NATURE

A WEEKLY ILLUSTRATED JOURNAL OF SCIENCE.

"To the solid ground
Of Nature trusts the mind which builds for aye."—WORDSWORTH.

No. 2651, Vol. 105] THURSDAY, AUGUST 19, 1920 [Price One Shilling

Registered as a Newspaper at the General Post Office.]

For other Official Advertisements see pages ccxxxiv *and* ii *of Supplement.*

THURSDAY, AUGUST 19, 1920.

Editorial and Publishing Offices:

MACMILLAN & CO., LTD.,

ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.

Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.

Telephone Number: GERRARD 8830.

The Control of Water Resources.

IN June, 1918, a Committee, with Sir John Snell as chairman, was appointed by the Board of Trade and the Ministry of Reconstruction "to examine and report upon the water-power resources of the United Kingdom and the extent to which they can be made available for industrial purposes." The Committee issued an Interim Report early in 1919, directing attention to nine large sources of water-power in Scotland which could be developed at once so as to supply electrical energy at economic rates. It was no doubt while investigating the conditions of water-power that the complexity of the general problem of the use of natural water was appreciated by the Committee, for in October, 1919, the terms of reference were extended by the Board of Trade to "consider what steps should be taken to ensure that the water resources of the country are properly conserved and fully and systematically utilised for all purposes." At the same time the Committee was strengthened by the addition of two officials of the Ministry of Health and three eminent water engineers. The enlarged Committee has issued a Report[1] dealing with the special subject of the new reference. It should be remembered that water for potable supplies must be delivered in a high state of purity, so that it cannot be collected from the surface in urban or agricultural areas. Water subject to organic impurities may, indeed, be rendered potable by chemical and bacteriological means, as Sir Alexander Houston has demonstrated on the citizens of Greater London. But many communities demand a natural and untreated supply, and this, in default of deep wells, can be obtained only from uncultivated moorlands, most of which in England and Wales have already been appropriated.

The present method of allocating supplies is for a local authority to select a suitable gathering-ground and then to promote a private Bill in Parliament. The proposed scheme, after being found to conform to Standing Orders, is examined in turn by a Committee of each House, the members of which may or may not have some knowledge of water supply and of parliamentary usage. An able counsel urges the necessity and perfection of the scheme on the Committee and brings forward experts to prove that the selected area can yield enough water and no more than is required. Certain Government Departments have the right to report upon the Bill, *e.g.* the Ministry of Health with regard to the quality of the supply and the needs of the population, the Ministry of Agriculture and Fisheries with regard to land drainage and possible damage to fish, and the Board of Trade or Ministry of Transport with regard to any possible effect on navigation. If the promoters succeed in arriving at an arrangement with the public bodies and private persons who appear as opponents, their scheme is likely to be passed by the Committee without any very critical inquiry, and it may be that broad national aspects of the case are never considered at all.

In Scotland there is in most cases an alternative to the promotion of a private Bill, by obtaining a provisional Order from the Scottish Office after an inquiry by a joint Committee of both Houses of Parliament sitting in the locality, and not at Westminster. In the absence of opposition the Order is confirmed by Parliament without further examination. A multitude of public and private opponents have a *locus standi* with regard to a Water Bill, but the fundamental idea appears to be that opposition is a matter for individual interests, and that it is not the business of any impartial authority to ascertain the facts of any particular case in the public interest alone. Selfish opposition often makes the passage of a Water Supply Bill difficult, and in the case of water-power the difficulty is much greater, as alternative sources of power are merely a matter of price.

The Report before us gives the considered

[1] Board of Trade. Second Interim Report of the Water-Power Resources Committee. Presented to Parliament by Command of His Majesty. Pp. 28. Cmd. 776. (London: H.M. Stationery Office, 1920.) Price 4*d*.

opinion of the Committee on the question of the most desirable mechanism of control for the whole water resources of the country, and it is evident that some diversity of opinion had to be reconciled in arriving at it. One member, Mr. W. A. Tait, of Edinburgh, submits a Minority Report in which he considers that all the reforms required can be secured by improving the present system, both by assimilating the law of England to that of Scotland and by making certain simplifications in procedure. He holds that there is no justification for a new central water authority. One member signs the Majority Report with a reservation in which he deprecates the creation of a Water Commission, on the ground that the Ministry of Health, if strengthened, can deal adequately with the matter. Another signs with the reservation that he would have preferred a Central Department to deal with all water interests. The remaining seventeen members found the terms of the Majority Report sufficiently comprehensive and guarded to express their views.

One might imagine that the easiest way to simplify the confusion of contending water interests would be to create a Central Department for the United Kingdom to which all existing Departments should transfer their duties as regards water, and in which any additional powers which might be required should be vested. By the constitution of the Committee the water problem in Ireland was referred to a special Irish Sub-Committee, and recent events naturally confirm the policy of keeping Irish interests by themselves. But the Committee has not found it possible or expedient even to recommend the retention of Great Britain as a unit, and the scheme outlined refers in its entirety to England and Wales, Scottish interests being left to the Scottish Office.

It seems unfortunate, in the present state of public feeling, that a rearrangement of duties could not have been suggested which should avoid adding to the present number of officials; but, on the other hand, it is necessary to bear in mind that the Committee set itself to devise a practicable scheme which could be got to work with the minimum disturbance of existing Departments. Viewed as a workable compromise, the plan suggested by the Committee has sound qualities which probably compensate its obvious theoretical deficiencies.

The Committee points out that nine previous Royal Commissions and Select Committees which had considered water problems between 1866 and 1910 had concurred in recommending the creation of a central water authority to control the allocation of water, to act as an advisory body to Parliament, and to collect information as to water resources. Much fresh evidence was called by the Committee, and the final scheme for control put forward in this Report is as follows.

The allocation of sources of water in England and Wales should be entrusted to a body of four Commissioners appointed by the Minister of Health, to whom their responsibility should be direct. The chairman of the Commission should be a Civil Servant or lawyer having ripe experience of administration and legislation. The other three should be technical members, all to be paid and to devote their whole time to the work. An Interdepartmental Committee representing the "multiplicity of interests to be reconciled" and including representatives of various scientific services should be set up by statute to assist the Commissioners.

In order that the Commission may perform its duty of allocating water, its first concern is held to be to acquire all necessary information on the subject. This should be obtained from the Departments already engaged in collecting such data, particularly the Ordnance Survey, the Geological Survey, and the Meteorological Office; but as these do not cover the whole ground the Commission should be empowered to set up a Hydrometric Survey. The Commission should consult with the Scottish and Irish authorities with a view to the compilation of all records on a uniform system.

It is recommended that every proposal to take water from the surface or from underground, except for private domestic use, should be submitted to the Commission for its licence. If the Commission sees cause to withhold its consent, the promoters can still proceed by means of a private Bill; but if a licence is issued, they need apply only to the Department dealing with the particular use of water, and this Department should be empowered to grant an Order which, if unopposed, should take effect without confirmation by Parliament. Existing Departments are empowered to deal with all uses of water except water-power, and it is proposed to create either in the Board of Trade or under the Electricity Commissioners a new Department for the study, control, and encouragement of the use of water-power in Great Britain. Encouragement should include the grant of temporary financial assistance to promising power schemes. This subject is to have fuller treatment in the final Report of the Committee.

In addition to new allocations the Water Commission should have power to revise existing allocations, including the compensation water already prescribed by Act of Parliament. Another duty would be the setting-up of local Rivers Boards to control individual rivers as a whole.

One further safeguard is suggested, namely, the appointment by the Commission of an advisory committee, or committees, consisting of "representatives of water undertakings and scientific institutions, consulting engineers, and other qualified persons." Presumably the services of these specialists are to be solicited gratuitously, for the Commission "also" ask to be empowered "to obtain and pay for professional advice in connection with their investigations."

Perhaps one might be inclined to doubt whether the Committee has always kept clearly in mind the essential distinction between scientific and technical advice; but in one respect at least the Report will be welcome to scientifically minded people. It places in the forefront of the duties of the Water Commissioners the investigation by scientific study of the actual water resources of the country and the strengthening of existing agencies by the creation of a hydrometric survey of rivers. One cannot help regretting that the various survey bodies are not united under one scientific Department, for it would be a natural development if the Department of Scientific and Industrial Research were to add to the care of the Geological Survey that of the Ordnance Survey, the Meteorological Office, and the proposed Hydrometric Survey. In these matters, however, simplification comes slowly, and it is a great matter to find a clear statement of the truth, which is not self-evident to all our legislators, that one must first ascertain what our resources are before we proceed to distribute them.

We have endeavoured to state the conclusions as briefly and simply as possible, but the Report goes into much detail and requires careful reading. The system suggested is, we believe, as simple and efficient as it could be made, bearing in mind the initial determination to work so far as possible through existing agencies. But it is open to doubt the wisdom of that determination and to ask whether the creation of a Central Department dealing with all water questions, and with water questions only, might not, after all, be a simpler, cheaper, and more efficient solution of the problem.

The Mathematician as Anatomist.

Department of Applied Statistics, University of London, University College: Drapers' Company Research Memoirs. Biometric Series, x.: A Study of the Long Bones of the English Skeleton. By Karl Pearson and Julia Bell. Text: Part i., The Femur. Chaps. i. to vi. Pp. v + 224. Atlas: Part i., The Femur. Pp. vii + plates lix + Tables of Measurements and Observations. (Cambridge: At the University Press, 1919.) Price, Text and Atlas, Part i., 30*s.* net.

Department of Applied Statistics, University of London, University College: Drapers' Company Research Memoirs. Biometric Series, xi.: A Study of the Long Bones of the English Skeleton. By Karl Pearson and Julia Bell. Text: Part i., Section ii., The Femur of Man, with special reference to other Primate Femora. Chaps. vii. to x., Appendices, Bibliography, and Indices. Pp. 225-539. Atlas: Part i., Section ii., The Femur of the Primates. Pp. vii + plates lx–ci + Tables of Femoral Measurements of the Primates. (Cambridge: At the University Press, 1919.) Price, Text and Atlas, Part i., Section ii., 40*s.* net.

If in the rapid increase of knowledge at the present time there is a tendency for men to limit their labours more and more to one narrow field of investigation, there is also, we are glad to note, an opposite tendency leading men who have become eminent in their own particular subject to cross professional frontiers and to carry war, seldom peace, into neighbouring or even distant specialities. In the present two great publications, devoted chiefly to the human thigh-bone, containing more than a quarter of a million words, with tables which give the results of at least 70,000 measurements, and illustrated by 105 anatomical plates, we find Prof. Karl Pearson, the mathematician, definitely settling himself in the front bench of speculative anatomists. He cannot have expected a warm welcome in his new quarters, for there are few British anatomists who do not bear the mark of at least one of those biometrical brickbats at the throwing of which Prof. Pearson has manifested very considerable skill. They did not hurt any the less because they were meant kindly! In spite of all their scars, however, British anatomists—nay, anatomists of every country—who study these volumes will forget their past sores and be glad to welcome him to their membership for the great service he has rendered to their subject, not only in this, but also in previous memoirs.

To understand aright what has been accomplished in the memoir now under review one has to go back twenty-five years to 1895, when Prof. Pearson, then the occupant of the chair of applied mathematics at University College, London, showed how the mathematical theory of statistics could and should be applied to all the manifestations of life. He was the only man then in England to perceive that Francis Galton was a really great man, and that if the knowledge relating to man and to living things was to be placed on a sound foundation, it must be laid by an application and an amplification of the Galtonian methods. Anatomists had made a survey of the human body and recorded their experience by giving accurate descriptions of what they had seen and broad generalisations as to what they thought. Prof. Pearson realised, as Galton had done before him, that no progress could be made in our knowledge of populations, races, or species until accurate standard methods of measurements had been applied to great numbers of individuals, and hence the first task which faced him, in building up a biometrical school, was the gathering of data to which statistical methods could be applied. Fortunately Sir George Thane, when professor of anatomy at University College, had had the foresight to store in his department great assemblages of human bones recovered from burial grounds in the East End of London—presumably remains of seventeenth-century Londoners who had died of the plague. This material became a treasure trove for the growing biometrical school.

Prof. Pearson's methods were applied to the skulls by the late Dr. W. R. Macdonald, and for the first time we had given to us standard data relating to the skull of the Englishman. Skulls have always been a favourite means for the study of racial characters, but Prof. Pearson wished to show that other bones had also their racial values, and by 1907 he was in a position, with the assistance of Miss Julia Bell, to commence his investigation of the thigh-bone.

