact figures, are responsible. It is assumed that the solar system once revolved around the centre of a star cluster, which, in turn, was revolving around the centre of the galaxy, and planetary rotations originated as a result of the difference in the attractions on the near and remote sides of the planets, to which reference has already been made. These rotations have been maintained since they were established, though, as pointed out, there were probably other disturbing factors which modified the original rates to a small extent.

No explanation is given in the first paper of planetary formation, but this problem is attacked in the second paper. The sun alone in the solar system is first dealt with, and it is conceived as originally describing an orbit around a centre of force which may be, as in the previous case, a stellar cluster or the galaxy. Under favourable conditions, such as approach to the periphery of the cluster, the disruptive force of the latter, due to its differential attraction, will at a certain stage overcome the combined forces of the sun's gravitational pull on its external layers and of the cohesion of the particles. A portion of the sun will be removed, and as it makes closer approaches to the cluster, more material will be torn off. Miller suggests that the outer planets were removed first, and as the disrupted sun moved closer to the cluster, it lost more and more material which formed the remaining planets, Pluto being the first to be removed at a great distance and Mercury the last when the sun was nearest to the centre of attraction.

The theory differs from the planetesimal hypothesis of Chamberlin and Moulton in many ways. A cluster, not another star, is held to be responsible for the disruption. In addition, internal forces in the sun, caused by the high temperature, are not considered necessary to assist with the ejection of matter. A tentative explanation of Bode's Law is given, but this is not worked out in detail. The physical condition of the sun at the time of the formation of the planets is left an open question; it may have been in a state somewhat resembling its present condition, or it may have been in a semi-nebulous state. It is assumed that the matter composing the superficial layers did not all possess the same cohesive force, from which it may be inferred that the sun was not entirely nebulous at the time of the disruption, though it may have been very much more extended than it is at present. Miller's theory requires that the outer planets, which were first disrupted, should possess less cohesion than those closer to the sun, so that the cohesive power should increase from Mercury outwards. As, however, great changes have taken place in the planets since their formation, this rule cannot be applied very strictly.

INDIAN FORESTRY RESEARCH*

AS a record of useful economic activities, a report entitled "Forest Research in India and Burma, 1940–41" is an encouraging summary of many-sided investigations under difficult conditions. It deals with the work of the Forest Research Institute at Dehra Dun during the period under review. Naturally the outstanding feature of the year's activities has been the influence of the War. At first the demands made upon the staff of the Institute were connected with supplies, but as its work is primarily research it was for this reason capable of dealing only with comparatively small quantities of materials. It became, therefore, wisely agreed that the Institute could not make its best war contribution by turning itself into a supply unit. It has confined its programme in consequence to research work in connexion with various war problems.

While the activities of the Utilisation Branch of the Research Institute were largely engaged upon war work, rather than normal programmes, those of the Botanical and Sylvicultural Branches were more especially engaged on the normal research and other duties where interruption would lead to waste of previous efforts. In the Utilisation Branch many inquiries were dealt with in connexion with timbers for various war uses. These included bamboos for aircraft work and tent poles; timbers for rifle parts and tool handles; containers for ammunition, for packing army boots, etc. As an example it may be

* Forest Research in India and Burma, 1940–41. Part 1: The Forest Research Institute. Pp. 161. (Manager of Publications, Delhi, 1941.) Rs. 1.12 or 2*s*. 6*d*.

mentioned that cases for army boots were generally made of wood of the chir pine from the Himalayas. The enormous demand created by the War made it necessary to consider other timbers. Semul timber was suggested by the Ordnance Department. Comparative tests of both chir and semul boxes were made and tests showed that the semul boxes were practically as strong as chir boxes and possessed in addition certain advantages. It appeared that the original design of the boxes could be greatly improved so as to produce a much stronger box by very small additions costing not more than a few annas per box. Boxes embodying the improvements suggested were, therefore, made and tested. They proved to be fifteen times stronger than boxes made according to the original design. Among other work of this branch has been the testing of various woods and bamboo for mechanical pulp for newsprint-quality papers. Five species were found suitable for this purpose and inquiries are going on as to supplies and whether they are accessibly situated so as to make the matter an economic proposition.

In the Chemical Branch much attention has been given to chir pine tar, which has been successfully modified to suit requirements of large consumers such as rope works and rubber companies. The cutting off of imported supplies of wood tar has also led to a heavy demand for wood creosote, and other by-products, on the Medical Department. Large-scale production of these has now been arranged and it is computed that the sale of these by-products will bring down the cost of production of heavy tar by about 20–25 per cent. Another problem of interest, but of a much smaller nature, has been the provision of prepared wood dust used by makers of dry electric cells to incorporate with inorganic oxide to give the necessary porosity. Hitherto this substance was imported from Germany, but a highly satisfactory substitute appears to have been obtained by mixtures of spruce and bombax sawdust. It is hoped that in future it will no longer be necessary to import this material.

The Entomological Branch has been occupied with the importation of the bug *Teleonemia scruplosa* from Australia as an aid in the extermination of the pest-plant Lantana. Trials have been successful, but the insect has not so far been released in the field in case, having destroyed lantana, it should attack teak, which belongs to the same natural order of plants. It is not considered likely that such an event would happen, but nevertheless the eventuality is not being overlooked. Problems created by the emergency exploitation of the wood of *Boswellia serrata* for hutting and packing-case timber have been explored, and more especially the best procedure for protection against boring insects of several kinds.