Prof. Pearson had in the East London collection about 800 examples of this bone—each of which was examined, and in almost every instance measurements were made and estimates formed relating to eighty characters—in some examples to as many as a hundred—in order to establish the prevailing features of the thigh-bone of English men and women. He had to standardise old methods of making measurements and indices and to invent many new ones. In the course of his work he has brought to light many important facts which are new to anatomists. From this first phase of his investigation he was led, very naturally, to a second—to see how the English thigh-bone compared with that of Continental peoples. He had to search foreign records, and found them almost as barren of accurate details as those at home, but we cannot help noting his leniency towards the shortcomings of anatomists who live beyond the shores of England. Then followed in due course a third step—a comparison of the thigh-bone of the European with that of other races of the world—and a fourth—a comparison of the thigh-bone of modern man with that of ancient and extinct races of mankind. A fifth extension of his original aim was a comparison of the human femur with that of other members of the Primate class—the gorilla, the chimpanzee, the orang (the great anthropoids), the gibbon (or small anthropoid), the monkeys of the Old and of the New Worlds, and lastly with the lowest of Primate forms—the Lemuroids, including Tarsius. Then came a sixth extension—a study and comparison of the thigh-bones of extinct apes and Lemuroids. Finally, on the evidence he had thus accumulated from an intensive study of the thigh-bone, we have the construction of a pedigree or lineage of their owners—a pedigree which gives us the conception he has formed of man's evolutionary history and of man's relationship to the higher members of the animal kingdom.

By this natural sequence of inquiries the professor of mathematics has become an exponent of human phylogenetics. Setting out in 1907 with the intention of examining the femur of the Londoner, he ended in 1919 with a survey of the world of Primates.

Those who have had experience in arranging the members of a group of plants or animals—in conformity with their natural affinities—in a scheme which will express their evolutionary relationships are well aware that diverse, even contradictory, results are obtained, according to the system of parts used in framing the scheme of classification. If we arrange the Primates by grouping them according to the anatomical characters of their teeth, we get one result; if by their brains and nervous system, a second and very different grouping; if by their digestive system, a third; if by their reproductive system, a fourth, and so on. All the systems have to be taken into account, and to some, such as the brain, much more weight must be given than to others. In the most perfect scheme of classification there are always blemishes; the evidence of one system will be found to contradict or be at variance with that of another.

There need be no surprise at this variance of evidence; it should be so if heredity works in a Mendelian way. If we confine our attention, in framing a pedigree, to the parts of one system, more particularly to a single element of one system, as Prof. Pearson has done, there is a great risk of obtaining a purely artificial scheme of arrangement. If we use the thigh-bone alone, our classification of the Primates will serve to show only the evolution of their locomotory systems.

We are not forgetful that the discovery of a single fossil thigh-bone may be the sole basis on which we have to reconstruct an extinct form of man or ape. In such an event this memoir would be invaluable, for it gives us, for the first time, the basis on which a rational prophecy can be framed. There is a case in point which is very elaborately dealt with by Prof. Pearson—the thigh-bone of Pithecanthropus. He has applied more accurate and more elaborate tests to the anatomical characters of this bone than has hitherto been the case, and comes to the conclusion, as the majority of anatomists have already done, that in no essential point does it differ from that of modern man. And yet the skull assigned to this primitive humanoid form is almost as much that of an ape as of a man. Prof. Pearson is too cautious a man of science to deny the possibility of a being having at the same time an almost perfect human femur and a skull and brain which are non-human, but he is clearly more than sceptical, for in his scheme of classification Pithecanthropus must be given a place amongst races of modern man. Even when he has given us, as he has promised—and it is sincerely to be hoped he will be able to carry it out—his programme of research—the correlationship of the thigh-bone to all the other bones of the body and their correlationships to the jaws and cranium—there will still remain the infinitely more difficult task of stating in mathematical terms the correlationship of one system to another, such as that of the nervous to the digestive system, or of the respiratory to the reproductive, circulatory, and other systems. For some time, it is clear, we must depend, as in the past, on the somewhat crude methods of anatomical appreciation and analysis.

We have already told how the principal author of this monograph was led, during the latter part of the twelve years he devoted to a study of the femur, to ascertain what light his results shed on the evolutionary histories of mankind, the anthropoid apes, monkeys, and lemurs. It is true that his method of comparison sometimes leads him to quite surprising situations—of the humour of which he is perfectly aware—as when man and the pig find themselves the closest of allies as regards the diameters of their femoral shafts, or when the Old World monkeys find themselves cheek by jowl with man because of the equality of length in their femoral condyles. But on the whole his results and deductions must be regarded as helpful and trustworthy. It so happens that the writer of this review has, these thirty years past, been collecting data from all the systems of the Primate body (see Nature, 1911, vol. lxxxv., p. 508), and has from time to time assorted his observations to see how far a scheme of Primate evolution could be framed which would give a coherent explanation of the distribution of anatomical characters such as is now seen in the bodies of man, the anthropoid apes, and the monkeys of the Old and New Worlds. The results which have been reached by Prof. Pearson and the reviewer are, in the main, in harmony. The mathematical anatomist insists upon an anthropoid or troglodytic link in man's lineage; he claims to have reinstated the great anthropoid or troglodyte as a necessary stage in man's ancestry; but he will find that very few anatomists who have given this problem due thought have dismissed the anthropoid apes from the place given to them by Huxley. Prof. Pearson gives Tarsius a remote place in his scheme of human evolution. He is right, too, in dismissing the present-day gibbon from man's family tree, but altogether wrong if he supposes that the hylobatian stock from which the modern gibbon (highly specialised so far as limbs are concerned) arose plays no part in man's lineage. He is right, too, in concluding that the gibbon has no claim to be brigaded with the great anthropoids—the gorilla, chimpanzee, and orang. In their essential structure the gibbons form a separate group, one which serves to link together—or at least to bridge the gaps between—the monkeys of the Old and New Worlds and the great anthropoids. They are the essential link between monkeys and anthropoids. The femoral characters of the gibbon give a somewhat misleading indication of its true place in the phylum of the higher Primates.

As a common ancestor of the human and great anthropoid group—the pre-troglodyte in man's lineage—Prof. Pearson postulates a "Protsimio-human" Primate form, which he believes will turn out to be more human than anthropoid, a mathematical deduction with which few naturalists will agree. On the other hand, certain inferences made regarding the status and relationship of early races of man in Europe, founded entirely on the characters of their thigh-bones, are particularly worthy of attention. There has been much speculation regarding the existence of negroids in southern Europe in late Pleistocene times, founded on the discovery of remains of two Grimaldi individuals in a cave near Mentone. From a study of their skulls the reviewer came to the conclusion that they had nothing of the African negro in them, but that they were of the Cromagnon race, a conclusion which Prof. Pearson has reached independently from a study of their thigh-bones. He is uncertain of the relationship of Neanderthal and of Cromagnon man to modern races of mankind—uncertain as to whether these two types of ancient Europeans should figure as stages, or links, in the chain of modern man's evolution, or whether they really represent branches which have sprung from that stem. The evidence of their skulls and teeth leaves modern anatomists in little doubt as to their true relationships; Neanderthal man represents the terminal stage of a side branch, whereas Cromagnon man is but one of the numerous varieties of modern man. One other point is to be noted: in surveying the evolutionary evidence yielded by a single bone the same discordant array of indications is found as when all the systems of the body are studied; the final result has to be obtained by an exercise of judgment on the part of the classifier.

It is a matter of everyday observation that no two people walk exactly alike; there is the same infinite variety in the human gait as is found in the human face. Women have their own particular kind of progression; not one of us uses the right limb in exactly the same way as the left; the left foot is more frequently inturned to a greater degree than is the right. If, as medical men believe, bone-cells are peculiarly sensitive and responsive to the muscular and other stresses which are brought to bear on them, then there ought to be just that range of variation of form in the thigh-bone which this monograph demonstrates to exist. A functional explanation of the structural variation of the femur is one which Prof. Pearson is not prepared to entertain, and unfortunately medical men have as yet neglected, or almost neglected, the study of the living femur, and are therefore unable to say whether or not the anatomical forms of the femur are correlated to certain peculiarities of gait. The improvement in our means of examining the anatomy of the thigh-bone in the living by the aid of X-rays is likely to fill up this blank in our knowledge, and at the same time to offer a rational explanation of many puzzling features noted and estimated by Prof. Pearson and his collaborator. A study of the manner of progression of anthropoids in their natural habitats will help to show how closely form and function are correlated. In the orang, for instance, the hind limbs are reduced to mere grasping organs; in it and in the gibbon the swinging arms are the chief organs of progression. In the reviewer's opinion all measurements and calculations should be made, so far as is practicable, not only to indicate the degree and kind of racial characteristics, but also to express degrees and kinds of function. Indices should be of such a nature as to convey to the student a precise conception of the degree and kind of function.

This great memoir opens up a prospect which may well appal the heart of the stoutest anatomist. Here we have two parts, running to 539 pages, each page containing on an average more than 500 words, devoted to the subject which the authors speak of as femoralogy and the special students of which are called femoralogists, with the promise of a third part. When the examination of the human skeleton is completed on a corresponding scale we shall have an immense library. We may not like the prospect, but is there any option if our knowledge of mankind is to be based on a foundation which will last? The reviewer does not think there is any other way, and feels sure that the time will certainly come, if it has not already come, when anatomists the world over will acknowledge the courage, industry, and prescience of the English school of biometrics and of its founder. It would be a set-back to the progress of our knowledge of mankind were Prof. Pearson's projected programme to be in any way curtailed by a lack of financial assistance.

A. KEITH.

The Theoretic Basis of Psychotherapy.

The New Psychology and its Relation to Life. By A. G. Tansley. Pp. 283. (London: George Allen and Unwin, Ltd., 1920.) Price 10*s*. 6*d*. net.

ABOUT fifteen years ago Prof. Scripture, of Yale, published his book upon "The New Psychology." The psychology which was "new" then was experimental psychology; now the new psychology is something very different—the study of the non-rational processes of the human mind. Most of the material of Mr. Tansley's book consists in theories which are contained in the works of Prof. Freud, of Vienna; of Dr. Jung, of Zurich; and of Mr. William McDougall, who is just now leaving Oxford to settle at Harvard. The work of these three researchers has achieved world-wide renown; Mr. Tansley has done a good service in presenting some important elements of them in a compact and readable form. Mr. McDougall's books are accessible enough, but the views of the two Continental savants are scattered through various publications in a way which is rather baffling to the English reader. With the help of Mr. Tansley anyone can now make himself acquainted with the main points at issue.

The work of Freud and Jung deals mainly with the sub-conscious, that mysterious twilight region of the mind whence spring most of our deepest and strongest motives. The key which Freud has used to unlock its secrets is sex. He lays stress upon the immature sex-experience of young children and upon the repressed sexual desires of adult life which show themselves in dreams and in lapses of memory and behaviour. In this way he explains not merely the unusual phenomena of hysteria, but also the mental strains and stresses which trouble the peace of ordinary sane men. Dr. Jung, on the other hand, takes a wider view; he argues that not only sex, but also every strong natural human interest—the desire for self-preservation, for example—may be the cause of mental conflicts and nervous disorders. His view has been strikingly confirmed by the experience of the physicians who have treated the complicated war-neuroses which are familiar to the public under the term of "shell-shock." It is another side of the sub-conscious that has engaged the attention of Mr. McDougall. He has written more upon our instinctive life and shown how much of the experience which seems to us distinctively human is really based upon tendencies that are shared with the animals below us. He has done a great work in analysing our various instincts and in showing how they influence our conduct and our emotional life.

The main reason why the new psychology has so greatly impressed popular imagination is that most excellent results have been produced by it in the treatment of nervous disorders. The early workers in this field were men who were either practising physicians, or closely in touch with medicine. As soon as they formed a theory they proceeded at once to put it to the test of practice. Extraordinary cures have been performed by working upon the assumption that the trouble in the patient is of mental origin, and that the bodily symptoms are merely the physical expression of mental strain. In psychotherapy, as in medicine generally, our knowledge of detail and of derivative facts far exceeds our knowledge of fundamental principles. We know, for example, that if the physician is able to discover the nature of a hidden mental conflict which is troubling the patient, and can talk and reason with him about it, the symptoms are usually relieved. This process is technically termed "ab-reaction," and the real efficacy of it is attested by scores of incontestable cures.

This being so, it is easy to explain why Mr. Tansley's book is most satisfactory when he is dealing with such matters as the interpretation of dreams, the "rationalisations" by which men try to justify conduct which is really prompted by non-rational motives, and the great psychic complexes which correspond to the main instincts of man. And we can explain why the book is less satisfactory in the general theoretical chapters with which it opens. Mr. Tansley has done his best to combine "new" psychological theories from Freud, Jung, and McDougall into a consistent whole. The result is not very clear or convincing. But perhaps in the present state of our knowledge we could scarcely look for greater success.

H. S.

Industrial Research.

The Organisation of Industrial Scientific Research. By Dr. C. E. Kenneth Mees. Pp. ix+175. (New York and London: McGraw-Hill Book Co., Inc., 1920.) Price 12*s.*

THE author of this book is a distinguished worker in the branch of science with which he is associated, and his experience as the director of a large industrial research organisation has been such as to warrant careful consideration of his views. The book is mainly intended for manufacturers who, while convinced of the need for research in their industries, have had no occasion to consider in detail the planning and administration of a works research department. Many scientific workers will also welcome an opportunity of acquainting themselves further with the broad questions of research policy and organisation in industry, which the individual engaged on a specific task often fails to see in correct perspective. The scope of the book and the sequence of chapters are admirable. Consideration is given to various types of research laboratories, to the development of co-operative research, and particularly to the internal organisation and staffing of the works research laboratory, together with its relation to the other parts of the factory. Some general details are also given relating to the design and equipment of the laboratory, and a comprehensive bibliography is attached.

The classification of research laboratories largely resolves itself into a list of the various agencies by which the laboratories are financially maintained. To avoid the obvious disadvantages of such a grouping, the author distinguishes between "convergent" and "divergent" laboratories, depending on whether varied problems and phenomena converging on a common object are studied, such, for instance, as at the pottery school at Stoke-on-Trent or at the laboratory for glass technology at Sheffield, or whether a wider field is covered having no particular common feature, such as at the National Physical Laboratory or at a laboratory serving the interests of a group of works producing many kinds of manufactured articles.

Criticising the research associations developed in this country, the author deprecates the degree of control remaining in the hands of the Research Department, the character of the *personnel* of the Advisory Council and its committees, and the policy of secrecy which is fostered by a research association comprising a group of manufacturers in one industry; and considers the difficulty of determining the choice of researches and the disposal of results to be serious. Many people, however, will not display any particular enthusiasm for the author's alternative proposal, a co-operative laboratory conducted by an association of users. It may be admitted that users have a common interest, but this is less clearly defined and much more difficult to focus on one line of research than that of an association of producers. Users also have less experience in the production of the material they employ, and in industry it is highly desirable to make use of existing knowledge as a basis for research. The author may not be aware that, in some cases at least, British research associations are dual in character, comprising both producers and consumers, this probably being an ideal combination.

It is important to note that the author considers it undesirable to divorce a works research department from works problems, and the success of notable instances to the contrary should not obscure the principle.

Many readers will doubtless wish that the author had gone further into detail than is the case in many chapters. The economic and social benefits of research should perhaps not have been taken for granted, and the question of the co-ordination of research and the collection and distribution of scientific intelligence could have been dealt with to advantage. In general, however, the book bears the marks of experience throughout, and will well repay perusal. 650

A. P. M. FLEMING.

Science and Crime.

Legal Chemistry and Scientific Criminal Investigation. By A. Lucas. Pp. viii+181. (London: Edward Arnold, 1920.) Price 10*s*. 6*d*. net.

THERE are numerous text-books on the subject of forensic medicine, but, with the exception of works on toxicology, there are very few which deal with analogous problems to the investigation of which chemistry is applicable. This little book makes no pretension to being a complete treatise on forensic chemistry, and to this extent its title is misleading, for it consists largely of notes on the cases which have come within the author's experience, together with a few general remarks on the methods of dealing with exhibits and presenting the evidence in such cases.

As director of the Government laboratory in a country such as Egypt, where frauds of all kinds appear to be exceptionally numerous, the author has had the advantage of applying the methods described in various journals in a great number of cases, and of noting their deficiencies, and he gives particulars of these cases arranged alphabetically under the headings of the different subjects.

As a rule, original methods have not been devised, but some of the sections give interesting details of the author's investigation in connection with special subjects. For example, referring to human hair, he shows that it is doubtful whether the alleged change in the colour of the hair to red has ever been caused by the Egyptian method of embalming. Another novel point of chemical interest is that in no instance has pitch or bitumen been found in the pitch-like material used in preserving human mummies, the material examined invariably consisting of resins or gums which have become naturally blackened by age.

From the point of view of the practical chemist, the most useful section is that dealing with the examination of documents, in which questions connected with the composition of paper and inks are dealt with at some length. In one land case it was found that out of 168 documents no fewer than 163 were forgeries, the frauds ranging from simple alterations of names to the elaborate fabrication of documents by joining parts of other documents, and concealing mutilations by partly scorching the paper. In this connection the author lays stress upon the importance of knowing the dates of changes in the methods of manufacturing paper and the like.

As carbon ink is still frequently used in Egypt for title deeds of land, the author has had the exceptional opportunity of studying modern documents written in ink similar to that used prior to the invention of iron gall inks, and he gives interesting particulars of his observations. Contrary to the commonly accepted belief, the carbon inks on several of the older Arabic documents between A.D. 1677 and 1871 were partly brown, and the same thing was noted on still earlier manuscripts dating back to A.D. 622. Hence the conclusion is drawn that it must be regarded as proved that carbon inks which were originally black may become brown with age.

The questions of secret writing and its development, the imitation of seal impressions, the forgery of postage stamps, and the examination of handwriting are also briefly touched upon in this section, whilst there is a cognate section upon the detection of robbery from letters and parcels in transit.

Other subjects which are discussed include the examination of dust and stains, the development of finger-prints, the investigation of the cause of fires and of damage to crops, and the examination of fibres, ropes, and clothing. In each case references to literature on the subject are appended, and illustrative cases usually given.

Regarded as a whole, the book should be welcomed by every chemist whose work is likely to include any problems in which legal questions are involved, and it might well be made the nucleus of a more comprehensive work on forensic chemistry. It is sometimes urged against the publication of details of scientific methods as applied to the detection of crime, such as are given here, that it is dangerous to provide prospective criminals with information in a convenient form for reference; but this objection applies with more cogency to the publication of the scientific methods of combating the adulteration of food. The adulterator is frequently waiting to be made acquainted with the scientific drawbacks of his methods, whereas the persons who commit other forms of fraud are nearly always without scientific training and, if they were to attempt to avoid one scientific pitfall, would be almost certain to fall into another.

C. A. M.

Our Bookshelf.

Optical Projection. By Lewis Wright. Fifth edition, rewritten and brought up to date by Russell S. Wright. (In two parts.) Part i., *The Projection of Lantern Slides.* Pp. viii + 87. (London: Longmans, Green, and Co., 1920.) Price 4*s.* 6*d.* net.

This completely revised edition of Mr. Lewis Wright's book is very welcome. We are glad to see that the oil-lantern, which is so handy in small class-rooms and in the huts of camps, is still regarded as a possible projector. It may be mentioned that if this lantern is filled for each occasion, and set up lighted in an adjacent room, or, better still, in the school-yard, for forty minutes or so before the lecture, all risk of producing offensive fumes will be avoided. In regard to screens for such class-rooms, may we add that a square of mounted diagram-paper, which is made 5 ft. wide, gives an excellent surface, and can be kept rolled up and fixed with large drawing-pins as required? Lastly, when Mr. R. S. Wright gives suggestions as to flash-signals, should he even tolerate the "next slide" system of communication with the operator? The recently introduced silent wave of the pointer has escaped mention in this useful treatise.

G. A. J. C.

Elementary Agricultural Chemistry: A Handbook for Junior Agricultural Students and Farmers. By Herbert Ingle. Third edition, revised. (Griffin's Technological Handbooks.) Pp. ix + 250. (London: Charles Griffin and Co., Ltd., 1920.) Price 5*s.*

There are no essential differences between this and the second edition of Mr. Ingle's book. The volume provides an excellent introduction to its subject in a form which should be intelligible to the practical agriculturist as well as to the scientific student. It contains a number of interesting and useful tables, and on account of its very reasonable price it should be popular with students of agriculture. Although described on the cover as "A Practical Handbook," it contains no account of experiments or methods of analysis, but these would no doubt have increased the size of the book beyond the limits desired.

Luck, or Cunning, as the Main Means of Organic Modification? An Attempt to Throw Additional Light upon Darwin's Theory of Natural Selection. By Samuel Butler. Second edition, re-set, with author's corrections and additions to index. Pp. 282. (London: A. C. Fifield, 1920.) Price 8*s.* 6*d.* net.

This is a reprint of the first edition published in 1886. The only important changes are in the index, which has been considerably enlarged by additions made from notes by the author in a copy of the first edition. As is announced in the introduction, the book is written round Samuel Butler's favourite theories, "the substantial identity between heredity and memory," and "the re-introduction of design into organic development."

Notes on Chemical Research: An Account of Certain Conditions which apply to Original Investigation. By W. P. Dreaper. Second edition. (Text-books of Chemical Research and Engineering.) Pp. xv + 195. (London: J. and A. Churchill, 1920.) Price 7*s.* 6*d.* net.

The first edition of this stimulating work was reviewed in Nature for February 6, 1913. The new edition is divided into two portions, the first dealing with the history and method of research, and the second with modern works practice. A chapter in the latter portion is given up to the consideration of the training desirable for a research student. An index would have been helpful.

Spiritual Pluralism and Recent Philosophy. By C. A. Richardson. Pp. xxi + 335. (Cambridge: At the University Press, 1919.) Price 14*s.* net.

The author examines the Weber-Fechner law of sensation and shows that "unperceived sense-data," such as are sometimes deduced from it, are not logically admissible. He expresses spiritual pluralism as the assumption that our sense-perceptions are due to other "subjects of experience" of a non-material nature, and akin to our own subjective self. Guided by this principle, he discusses determinism and immortality, the relation of mind and body, and certain abnormal phenomena usually called "spiritualistic."

Unconscious Memory. By Samuel Butler. Third edition, entirely reset; with an Introduction and Postscript by Prof. Marcus Hartog. Pp. xxxix + 186. (London: A. C. Fifield, 1920.) Price 8*s*. 6*d*. net.

THE first edition of this work was reviewed in NATURE for January 27, 1881. The second edition, noticed in NATURE for November 3, 1910, contained an introduction by Prof. Marcus Hartog, giving an outline of Samuel Butler's works and discussing their value to science. In the present edition Prof. Hartog has appended to his introduction a postscript in which he sets forth, briefly, the position of Samuel Butler's biological works in modern science.

Wild Fruits and How to Know Them. By Dr. S. C. Johnson. Pp. xi + 132. (London: Holden and Hardingham, Ltd., n.d.) Price 1*s*. net.

A BRIEF description of most of the trees and shrubs found on the English countryside is given, special attention being paid to the forms of inflorescences and fruits. Identification of specimens is greatly simplified by the large number of sketches, showing both foliage and fruit, which are included. The last chapter is devoted to the commoner plants and weeds which have conspicuous fruits.

Silver: Its Intimate Association with the Daily Life of Man. By Benjamin White. (Pitman's Common Commodities and Industries.) Pp. xi + 144. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 2*s*. 6*d*. net.

THIS volume is more concerned with the statistics and economics of silver than with technology, although an interesting account of the extraction, purification, and utilisation of silver is given. There are many useful tables. An interesting chapter deals with "The Evolution of British Coinage." The book is addressed to the general reader, but contains much of service to teachers and students.

The Identification of Organic Compounds. By the late Dr. G. B. Neave and Prof. I. M. Heilbron. Second edition. Pp. viii + 88. (London: Constable and Co., Ltd., 1920.) Price 4*s*. 6*d*. net.

THE second edition of this useful manual has undergone practically no alteration. It is one of the best books of its kind, and contains a large amount of information in a handy and compact form. We have no doubt that it will continue to find favour among students and teachers of chemistry.

Gold: Its Place in the Economy of Mankind. By Benjamin White. (Pitman's Common Commodities and Industries.) Pp. xi + 130. (London: Sir Isaac Pitman and Sons, Ltd., n.d.) Price 3*s*. net.

THE steps by which gold has acquired its high value, and its past history with regard to production and uses, are described. The last portion of the book is devoted to a review of the gold stocks in the world and their movements before and during the Great War. A number of tables is included, showing the amount and value of gold in use in various countries; these should be of interest to students of commercial geography and economics.