A notable feature stressed in the report is the importance of the results obtained by the Botanical and especially the Sylvicultural Branches in the past. These have made possible the economic exploitation of the immense Indian timber supplies with the least damage to their future continuity.

FORTHCOMING EVENTS

Sunday, August 16

ASSOCIATION OF SCIENTIFIC WORKERS (at the Institution of Mechanical Engineers, Storey's Gate, Westminster, London, S.W.1), at 3 p.m.—Conference on "The Scientific Film and Scientific Film Societies".

APPOINTMENTS VACANT

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

LECTURER IN MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (August 24).

BOROUGH ELECTRICAL ENGINEER AND MANAGER—The Town Clerk, Municipal Offices, Cheltenham (endorsed 'Borough Electrical Engineer and Manager') (August 28).

GRADUATE TEACHER OF MECHANICAL ENGINEERING in the West Hartlepool Technical College—The Chief Education Officer, Education Committee, West Hartlepool (August 28).

PRINCIPAL OF THE SOUTH DORSET TECHNICAL COLLEGE, Weymouth—The Acting County Education Officer, Education Department, Shire Hall, Colliton Park, Dorchester (August 31).

REGIUS PROFESSOR OF ENGINEERING AT EDINBURGH UNIVERSITY—The Private Secretary, Scottish Office, Fieldon House, 10 Great College Street, London, S.W.1 (September 7).

HEAD OF THE CHEMISTRY DEPARTMENT—The Principal and Clerk to the Governing Body, Wigan and District Mining and Technical College, Wigan (September 12).

HARRIS CHAIR OF PHYSICS, University College, Dundee—The Secretary, The University, St. Andrews (December 31).

ASSISTANT LECTURER IN ZOOLOGY—The Registrar, University, College, Exeter.

GRADUATE TEACHER OF CHEMISTRY in the Smethwick Junior Technical School—The Chief Education Officer, Education Offices, 215 High Street, Smethwick 41.

LECTURER IN CIVIL AND MECHANICAL ENGINEERING—The Secretary, Woolwich Polytechnic, Woolwich, London, S.E.18.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Scientific Proceedings of the Royal Dublin Society. Vol. 23, No. 1: Report of the Irish Radium Committee for the Year 1941. Pp. 5. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) [277

Economic Proceedings of the Royal Dublin Society. Vol. 3, No. 10: The Influence of the Type of Equipment used for the Separation and Treatment of Cream on Churning Time and Loss of Fat in the Buttermilk. By J. Lyons. Pp. 119–129. (Dublin: Hodges, Figgis and Co., Ltd.; London: Williams and Norgate, Ltd.) 1*s*. [277

Sixty Years of Planning: the Bournville Experiment. Pp. 48. (Birmingham: Bournville Village Trust.) [287

Other Countries

Commonwealth of Australia: Council for Scientific and Industrial Research. Bulletin No. 146: An Analysis of the Outbreaks of the Australian Plague Locust (*Chortoicetes terminifera* Walk.) during the Seasons 1937–38 and 1938–39. By Dr. K. H. L. Key. Pp. 88. (Melbourne: Government Printer.) [277

National Research Council of Canada. Abstracts of Articles and Patents on the Production of Glycerol by Fermentation. By Muriel E. Whalley. (N.R.C. No. 1070.) Pp. 66. 50 cents. Extraction of Rubber from Plants. By Muriel E. Whalley. (N.R.C. No. 1071.) Pp. 19. 25 cents. (Ottawa: National Research Council of Canada.) [277

National Geographic Society. Solar Eclipse Series, No. 2: National Geographic Society—National Bureau of Standards Solar Eclipse Expedition of 1940 to Brazil. Pp. 98. (Washington, D.C.: National Geographic Society.) [277

Smithsonian Institution: United States National Museum. Bulletin 179: Life Histories of North American Flycatchers, Larks, Swallows and their Allies; Order Passeriformes. By Arthur Cleveland Bent. Pp. xi+555+70 plates. (Washington, D.C.: Government Printing Office.) 1 dollar. [277

Brooklyn Botanic Garden Record. Vol. 31, No. 2: Containing the Thirty-first Annual Report of the Brooklyn Botanic Garden, 1941. Pp. viii+55–182. (Brooklyn, N.Y.: Brooklyn Institute of Arts and Sciences.) [277

Bulletin of the American Museum of Natural History. Vol. 79, Art. 3: Results of the Archbold Expeditions, No. 41: Summary of the 1938–1939 New Guinea Expedition. By Richard Archbold, A. L. Rand and L. J. Brass. Pp. 197–288+35 plates. Vol. 79, Art. 4: Results of the Archbold Expeditions, No. 42: Birds of the 1936–1937 New Guinea Expedition. By A. L. Rand. Pp. 289–366. (New York: American Museum of Natural History.) [277

U.S. Office of Education: Federal Security Agency. Education and National Defense Series, Pamphlet No. 16: How to Read the News. Pp. iv+27. 15 cents. Education and National Defense Series, Pamphlet No. 21: Helping the Foreign-Born Achieve Citizenship; a Teachers' Guide. Pp. vi+36. 20 cents. Bulletin 1941, No. 9: Secondary Education in Austria, 1918–38. By Max Leclerer. Pp. vi+41. 10 cents. Pamphlet No. 94: Some Principles of Consumer Education at the Secondary School Level. Pp. v+42. 10 cents. (Washington, D.C.: Government Printing Office.) [277

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