Pastimes for the Nature Lover. By Dr. S. C. Johnson. Pp. 136. (London: Holden and Hardingham, Ltd., n.d.) Price 1*s*. net.

SOME of the plants and smaller animals commonly found in this country are described, and methods of preserving them or of studying their habits, as the case may be, are given. Silkworms and Nature photography are also mentioned. The book would be of use to young collectors.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

University Grants.

I AGREE with Sir Michael Sadler in thinking that the article on university grants in NATURE of August 5 is very opportune, and I concur completely in all that he says on the subject in the issue for August 12. It is not necessary for me to repeat the arguments and the statements so briefly and emphatically expressed by the Vice-Chancellor of the University of Leeds, because I feel sure that everyone with a competent knowledge of the situation in the modern universities would agree that Sir Michael Sadler has by no means understated the gravity of the crisis with which the universities are faced.

At Birmingham, as at Leeds, we have been rigidly economical in our expenditure. We know that we are doing work the value of which is appreciated by our students and the community of the Midlands whom we endeavour to serve. But unless large new grants are forthcoming it will be impossible for us not only to continue to meet those needs, but also to maintain the standard of work in the various departments.

To what Sir Michael Sadler has said I would add only two points:

(1) Unless the stipends of the non-professorial staffs of the universities are placed on something like equality with those obtaining for skilled intellectual work elsewhere, *e.g.* in the Government service or in the service of the great municipalities, it will be impossible to obtain or retain the men and women with the requisite qualifications for university work; and it is from the members of the non-professorial

staffs, when they have been trained in the universities, that the universities must later look for filling the professorships. A decrease, therefore, in the number and the quality of the non-professorial staffs of the universities means ultimately a decrease in the number and quality of the professors throughout the country. University teachers, particularly of professorial status, cannot be improvised or provided at a moment's notice. Competent professors are the result of attracting the requisite ability to the service of the universities in the junior grades and providing those junior grades with the opportunities for training in teaching and in research until they have reached the standard expected for professorial purposes. Unless, therefore, the universities are properly staffed, in a few years' time the whole standard of teaching and of research and of knowledge throughout the universities will inevitably drop; and it is desirable to remember that on the maintenance of the standards of the professoriate the training of the non-professorial staff largely depends.

Serious as is the situation to-day, its full meaning will not be apparent until some years hence, and it will then be impossible to make good what can be made good now, if we are not penny wise and pound foolish.

(2) Inadequate staffs, inadequate teaching, and overworked professors mean a drop in the quality of the students turned out by the universities. It is to the university-trained student that the Government, the municipalities, the schools, and the whole commerce and industry of the country must look for its *personnel*. If the universities are not doing their work up to the standard required, it is not the universities ultimately which will suffer most, but the whole nation. We shall be beaten as a nation because we shall be inferior as a nation.

The policy of the Government and of the local education authorities at present is to encourage, and rightly to encourage, the extension and the elevation of secondary schools in order to increase both the number of boys and girls to be kept on until they are eighteen years of age, and the number of boys and girls who will be fit to profit by a university education. What is the use of spending millions on adding to and improving the secondary schools throughout the country if the universities, which are the apex of this educational system, are to be starved? The secondary schools will be pouring out students which the universities will not be able to take; or, if they do take them, will not be able to give them a proper university education under proper teachers. Because you refuse to spend three millions, you will waste twenty or thirty millions.

Research in the universities, owing to the present congestion and inadequacy in numbers of the staff, is at present at a standstill; and unless steps are taken *now* to provide competent researchers, as well as a proper organisation and opportunities for research, the advancement of knowledge in Great Britain will come to an end. Organised research cannot be carried on anywhere except in a properly equipped university; and where industrial firms are carrying it on in a few specialised branches of industrial science from their own resources, they rely upon being provided from the universities with men and women fit to do the research required. It is not the business of, nor is it possible for, great firms to do the work of the universities in all the departments of knowledge.

The Government and the nation must make up their minds not so much as to whether the universities are to continue as to seeing that the universities are really universities and doing university work. The funds cannot be provided from the tuition fees of the students. Seventy-five per cent. of the cost of maintaining a university must be provided from other sources than those of fees. I agree, therefore, with Sir Michael Sadler that while we welcome the additional half-million promised twelve months hence, another million and a half at least are required in order that the universities may be maintained on an adequate basis.

At Birmingham, as at Leeds, we need another 60,000*l.* a year in income in order to meet absolutely necessary expenditure. C. GRANT ROBERTSON.

The University, Birmingham, August 13.

Aerial Navigation and Meteorology.

PROF. VAN EVERDINGEN'S outspoken criticism in NATURE of July 22, p. 637, of the meteorological arrangements outlined in Annexe G of the Convention for International Air Navigation is very welcome. Prior to the war the International Meteorological Committee met every three years in friendly gatherings for social intercourse and the transaction of business. Broadly speaking, the difficulties of the members were in obtaining sufficient funds to enable them, in their respective services, to achieve the ends upon which they were agreed rather than in securing agreement on the desiderata for international exchange. Now that the former difficulties have been largely met as a result of the achievements of meteorology in the war, it would be calamitous if meteorologists failed to overcome the latter, and disturbed the unity of European meteorology at a time when their efforts ought to be directed to achieving unity in world-meteorology.

I am convinced that the scheme of Annexe G is a good one, and that a frank discussion of the details with the Continental meteorologists who were not present at the Peace Conference in Paris in May, 1919, would lead to the general adoption of the scheme with the slight modifications which experience of its working has indicated.

Prof. van Everdingen states that Annexe G was discussed at the meeting in London of members of the pre-war International Meteorological Committee. He has been misinformed. Permission to put Annexe G before that meeting was definitely refused. If such a discussion had been permissible, it would probably have removed many misapprehensions.

To take some examples from Prof. van Everdingen's article:

(1) He objects that in Appendix III. (apparently a misprint for Appendix I.) he finds "wind, temperature, and humidity in the upper air as additional and facultative." By "facultative" he means "optional." But Annexe G neither says nor implies that such reports are "optional." The exact words are: "Reports will give information on [wind, etc.], and also on upper air-currents and upper air-temperature and humidity from stations where facilities are available for observation." All standard meteorological stations are able to report wind, pressure, temperature, and weather phenomena three or four times daily all the year round; but only specially equipped stations can report upper air-currents, temperature, and humidity, and no station could in 1919, or can now, report upper-air information with the same frequency and regularity as standard stations report surface observations.

(2) Prof. van Everdingen states that the use of the telegraphic scale 1–72 means that an accuracy of 5° is claimed for surface wind direction. That is not so. In the past a scale of 1–32 has been nominally used (actually the

odd numbers are usually not utilised), but no one thinks that an accuracy of $11\frac{1}{4}^\circ$ is thereby claimed, and everyone knows that the exposure of the anemometer and the turbulence of the wind cause larger variations with space and time than $11\frac{1}{4}^\circ$. The scale 1–72 was adopted for the following reasons: Nearly all the observations of wind in the upper air are made by theodolites graduated in degrees and read to tenths of a degree (or exceptionally to minutes). The direction of the upper wind is obtained in degrees. Division of the number so obtained by 5 leads to the scale 1–72. It is much simpler than division by $11\frac{1}{4}$, which would lead to the scale 1–32. Moreover, the variation of wind direction with height cannot be indicated with sufficient precision by a scale 1–32. Also, the general practice in scientific work is to specify directions in degrees, and the practice is extending both at sea and in the air. The scale 1–72 is the most precise two-figure scale which is readily converted into degrees.

Whatever method is used for obtaining wind direction at the surface, the result can be telegraphed in the scale 1–72 without difficulty; if only the eight principal directions (N., N.E., E., etc.) are used, then only the corresponding numbers of the scale (72, 9, 18, etc.) will be used.

(3) Prof. van Everdingen objects to the use of two figures for reporting "weather." The need for an extension of the existing one-figure code has been apparent for a long time. A meteorologist at headquarters requires from a reporting station sufficient information to enable him to say with precision and certainty what the weather was at the station at the time of report. With the pre-war code for international exchange this was not done. A few drops of rain or a little drizzle were reported by the same figure as the most torrential downpour. A few flakes of snow or some fine ice-crystals were reported by the same figure as the heaviest snowstorm. No figure was provided for hail or sleet, and no indication given of the thickness of a fog (in past weather). A sky nearly covered with thin, white clouds at 20,000 ft. or 30,000 ft. was described by the same figure as the darkest, gloomiest day of the year. All this was due to the restriction of the pre-war code to one figure. It was not due to failure on the part of pre-war meteorologists to recognise the phenomena which ought to be recorded and the need for differentiation of intensity. *Practically the whole of the phenomena for which provision is made in the ninety-five figures of the code of Annexe G are included in the "hydrometeors" for which provision was made in Appendix I. of the fourth meeting of the International Meteorological Congress at Vienna in* 1874. Annexe G merely makes provision for reporting by telegram, at the time when it is of direct use, the information which the Congress at Vienna arranged should be written down and reported in *monthly returns* for later scientific investigation. As to the observer being puzzled, there will always be some occasions when he is required to use intelligence in deciding which number to select, whether the single-figure pre-war code is in use or the fuller two-figure code. The difficulty is minimised for him in Annexe G by arranging that all occasions on which precipitation occurs shall be reported by a number greater than 50. We have not found in actual practice the troubles which Prof. van Everdingen fears.

The severest criticism is directed against the inclusion of detailed codes in the Convention. Holland signed the International Convention for the Safety of Life at Sea in 1914; that Convention included detailed codes for meteorological reports. Meteorology is more vital to the safety of life in the air than even ice reports to the safety of life at sea. The latter were made obligatory in 1914.

No one questions the *competence* of the International Meteorological Committee to fix the details of a code. That Committee must be in substantial agreement on the details of any code before it can be made generally obligatory. But at present the urgent need is for the trial of a scheme by the nations of Western Europe which is capable of being extended to the whole globe. The scheme of Annexe G is the only one in the field which provides both the general forms for meteorological messages and the detailed specifications necessary for reports to be made and interpreted in the confidence that their meaning is clear and definite, and that the information which they contain meets the present needs of an organised meteorological service. E. GOLD.

8 Hurst Close, N.W.4, July 25.

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(1) COL. GOLD is not too well informed about the history of the International Meteorological Committee. The introduction of improvements in the reports and codes has often given rise to animated discussions; for example, when barometric tendency was introduced. It is true that the opponents remained friends, and that the minority co-operated in carrying out the resolutions, but that was a reason not to insist upon the introduction of a resolution which had been adopted by 7 votes against 6.

(2) There is at present no unity in European meteorology; it is no use to quarrel about who disturbed it; discussion of *various systems* by a competent body is the only way to restore it. I am very glad that the British weather reports for aerial navigation have modified already part of the codes of Annexe G. This certainly is a step towards reconciliation.

(3) The minutes of the meeting of members of the pre-war International Meteorological Committee held in London in July, 1919, at which both Col. Gold and I were present, contain a collection of codes almost identical with that of Annexe G. Col. Gold is right when he says that Annexe G was not discussed then, but that makes very little difference.

(4) Every standard station can report cloud motion or pilot-balloon observations. I am glad to state that cloud motion has now been introduced in regular British reports.

(5) The reading of the theodolite is accurate enough, but the direction of upper wind derived from the results is, in general, not accurate to less than 10°. A scale 1–36 is used in Holland and elsewhere. For scientific use a more accurate indication may be useful; for practical purposes it is useless.

(6) I only object to the way in which the two figures are combined for reporting weather; extension of the space for description of weather is welcome.

(7) My remarks referring to numbers to be used by observers in reporting phenomena are based on the practice *we* actually have had with the British reports.

(8) Annexe G can have its trial at the present moment if the Powers who signed it care. There are several other systems and codes being tried by various countries, and when these have had their course we shall be in a better position to decide what the present needs of an organised meteorological service are and how they can be met. E. VAN EVERDINGEN.

Koninklijk Nederlandsch Meteorologisch Instituut, De Bilt, August 9.

Growth of Waves.

THERE has always been some difficulty in accounting for the growth of waves under the action of wind. Do the individual waves grow in length, or does the wind raise waves of all lengths which separate in virtue of the dependence of wave-velocity on wave-length? The late Lord Rayleigh was in favour of the latter hypothesis, but I believe that the true explanation is that the waves do not increase in length unless they are breaking.

The excess of energy supplied by the wind to the water beyond that which can be carried in an unbroken wave is expended partly in causing local turbulence (ultimately converted into heat) and partly in producing a surface current in the direction of the travel of the wave. In effect, this surface current increases the wave-velocity; and since the addition to the current by each wave depends on the time for which that wave has been in existence, the waves first formed will, after the lapse of time, be travelling faster than the more recently formed waves which follow. Thus if waves are set up by wind on a previously calm water-surface, the wave-length will continuously increase from windward to leeward.

I have made some rough observations on a pond something like 1000 ft. in length, and found that in a brisk breeze the waves formed at the windward end showed as ripples of a few inches from crest to crest, while at or near the leeward margin the wave-length was about 2 ft. If it is assumed that the wave-length increases regularly, there would be about a thousand crests in the length of the pond, and the gain in length from wave to wave would be about 1/1000th of the mean wave-length. All the waves from the least to the greatest were in a breaking condition. The ripples did not show any foam at their crests, but it was clear from their shape that they were actually breaking.

There is no satisfactory theory of the shapes assumed by breaking waves. Stokes, in one of his earlier papers, showed that the irrotational form of wave cannot have an angle of less than 120° at the crest (the corresponding limit for the trochoidal wave, *i.e.* for the cycloid, is 0°), but he considers that the wave will break before the 120° limit is reached.

In the problem presented by breaking waves—as, indeed, in most problems relating to the actual phenomena exhibited by fluids in motion—the simple assumptions on which the hydrodynamical theory of text-books rests are insufficient, and experiments are required.

It would be quite possible to try (say at the Froude tank at the National Physical Laboratory) the effect of a steady artificial wind on a length of several hundred feet of water, and to observe and record the form, length, and velocity of the waves throughout the length of the channel. It would probably be found that the waves were started by the instability due to the discontinuous motion at the boundary of two fluids, and that these waves increased in amplitude only until they began to break, but that after the breaking state was reached the wave-length, as well as the amplitude, increased until there was some approach to equality between the velocity of the wind and the wave.

I have worked out the results for various assumptions as to the rate at which the wind can transfer energy to the water, but in the absence of experimental data the conclusions are scarcely worth publication.

A. MALLOCK.

9 Baring Crescent, Exeter, August 10.

The Antarctic Anticyclone.

IN his letter entitled "The Mechanics of the Glacial Anticyclone Illustrated by Experiment" published in NATURE for July 22, Prof. Hobbs remarks: "In all my writings upon the glacial anticyclone I have been at much pains to explain that the domed surface of the ice is essential to the development both of the anticyclone and of the alternating calms and blizzards which record its strophic action." As, however, one goes on to read the letter one finds that Prof. Hobbs's explanation demands another "essential," namely, that the domed surface must be cooler than the air in contact with it. Remove this defect of temperature, and the mechanism ceases to act; reverse it, and the mechanism works in the reverse direction, producing a cyclone instead of an anticyclone.

Assuming that the Antarctic continent has the domed form postulated by Prof. Hobbs, one might be led to accept his conclusions so far as the winter months are concerned, but what about the summer months? During the summer, with its continuous insolation, the surface of the dome must be at a higher temperature than the adjacent air, for there is plenty of evidence that the temperature of a snow surface is very susceptible to solar radiation. The mean amplitude of the daily variation of air-temperature over the Barrier during November, December, and January was found by Scott's Expedition to be 11·5° F., while between November 17–22, 1911, the average amplitude was 20° F., and this with the sun oscillating only between 10° and 35° above the horizon! If Prof. Hobbs's theory were correct the Antarctic would have a pronounced monsoon climate, while we know from observations that anticyclonic conditions last throughout the year.

G. C. SIMPSON.

London.

Trichodynamics.

THE present writer has had interesting associations since 1915 in various ways with projects for industrial research in the cotton industry and with its actual conduct. In all these the need for a word which would define and describe the field of research peculiar to the textile industries has been intermittently obvious, especially with respect to the processes of spinning and weaving.

In consequence of this I proposed, in the course of the discussion on industrial research at the tenth International Conference held in Zurich in June last, that the word "trichodynamics" should be adopted in order to effect this generalisation, together with the related term "trichostatics." The analogy with aerodynamics is obvious, and hence also my justification for suggesting the word. The word itself is open to question, since, if used in the literal sense, it includes only the hair textiles, *e.g.* wool and cotton, but the significance intended is akin to that of the word "capillary," which now conveys a definite meaning independently of actual hairs.

The chemical and colloidal constitution of textile raw materials, their biology, and the engineering aspects of their utilisation are fields of study not strictly peculiar to the textile industry. On the other hand, the movements and mutual contacts of attenuated filaments and the changes which take place in their arrangement as they pass from the tangle of the raw material to their orderly sequence in yarn or cloth, which the proposed names would cover, form a well-defined field of a peculiar kind which awaits physical investigation.

W. LAWRENCE BALLS.

Edale, Derbyshire, August 11.

Helium: Its Production and Uses.[1]

By PROF. J. C. MCLENNAN, F.R.S.

II.

Miscellaneous Investigations.

IN the course of the investigation on the development of a machine for extracting helium from natural gas, supplies of helium of varying degrees of purity became available. These were highly purified, and used for the investigation of certain collateral problems which demanded solution. Among the results obtained, it was found that for aeronautical purposes hydrogen could be mixed with helium to the extent of 15 per cent. without the mixture becoming inflammable or explosive in air. Mixtures containing even as much as 20 per cent. of hydrogen could be burnt or exploded only when treated in an exceptional manner. The permeability of rubbered balloon fabrics for helium was shown to be about 0·71 of its value for hydrogen. For skin-lined fabrics, the permeability to hydrogen and helium was about the same. Thin soap films were found to be about one hundred times more permeable to hydrogen and helium than rubbered balloon fabrics, but untreated cotton fabrics when wetted with distilled water were but feebly permeable to these gases. It was found that rapid estimations of the amount of helium in a gas mixture could be made with a pivoted silica balance, a Shakspear katharometer, or a Jamin interferometer.

The latent heats of methane and ethane have been determined, as has also the composition of the vapour and liquid phases of the system methane–nitrogen. It has also been shown that helium containing as much as 20 per cent. of air, oxygen, or nitrogen can be highly purified in large quantities by simply passing it at slightly above atmospheric pressure through a few tubes of coconut charcoal kept at the temperature of liquid air. In the spectroscopy of the ultra-violet helium has been found to be exceptionally useful. Arcs in helium between tungsten terminals can be easily established and maintained. In a particular investigation with a vacuum grating spectrograph, it was found that by the use of arcs in helium under 30 cm. pressure illumination could be maintained continuously for hours, and with such arcs spectra could easily be obtained extending to below 1000 Å.U.

Although it is known that free electrons can exist in highly purified helium to an amount easily measurable, it was found that pure helium under a pressure of more than 80 atmospheres did not exhibit anything in the nature of metallic conduction. Moreover, the mobilities of both positive and negative ions formed by α-rays in helium under this high pressure were found to have about one-third the value expected on the basis of an inverse pressure law.

[1] From a lecture delivered before the Chemical Society on June 17. Continued from p. 751.

The Uses of Helium.

The investigation into the problem of producing helium in large quantities was originally undertaken with a view to the utilisation of the gas in aeronautical warfare. The investigation has shown that it can be produced at a cost which is not excessive, but it has also been shown that from the sources in the Empire which are known and have been examined the supply of helium cannot be greater than about 12,000,000 cubic feet per year. This quantity clearly would be sufficient to keep only a very few of our airships of the larger type in commission, even if the gas were diluted to the extent of 15 per cent. with hydrogen. This amount would, however, suffice to keep a number of the smaller aircraft supplied. Moreover, it might be used to fill fireproof compartments adjacent to the engines if it were ever decided to install these within the envelopes of our larger airships.

Since it has been demonstrated that helium can be produced in quantity, one is led naturally to consider in what directions one can hope to use the gas other than that originally intended. In industry it may be used as a filling for thermionic amplifying valves of the ionisation type. It may also be used for filling tungsten incandescent filament lamps, especially for signalling purposes where rapid dimming is an essential, and for producing gas arc lamps in which tungsten terminals are used, as in the "Pointolite" type. Both these varieties of lamp possess the defect, however, of soon becoming dull owing to the ease with which incandescent tungsten volatilises in helium and deposits on the surface of the enclosing glass bulbs. As regards illumination, helium arc lamps possess an advantage over mercury arc lamps in that the radiation emitted has strong intensities in the red and yellow portions of the spectrum.

It has been shown by Nutting (*Electrician*, March, 1912) that Geissler tubes filled with helium are eminently suitable, under certain conditions, for light standards in spectrophotometry, but the amount of the gas which could be used in this way is very small.

In spectroscopy, especially for investigations in the ultra-violet region, helium is invaluable. Doubtless its use in this field will be rapidly extended. The use of the gas in physical laboratories generally, and especially where certain investigations on the properties of matter are carried out, will also be greatly increased.

It has recently been proposed to use helium in place of oil for surrounding the switches and circuit-breakers of high-tension electric transmission lines. If the gas should prove suitable for this purpose, large quantities could be utilised, but it has yet to be demonstrated (and it is not clear that it can be) that in this field helium possesses any advantage over the oils now used.

It has been suggested by Elihu Thomson and others that if divers were supplied with a mixture of oxygen and helium, the rate of expulsion of carbon dioxide from the lungs might be increased, and the period of submergence as a consequence be considerably lengthened.

It is probable, however, that in the field of low-temperature research helium will immediately find its widest application. For this work helium is unique in that, when liquefied and possibly solidified, it enables one to reach the lowest temperatures attainable. Every effort should be exerted towards the exploitation of its use in this direction.

One point that is important and should not be overlooked is that the supplies of natural gas from which helium can be extracted are being rapidly used up. When our natural gas fields are depleted it would appear that our main source of supply of helium will have disappeared. Careful consideration should, therefore, be given to the problem of producing helium in large quantities while it is still available, and of storing it up for future use. As already stated, it may be that in the future it will be of paramount importance to have even a moderate supply of the gas available.

A Cryogenic Laboratory.

To chemists and physicists especially, the discovery that helium can be produced in quantity at a moderate cost opens up a vista in the realm of low-temperature research of surpassing interest. By means of liquid oxygen, the properties of substances can be studied down to a temperature of $-182.5°$ C. Liquid nitrogen provides us with a temperature of $-193.5°$ C., and hydrogen, which was originally liquefied in 1898 by Sir James Dewar, enables us to reach $-252.8°$ C. It is but a few years since Onnes, after prolonged effort, secured sufficient helium to enable him to liquefy this gas, too. In a brilliantly conceived research he succeeded in accomplishing this feat in 1908, and in doing it reached a temperature within approximately 1° or 2° C. of the absolute zero.

The amount of liquid helium which Onnes obtained in his investigation was small, but it sufficed to enable him to show that a number of the elements possessed a remarkable "super-conductivity" at this low temperature. Mercury in particular, at the temperature of liquid helium, possessed an electrical conductivity ten million times greater than at ordinary room temperature, and currents started by induction in a coil of lead wire at the temperature of liquid helium maintained their intensity for more than an hour with but little diminution in magnitude.

The results obtained by Onnes, although limited in number, are of great importance, for they show that if liquid helium were rendered available in quantity, fundamental information of the greatest value on such problems as those connected with electrical and thermal conduction, with specific and atomic heats, with magnetism and the magnetic properties of substances, with phosphorescence, with the origin of radiation, and with atomic structure, could be obtained.

In spectroscopy supplies of liquid helium would enable us to extend our knowledge of the fine structure of spectral lines, and thereby enable us to obtain clearer ideas regarding the electronic orbits existing in the atoms of the simpler elements. This would lead naturally to clearer views on the subject of atomic structure generally.

In other fields, too, important information could be obtained by the use of temperatures between that of liquid hydrogen and that of liquid helium. What of radio-activity? Would this property be lost by uranium, thorium, radium, and other similar elements at temperatures attainable with liquid helium? Would all chemical action cease at these temperatures? Would photo-chemical action disappear completely? Would photo-electric action cease or be maintained at such low temperatures?

In the fields of biological and botanical research, information on problems pressing for solution could be gained also. For example, would all life in spores and bacteria be extinguished by subjecting them to temperatures in the neighbourhood of absolute zero?

The list of problems rendered capable of attack by the use of liquid helium might be easily extended; but those cited already will serve to show that the field is large, and that it is well worth while for us to make a special effort to secure adequate financial support for the equipment and maintenance of a cryogenic laboratory within the Empire.

It is probably beyond the ordinary resources of any university to equip and maintain such a laboratory; but the project is one which merits national, and probably Imperial, support. It should appeal to private beneficence as well, for it is a project deserving strong and sympathetic help.

A properly equipped cryogenic laboratory should include:

(1) A liquid-air plant of large capacity.
(2) A liquid-hydrogen plant of moderate capacity.
(3) A liquid-helium plant of small capacity.
(4) Machine tools, cylinders, glass apparatus, measuring instruments, etc.

Such an equipment would probably cost more than 10,000*l*.

For building purposes, probably an additional 10,000*l*. or 15,000*l*. would be required.

The staff should include one or two skilled glass-blowers, two or three mechanics and instrument-makers, and two or three helpers for running the machinery. To provide this staff and meet charges for light, heat, and power, probably 3000*l*. a year at least would be needed.

For an administrative and technical staff, probably 2500*l*. would be necessary.

In addition to the above, special provision would have to be made to secure an adequate supply of helium. If industrial uses can be found for helium and a works were established in

Alberta for the production of helium on a large scale, the problem of supply would be solved, for the amount of the gas which would be required for low-temperature research would probably not be more than 20,000 or 30,000 cubic feet a year. In default of a production-works on a large scale being established, it would be necessary to install a small plant at Calgary for the specific purpose of supplying the cryogenic laboratory with helium. This could easily be done at the present time, as the experimental plant is still *in situ*. It would require from 3000*l*. to 4000*l*. to make the changes in the plant which experience has shown are necessary, and to provide the additional auxiliary machinery, tools, etc., required.

If this plant were run for three or four months each year, an adequate supply of helium could be obtained. The expense of running the plant under these conditions would be high, and it would probably be found that it would require from 2000*l*. to 3000*l*. to operate it for a period of three or four months each year. This amount would, of course, have to cover charges for salary of staff, compensation to the owners of the natural gas, light, power, miscellaneous supplies, freight charges on cylinders, etc.

From the above it will be seen that a scheme such as that outlined would require in the aggregate a capital expenditure of about 30,000*l*. for buildings and plant, and the interest on an endowment of about 125,000*l*. for operating and maintaining the cryogenic laboratory, together with the supply station.

If a cryogenic laboratory, with its auxiliary supply station, were established along the lines indicated, it would probably be found to be more economical to run the supply station continuously for a number of years, and to store for future use the helium accumulated. In this connection it should be stated that the experimental plant as it exists would probably not produce more than 100,000 cubic feet of helium per year. The plant could, however, be easily manifolded, and the Governments of Great Britain and Canada might, from the point of view of national safety, legitimately be asked to assume responsibility for operating it.

Much of our knowledge acquired in the field of low-temperature research we owe to the brilliant work of such distinguished men as Andrews, Davy, Faraday, and Dewar. The discovery of the rare gases, helium, neon, argon, krypton, and xenon, we owe to Lockyer, Rayleigh, Ramsay, and Dewar. How could we more fittingly perpetuate the work of these great men than by establishing on a permanent basis a cryogenic laboratory for the purpose of making still further progress in the field of low-temperature research—a field in which British men of science have made such brilliant and notable advances?

The Cardiff Meeting of the British Association.

IT is twenty-nine years since the Association met in Cardiff. It is safe to say that any members who may have been present on that occasion will not now be able to recognise the city, for there can scarcely be any other town in the country which has not merely grown, but also altered, so much in that period. In 1891 there was on the north side of what is now one of the main streets a large tract of finely timbered ground called Cathays Park, adjacent to Cardiff Castle and its park, and also the property of the Marquess of Bute. In Cathays Park now stand a number of large and handsome public buildings, including the City Hall, Law Courts, University College, Technical College, and the National Museum of Wales. These are the buildings in which the meetings of the Association will take place, and not one of them was in existence at the time of the former meeting.

As usual, it is difficult to estimate the probable success of the meeting from the point of view of numbers, but locally every effort is being made to ensure it, and a good average meeting is expected. It is certain that the Association can never have been better provided in the matter of meeting rooms and lecture halls. The local arrangements are now almost complete. The housing shortage, particularly serious in Cardiff, and the fact that this is the holiday season have made the task of the rooms and hospitality committees rather trying, but it has been accomplished, and ample accommodation will be available.

The reception room, general offices, post office, and luncheon and tea room are situated in the City Hall; Sections A, F, H, and L meet in the University College; Section G has the use of the South Wales Institute of Engineers close by; and all the other sections are accommodated in the Technical College. In the Technical College also there is an assembly hall for special meetings. The inaugural general meeting, evening discourses, and citizens' lectures take place in the Park Hall, which is near one corner of Cathays Park.

Regarding the programmes of the individual sections, little can be added to the account of them published in NATURE of July 15. The journal of sectional and other proceedings will be ready on the first day of the meeting, but has lost its right to the name, for it will not be published daily as hitherto. Members should therefore retain their copies throughout the meeting. Any alterations in the sectional programmes will be shown from day to day on the notice board in the reception room.

The inaugural general meeting will take place on Tuesday, August 24, in the Park Hall, at 8 p.m., when the president, Prof. W. A. Herdman, will deliver his address. On Wednesday there will be a reception by the Lord Mayor of

UNIVERSITY OF BRISTOL.

FACULTY OF ENGINEERING.

Dean—Professor J. WERTHEIMER, B.A., D.Sc.

The SANDWICH SCHEME provides academic training for the B.Sc. DEGREE in ENGINEERING, combined with works experience with one of twenty-three leading engineering firms in the United Kingdom.

Prospectus from the REGISTRAR, Merchant Venturers' Technical College, Bristol.

DONCASTER GRAMMAR SCHOOL.

Headmaster—Mr. J. A. CLAXTON, M.A.

WANTED, at once, JUNIOR FRENCH and JUNIOR SCIENCE MASTER for Term commencing September 14, 1920. Initial salary (Graduate) £240 to £360, according to experience, rising to £450 plus £60 per annum until Burnham Scale is issued.

Forms of application may be obtained from me, and must be returned not later than August 27, 1920.

G. R. H. DANBY, M.A., Secretary.

Education Offices,
Doncaster,
August 11, 1920.

UNIVERSITY OF LEEDS.

SCHOOL OF MEDICINE.

LECTURER IN EXPERIMENTAL PHYSIOLOGY.

Applications are invited for the post of LECTURER in EXPERIMENTAL PHYSIOLOGY which shortly falls vacant.

Salary £500 per year.

Applications, with statement of qualifications and copies of recent testimonials, should be submitted to the SECRETARY of the University as early as possible.

Information as to duties may be obtained from the DEAN of the Faculty of Medicine.

CITY OF BIRMINGHAM EDUCATION COMMITTEE.

HANDSWORTH TECHNICAL SCHOOL.

REQUIRED, in September next, the full-time services of a LECTURER in MATHEMATICS, PHYSICS, and EXPERIMENTAL MECHANICS.

The commencing salary offered will depend upon the previous training and experience of the candidate. For full particulars apply to the PRINCIPAL, Handsworth Technical School, Goldshill Road, Handsworth, Birmingham.

UNIVERSITY COLLEGE, NOTTINGHAM.

DEPARTMENT OF MATHEMATICS.

The Council invites applications for the position of LECTURER in MATHEMATICS at a commencing salary of £300 per annum.

Candidates to have an Honours Degree.

Further particulars and forms of application, which must be returned not later than Monday, August 23, may be obtained on application to the REGISTRAR.

BLACKBURN EDUCATION COMMITTEE.

REQUIRED, at the Blackburn Municipal Technical College, an ASSISTANT LECTURER in CHEMISTRY, preferably with a good knowledge of physical chemistry and able to demonstrate in Organic Chemistry. Duties to begin in September. Commencing salary £350. Apply, with full particulars of age, training, &c., and testimonials, to the VICE-PRINCIPAL.

A. H. WHIPPLE, M.A., B.Sc.,
Director of Education.

SCHOOL OF PHARMACY OF THE PHARMACEUTICAL SOCIETY OF GREAT BRITAIN.

Applications are invited for the post of ASSISTANT LECTURER in CHEMISTRY, to take charge of the teaching of Physics and assist in the general supervision of Practical Chemistry. Salary £300 per annum.

Applications to be forwarded to the REGISTRAR of the School of Pharmacy, 17 Bloomsbury Square, W.C. 1.

THE QUEEN'S UNIVERSITY OF BELFAST.

Applications are invited for the DEMONSTRATORSHIP in AGRICULTURAL BIOLOGY.

The Demonstrator will enter on his duties on October 1, and will work under the supervision of the Professor of Botany.

Salary £300 per annum.

Further particulars may be obtained from

J. M. FINNEGAN, Secretary.

OUNDLE SCHOOL.

An ASSISTANT MASTER is required to take charge of the Agricultural Department of the School.

Commencing salary £400–600, according to qualifications and experience.

Applications, with testimonials, to be sent to the HEADMASTER, the School, Oundle, Northants.

The school has an experimental farm, a botanical garden, and a biological laboratory.

UNIVERSITY OF BRISTOL.

LECTURER IN PHYSICS, £400.
ASSISTANT LECTURER IN PHYSICS, £300.

For particulars send stamped addressed envelope to REGISTRAR. Candidates should state the earliest date on which they can take up their duties.

THE UNIVERSITY OF LIVERPOOL.

GRADE III LECTURESHIP IN PHYSICS.

The Council invite applications for this post. Salary £300, increasing to £400 by annual increments of £50. Full particulars may be obtained from the REGISTRAR, to whom applications must be made on or before September 14, 1920.

HUDDERSFIELD TECHNICAL COLLEGE.

Applications are invited for the position of ASSISTANT LECTURER in MATHEMATICS.

Initial salary £300 per annum. Further particulars may be obtained on application to the SECRETARY, Technical College, Huddersfield.

UNIVERSITY OF MANCHESTER.

Applications are invited for the post of ASSISTANT LECTURER in PHYSICS.

Stipend £300. Applications, marked "Physics," should be sent to the REGISTRAR, from whom further particulars may be obtained not later than August 31.

WANTED, JUNIOR ASSISTANT for Research Work on Adhesives. Graduate in Chemistry. Applications should be forwarded to Professor S. B. SCHRYVER, Imperial College of Science and Technology, South Kensington, S.W. 7, from whom further particulars can be obtained.

REQUIRED, an ASSISTANT, a graduate in Chemistry, to carry out some Research Work under the Research Fund Committee of the Institute of Brewing. For particulars apply to Professor SCHRYVER, Imperial College of Science and Technology, South Kensington, S.W. 7.

THE BRUNTS SCHOOL, MANSFIELD.

WANTED, next Term, a FORM MASTER. Principal subject Geography.

Commencing salary to graduate, £260 to £300 per annum.

Apply C. E. STACEY, B.A., B.Sc.

GOVERNMENT LABORATORY.—TEMPORARY CHEMICAL ASSISTANTS required; salary, including present war bonus, £326. Age 20 to 25.—Apply, with copies of testimonials, GOVERNMENT CHEMIST, Clement's Inn Passage, W.C. 2.

A POSITION HAVING BEARING ON GEOLOGY REQUIRED IN LONDON by young London Inter-Science Man (Geology, Chemistry, Zoology, Physics). Three years' works laboratory discipline.—Box 70, c/o NATURE Office.

ASTRONOMICAL ASSISTANT.—Experienced graduate and lecturer offers services temporarily.—Box 2652, c/o NATURE Office.

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READER willing to share "Nature" weekly. Back numbers current volume.—E. HOLDEN, 41 West Parade, Lincoln.

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Cardiff at the University College at 8 p.m. The evening discourses by Sir R. T. Glazebrook and Sir Daniel Hall will be delivered in the Park Hall at 8 p.m. on Thursday and Friday respectively. The conference of delegates of corresponding societies will be held at 2 p.m. on Wednesday and on Friday in the assembly hall of the Technical College.

Three citizens' lectures will be delivered in the Park Hall at 8 p.m. on Monday, Wednesday, and Saturday, the lecturers being respectively Prof. J. Lloyd Williams ("Light and Life"), Prof. A. W. Kirkaldy ("Present Industrial Conditions"), and Dr. Vaughan Cornish ("The Geographical Position of the British Empire"). Members of the Association as such are not admitted to these lectures. The distribution of tickets, which are free, is in the hands of the Workers' Educational Association, and they may be obtained at the reception office during the meeting.

The programme of excursions is a varied one. The geologists are visiting Cefn On and Caerphilly on Tuesday, Penylan on Wednesday, the Barry Coast on Thursday, and Lavernock on Friday. Section E (Geography) will explore the Vale of Glamorgan on Wednesday, and the Taff and Rhondda Valleys on Thursday. The engineers will be shown over the Bute Docks on Tuesday, the Melingriffith Tinplate Works on Wednesday, the Dowlais Steelworks on Thursday, and the Great Western Colliery on Friday. Section H (Anthropology) will investigate the Roman remains at Caerwent (between Newport and Chepstow) on Wednesday. A botanical expedition to Wenvoe takes place on Thursday. The Section of Education will inspect the summer school at Barry on Friday. One or two demonstrations have also been arranged. On Wednesday Section I will be shown the new physiological laboratories of the University College, where a new electrokymograph will be demonstrated. On Thursday afternoon members of the Association, particularly those of Sections B, A, and I, are invited to the chemical laboratories of the Cardiff City Mental Hospital, where demonstrations will be given of some new chemical and physiological methods, and also of a modern high-powered X-ray installation equipped with auto-transformer and Coolidge tube. All these sectional excursions and demonstrations take place in the afternoons.

On Saturday, August 28, two general excursions of the Association will be made. One party will drive through the Wye Valley, taking lunch at Tintern and calling at Llanover, near Abergavenny, at the invitation of Lord Treowen, to take tea on the return journey. The other party will cross the Bristol Channel and visit the famous Cheddar caves, Wells Cathedral, and Glastonbury Abbey. The numbers in these excursions (and also in many of the sectional expeditions already mentioned) are limited. Members are requested to signify their intention of taking part in any of them as soon as possible after the beginning of the meeting. By so doing they will not only ensure their own participation, but also lighten the work of those responsible for organising the excursions, for in the present local conditions the difficulties of arranging transport are considerable.

Obituary.

Sir Norman Lockyer, K.C.B., F.R.S.

THE death of Sir Norman Lockyer on Monday last deprives the world of a great astronomer, and the nation of a force which it can ill afford to lose. Though it had been known for several months that Sir Norman was in a feeble state of health, his many friends cherished the hope that the vigour which was characteristic of him would revive, and that the devoted attention of his wife and daughter would preserve him to us for a few more years; but this was not to be. The alert mind and acute understanding which influenced so many men and advanced so much scientific work over a period of sixty years or so are now at rest, yet there remains to us a recollection which will not soon be effaced, and there stands in the archives of science a record of his achievement which will command admiration so long as the pursuit of knowledge is regarded as worthy human endeavour.

In the jubilee issue of NATURE in November last Dr. Deslandres, Sir Archibald Geikie, Sir Ray Lankester, and other distinguished men of science paid tribute to the work and influence of the founder of this journal, the volumes of which form an enduring monument to his memory. Sir Norman was not only a pioneer worker in the fields of science, but also an advocate of the claims of science to recognition in modern polity, and this rare combination was used to further scientific interests as well as to secure the progress of knowledge. He was the embodiment of mental activity, and never relinquished a task to which he had put his hand. Until a short time ago he was as eager to learn of developments and discoveries in astronomical work, and as ready to suggest new lines of research, as a man in the prime of life, and it is difficult to realise that this fund of energy is now no longer available to those of us who derived benefit from it. When Goethe wrote: "The quickening power of science only he can know from whose soul it gushes free," he must have had in mind a researcher of the type of him whose loss we now mourn.

Sir Norman Lockyer was born at Rugby on May 17, 1836. He was educated at various private schools, and in 1857 received an appointment at the War Office. His work there was so much appreciated that in 1865 he was entrusted with the editorship of the Army Regulations. In 1870 he was appointed secretary of the Duke of Devonshire's Royal Commission on scientific instruction and the advancement of science. The reports of this Commission are most valuable records of the position and needs of science, and if the recommendations had been put into force this country could easily have been in advance of all others as regards scientific development. When the work of the Commission was completed in 1875 Sir Norman was transferred to the Science and Art Department. He afterwards became professor of astronomical physics in the Royal College of Science, and was director of the Solar Physics Observatory at South Kensington from 1885 to 1913. He was elected a fellow of the Royal Society in 1869, was Rede lecturer to the University of Cambridge in 1871, and Bakerian lecturer to the Royal Society in 1874, in which year he received the Rumford medal of the society. In 1875 the Paris Academy of Sciences elected him a corresponding member in the section of astronomy. He was a corresponding member of numerous national scientific societies, and honorary member of many others. He received honorary degrees from the Universities of Oxford, Cambridge, Glasgow, Edinburgh, and Aberdeen, and the Order of Knight Commander of the Bath was conferred upon him by the King in 1897.

Sir Norman Lockyer's early spectroscopic work was devoted to the sun. His first observations were directed to a scrutiny of the spectrum of sunspots as compared with that of the general surface. In the course of the paper in which these observations were described, read before the Royal Society on November 15, 1866, he remarked:—"May not the spectroscope afford us evidence of the existence of the 'red flames' which total eclipses have revealed to us in the sun's atmosphere, although they escape all other modes of examination at other times?" The spectroscope he then employed proved to be of insufficient dispersive power for his researches, but by the aid of the Government Grant Committee of the Royal Society an instrument of greater power, though not quite complete, was obtained on October 16, 1868. Four days later his efforts were crowned by the detection of a solar prominence by means of the bright lines exhibited in its spectrum. An account of this discovery was immediately communicated to the Royal Society and to the Paris Academy of Sciences. Meanwhile had occurred the total solar eclipse of August 18, and Dr. Janssen, who had observed with eminent success the spectrum of the prominences during the eclipse, came to the conclusion that the same mode of observation might enable one to detect them at any time, and he saw them in this manner the next day. The first account of the discovery, which was sent by post, reached the Paris Academy a few days after the communication of Sir Norman Lockyer's observation of October 20, and, as was described in NATURE of May 20 last, a medal was struck in honour of the joint discovery.

This notable application of the spectroscope revealed the prominences as local disturbances in the continuous luminous layer which Sir Norman Lockyer called the chromosphere, and from the field of research opened by his discovery rich harvests have since been reaped. The gas, named by him helium, commonly occurring in solar prominences, was not isolated on the earth until twenty-seven years later, when Sir William Ramsay extracted it from the mineral clèveite. Now, as Prof. McLennan has described in these columns, it is possible to obtain millions of cubic feet of helium per day from natural gas in Alberta, and there is every reason to believe that this supply will become of immense scientific and industrial value.

It is beyond the bounds of this general record of Sir Norman Lockyer's scientific services to venture into the field of astronomical physics which he made particularly his own. An appreciative account of that work will be contributed to a later issue by a spectroscopist familiar with its special significance and value. Here we need only remark that Sir Norman's meteoritic hypothesis of celestial evolution is chiefly responsible for the change of view which has taken place as to the nature of nebulæ and the existence of stars of increasing as well as of decreasing temperatures. Dark nebulæ—sheets or streams of non-luminous cosmic dust—are no longer considered hypothetical, but are as real as dark stars, and the incipient luminosity of nebulæ in general represents the visible portion only of vastly more extensive congeries of invisible cosmic matter. Some of the most noteworthy discoveries of astronomical science in recent years are, indeed, those which suggest or demonstrate that space may include as much dark matter as bright, and they largely owe their origin to Sir Norman Lockyer's meteoritic hypothesis and the classification of stellar types based upon it.

In his work and conclusions upon the subject of dissociation, Sir Norman Lockyer was likewise much in advance of his times. Fifty years ago he was convinced by his spectroscopic observations that the view that each chemical element had only one line spectrum was erroneous, and that the various terrestrial and solar phenomena were produced by a series of simplifications brought about by each higher temperature employed. In his studies of dissociation he was really collecting facts concerning the evolution of the chemical elements, and he pointed out especially that the first steps in this evolution were probably best determined by observations of stellar spectra.

Sir Norman Lockyer was the chief of eight British Government solar eclipse expeditions, and organised the programmes of several others while director of the Solar Physics Observatory. His use of the slitless spectroscope during the eclipses from 1871 onwards provided a wealth of information for study. From the photographs obtained during the total solar eclipse of 1893 the wave-lengths of many chromospheric and coronal lines were determined, and a very complete series of pictures and spectra of the corona and chromosphere was obtained during the eclipse of 1898, the true wave-length of the chief corona line being then determined as 5303·7. Further knowledge was secured from the eclipses of 1898, 1900, and 1905, and it was all brought into relationship with the laboratory work and discussions of stellar types carried on at the Solar Physics Observatory.

When the first Solar Physics Committee was appointed in 1879, reference was made to the desirability of an inquiry into the possible effect of solar conditions on meteorological phenomena, but it was not until 1898 that Sir Norman Lockyer undertook, with his son, Major W. J. S. Lockyer, a definite and searching inquiry into the most trustworthy meteorological records, with the view of discovering indications of solar influence on weather factors. It was established that the oscillations of annual pressure in South America are closely related to those of the Indian Ocean, but inverse in character, high pressure years in India being represented by low pressure years in Cordoba. This "see-saw" phenomenon was found to hold good for numerous other districts, and its importance for long-period forecasting is now being recognised. Drs. Helland-Hansen and Nansen refer particularly to the work of Sir Norman and Major Lockyer upon this subject in their valuable memoir noticed in Nature of August 5, p. 715.

A report on the work of the Solar Physics Observatory during the period 1889–1909 was issued by Sir Norman Lockyer when the Solar Physics Committee was dissolved and the observatory transferred to Cambridge. This abrupt break in his life's work was acutely felt by Sir Norman, and he never really recovered from its effects, though he was as keen as ever upon progress in astrophysics. What he desired particularly was that the observatory should be transferred to a site which would permit increased opportunity for observation, and when, to his great disappointment, the institution to which he had devoted so many active years was summarily reorganised without consideration for his interests in it, and placed in a position little better than that which it had long occupied under his directorship, his hope for the development of astrophysical researches started at the observatory received a sudden and pathetic check.

Obstacles were, however, always used by Sir Norman Lockyer as opportunities. When the Solar Physics Observatory was taken from South Kensington to Cambridge in 1913, and his official connection with the observatory ceased, he devoted himself to erecting a new observatory at Salcombe Regis, Sidmouth, where he spent his declining years. Later, the Hill Observatory Corporation was formed to promote the development of this observatory and to carry on its work permanently. Sir Norman and Lady Lockyer gave the site of seven and a half acres upon which stand the present buildings, and there is ample room for extension, while the position of the observatory is as fine as could possibly be desired. Thanks chiefly to Sir Norman's gifts of instruments and to the generosity of Lt.-Col. Frank McClean, Mr. Robert Mond, and others, the observatory is already one of the best equipped in the country, and it could become one of the best in the world if wealthy benefactors here were as much interested in the promotion of astronomical science as they are in the United States, where the most notable work is now being done in astrophysics. No memorial to Sir Norman Lockyer could have a more appropriate object than that of providing means to increase the staff and develop the work of the Hill Observatory.

Sir Norman Lockyer's archæological observations are not so well known as they should be, for most of them belong to the first rank. In continuation of his work on the astronomical uses of Egyptian temples, he turned his attention to some of the stone circles and other stone monuments in this country, and he was able to establish the conclusion that such monuments were built to observe and mark the rising and setting of the sun and other heavenly bodies at different times of the year. The date of construction of Stonehenge was thus found to be between about 1900 and 1500 B.C., and it appeared that a thousand years before circles were built in Cornwall, commencing about 2400 B.C., avenues were erected in other parts of Britain.

When president of the British Association in 1903–4, Sir Norman Lockyer delivered at the Southport meeting a notable address on "The Influence of Brain-power on History." This address attracted wide attention, but the nation was not then ready to learn the lesson taught by it, and it has taken the greatest war of all time to awaken national consciousness to its significance. A strong plea was made to prepare by intellectual effort for the struggles of peace and of war, and it was added:—"Such an effort seems to me to be the first thing any national or Imperial scientific organisation should endeavour to bring about." Sir Norman Lockyer hoped that the British Association would expand one of its existing functions and become the active missionary body adumbrated in his address; but his appeal did not meet with the active support he expected from the council, most of the members of which were more interested in scientific work itself than in national aspects of it. With characteristic energy, however, Sir Norman set himself the task of establishing an organisation which would bring home to all classes of the community the necessity of making the scientific spirit a national characteristic to inspire progress and determine policy in affairs of all kinds, and as a result the British Science Guild was founded in 1905.

Throughout his career Sir Norman Lockyer's public activities made contact with national life at many points, and the British Science Guild is an institutional representation of them which remains to attain the objects at which he consistently aimed. The purpose of the Guild is to stimulate not so much the acquisition of knowledge as the appreciation of its value, and the advantage of applying the methods of scientific inquiry in affairs of every kind. Such methods are not less applicable to the problems which confront the statesman, the administrator, the merchant, the manufacturer, the soldier, and the schoolmaster than to those of the scientific worker. These were the convictions of Sir Norman Lockyer, and he had the satisfaction in recent years of hearing them proclaimed from the housetops, while the Guild itself stands as a monument of their power and his prescience.

In 1904 a large and influential deputation urged upon Mr. Balfour, then Prime Minister, the need for further assistance to university education and research, and in announcing that the grant would at once be doubled, as well as redoubled in the following year, Mr. Balfour stated that the increase, which represented a capital sum of 3,000,000*l*. at $2\frac{1}{2}$ per cent., was given as the result of the appeal made in 1903 by Sir Norman Lockyer in his presidential address to the British Association at Southport. This represents one result only of his ceaseless activity on behalf of science and higher education; the pages of NATURE throughout its existence afford ample testimony of the use of the same zeal for progress.

"There must," he once said, "be only one kind of education—the best—and that is to be given to everybody." He expected the best work from everybody associated with him, and would not tolerate any lower standard for either individual or national aims. His fingers have now loosed their grasp upon the torch of science which he held aloft for so many years, but the light still burns on the bank of the dark river he has crossed; and in admiration, hope, and reverence it will be borne onwards by workers whom he inspired. His body will be laid to rest on Saturday morning at Salcombe Regis Church, Sidmouth, but his spirit will remain in the observatory on the hill-top near-by to stimulate others to reach out and touch the sky.

Sir Edward Brabrook writes:—

Among the many who have been honoured by the friendship of Sir Norman Lockyer and are in sorrow at his death, I count myself, as having had opportunities of being associated with him in more than one capacity. I was one of those members of the Civil Service whom he invited to join with him in a welcome to Mowatt, of the Treasury, on the occasion of his election as a member of the Athenæum. In the year when Sir Norman presided over the British Association, I was one of the sectional presidents, and was nominated by him as a member of the council. I warmly sympathised with the wishes he then entertained for the extension of the functions of the association, and when these were seen to be not realisable in the form in which he desired them, I accepted his invitation to join in the formation of the British Science Guild. Others will be better able than I to tell the story of his labours for that institution, and of the success that has attended them; but I may say a few words on another aspect of his untiring intellectual work, viz. his contributions to archæology. In this respect he was an example of the interdependence that exists between the sciences, for it was the pursuit of his favourite science of astronomy that gave the direction to his studies of ancient civilisation. In the temples of Egypt and in the stone circles of our own country he found evidence of the astronomical knowledge and purpose with which they were erected, and his own profound acquaintance with the problems they presented to him from that point of view led him to conclusions which, as in the case of fixing the date of Stonehenge, were closely verified by the evidence afterwards derived from excavations on the spot.

AGRICULTURAL chemistry has lost a distinguished exponent by the death of PROF. EDWARD KINCH on August 6 at the age of seventy-one. Prof. Kinch was educated at the Grammar School, Henley-on-Thames, and the Royal College of Chemistry, and successively occupied the following positions:—Chief assistant to the professor of chemistry (the late Sir Arthur Church) at the Royal Agricultural College, Cirencester, 1869–73; on chemical staff of Royal School of Mines, 1873–75; superintendent of minerals, India Museum, 1875–76; professor of chemistry, Imperial College of Agriculture, Tokyo, 1876–81; professor of chemistry, Cirencester, 1881–1915, when the Royal Agricultural College closed on account of the war. He published many technical papers on agricultural chemistry, in which he was a leading authority, always distinguished by the soundness of his judgment. As a teacher Prof. Kinch did much for his subject both in this country and in Japan, and he will be remembered with respect and affection by many generations of students and numerous former colleagues. His life was saddened by the premature death of his young wife (a daughter of the late Rev. Geo. Huntington), whom he married in 1889, and after this he led a somewhat retired life. Those privileged to be his intimate friends will not easily forget his many sterling qualities and quiet sense of humour.

J. R. A.-D.

WE regret to note that the death of MR. JOHN KIRKALDY is announced in *Engineering* for August 13. Mr. Kirkaldy was born in 1853, and was head of the well-known London firm of John Kirkaldy, Ltd. Quite early in life he took over the management of his father's business, and under his direction the firm played an important part in introducing fresh-water distilling apparatus for use on board ship. Plant of this kind was also designed for use in the Ashanti campaign, and in 1883 and 1885 in connection with the Egyptian campaigns. Mr. Kirkaldy was a member of the Institution of Civil Engineers, and also of the Institution of Mechanical Engineers.

Notes.

ARCHÆOLOGISTS will fully appreciate the announcement that one of the first official acts of the new High Commissioner of Palestine has been the establishment of a Department of Antiquities. An International Board will advise the director on technical matters. Provision is made for an inspector, for a museum, and for the custody of the historical monuments. The museum starts with more than 100 cases of antiquities collected by the Palestine Exploration Fund and other bodies before the war. On August 9 the new British School of Archæology was formally opened at Jerusalem by Sir Herbert Samuel.

AT the council meeting of the National Association of Industrial Chemists, held at Sheffield on August 7, the hon. secretary reported that a number of firms had given a definite undertaking to consult the officials of the association in all matters relating to chemists, their appointment, salaries, and conditions of employment. On the whole, the salaries paid to members of the association were fairly satisfactory; in this connection a report had been issued giving a schedule of minimum salaries, and this would be circulated shortly. The hon. secretary took a gloomy view of the future before industrial chemists. He stated that the number of unemployed was increasing rapidly, and there was every indication of a coming great slump in the engineering and allied industries in which their members were employed. It was more than ever imperative for industrial chemists to unite to preserve their interests. Mr. A. B. Searle (Sheffield) was unanimously elected president for the coming year, and Mr. J. W. Merchant appointed secretary. The proposal to appoint an organising secretary for propaganda work was also carried.

A MEMORIAL has been presented to the German National Assembly urging the formation of an Imperial Chemicotechnical Test Laboratory, which it is recommended should be formed from the Military Test Bureau which existed during the war. According to a report in the *Zeits. des Vereines deutscher Ingenieure* for May 29, it is suggested that the functions of the new laboratory should be, *inter alia*, the execution of scientific and technical investigations relative to raw materials, and particularly (1) the production of materials of importance to the public, *e.g.* spirit from wood and acetylene instead of from potatoes, and of fatty acids from the products of coal- or lignite-tar or paraffin, and the utilisation and improvement not only of cellulose as a substitute for cotton, but also of ammonium nitrate obtained synthetically in large quantities as a fertiliser; and (2) the determination of substitutes for chemical and metallurgical products not available in the country or of which there is a shortage, *i.e.* substitutes for paraffin, camphor, and glycerine, for substances used in the preservation of leather and metals, also substitutes for lubricants, rubber, gutta-percha, etc. In addition, the proposed new institute would carry out researches of general interest, *e.g.* on rust-prevention and the corrosion of metals, on the determination of stresses in internal-combustion engines, on the effect of winter cold and upper-air temperatures on implements and raw materials, and on the testing and improvement of aeroplane and airship fabrics. It is also suggested that scientific and technical investigations should be carried out dealing with the prevention of accidents and the protection of workers in a number of important industries.

THE autumn meeting of the Institute of Metals will be held at Barrow-in-Furness on September 15–16, under the presidency of Sir George Goodwin.

WE have received the quarterly report of the Research Defence Society containing an account of the annual general meeting. The Jenner Society has become affiliated to the society, and its hon. secretary, Dr. Drury, has joined the committee. At the close of the meeting Col. McCarrison gave an address on "Vitamines," an abstract of which is published in the report.

Medical Science: Abstracts and Reviews for August (vol. ii., No. 5) contains a review of recent work and articles upon "lethargic encephalitis" (see NATURE, January 1, p. 452), a disease which appeared in this country at the commencement of 1918. Cases have been reported in almost every European country and in Africa, India, the United States, and Canada. Netter points out that descriptions of a similar disease are given by Hippocrates, Aretæus, and Cælius Aurelianus, and the works of Celsus contain a chapter on "lethargic fever." Sydenham in the seventeenth century also gave a description of the same kind of disease under the name of "comatose fever." It appears reasonable to suppose, therefore, that this disease is not new, but has been in abeyance for seventy years or more. No causative organism has yet been discovered.

ON the occasion of the opening of the third laboratory of the Liverpool School of Tropical Medicine on July 24 (see NATURE, July 29, p. 696) the Liverpool University Press issued a volume (103 pp., 37 plates) giving an account of the inception of the School and its history from that time up to the present. In addition to the records of the important contributions of the School to the advance of our knowledge of tropical diseases, the volume records the benefactions which have enabled the School to develop and to perform its functions so successfully. Among recent developments may be mentioned the establishment of research laboratories at Manáos and at Sierra Leone, where continuous investigations into the diseases of these localities can be carried on. We join in the confident hope expressed that the city of Liverpool and those "whom destiny binds in diverse ways to tropical lands" will continue to support the School.

THE Research Defence Society has issued a paper by Major-Gen. Sir David Bruce on the prevention of tetanus during the Great War by the use of antitetanic serum. Sir David Bruce states in his introduction that the object of this paper is to controvert the assertions of the supporters of anti-vivisection in regard to tetanus, and to prove that antitetanic serum is of the greatest use in preventing the onset of the disease, and if not successful in this, in mitigating the severity of the symptoms and lessening the death-rate. Statistics of the incidence of tetanus among the wounded sent home, about 1,242,000, are given; there were among them 1458 cases of tetanus, a ratio of about 1 per 1000. In September, 1914, 6000 wounded men were landed in England, and 54 men wounded in that month were attacked by tetanus, a ratio of 9 per 1000. In November, 1914, there was a sudden drop to a ratio of 2·3 per 1000, and the ratio never afterwards exceeded about 2·7, and was frequently less. This sudden drop coincides with the systematic inoculation of all the wounded with antitetanic serum. The case-mortality per cent. of those who developed tetanus was 53·5 among those unprotected with antitetanic serum, and 23·0 among those who received a preventive injection of the serum. The use of antitetanic serum also markedly lengthened the incubation period of the disease, and the longer the incubation period, the milder does the disease tend to be. With a long incubation period the disease frequently assumes a localised form in the neighbourhood of the wound, and while in 1914 the percentage of cases of the acute and generalised form was 98·9 and of the local form 1·1, in 1918 the respective figures were 83·5 and 16·5. Sir David Bruce concludes, therefore, that by the preventive use of antitetanic serum (1) the incidence of the disease is lowered ten to twelve times; (2) the incubation period is lengthened four or five times; (3) the disease becomes milder, many of the cases showing only local manifestations; and (4) the death-rate is lowered fourfold.

FOUR specimens of Gephyrea were taken from the stomachs of fish at two widely separated stations by the Canadian Arctic Expedition, 1913–18. These are referred by Mr. R. V. Chamberlin (Report of the Expedition, vol. ix., Part D, 1920) to the widespread northern *Priapulus humanus*. A short account is given of other Canadian Gephyrea, which represent six species—the Priapulus already mentioned and five Sipunculids, one of which is a new species of Phascolosoma. The author appends a useful, but not quite complete, bibliography of the Gephyrea containing the titles of about 430 works.

THE remarkable habits of the sage grouse form the subject of a brief but valuable essay by Mr. Bruce Horsfall in *Zoologica* (vol. ii., No. 10), the organ of the New York Zoological Society. One of the most striking features of the displays described is the use of the wings in thrusting forward the inflated air-pouch, which plays a prominent part in the performance. The author contends that these displays are not "courtship" antics, because no notice was taken of one or two females which "meandered through the throng" while the performance was in full swing. But since the breeding season seems only just to have begun, one feels inclined to doubt the validity of this interpretation. A number of unusually good text-figures and a coloured plate add greatly to the value of this most welcome addition to our knowledge of the ecology of the sage grouse.

THE nesting of the bee-eater in Scotland is an event in the annals of British ornithology which is indeed worthy of record, and we are greatly indebted to Mr. J. Kirke Nash for his carefully kept notes thereon which he publishes in *British Birds* for August. A pair of these birds were first seen on June 3 perched on a wire fence surmounting a sand-bank of the River Esk, near Musselburgh. When discovered they were engaged in catching flies, after the fashion of the flycatcher. On June 7 they were found entering and leaving a hole in the bank, and as the male was seen feeding his mate it was clear that they were nesting. On June 13, however, the female fell a victim to the stupidity of a gardener, who captured it, placed it in a greenhouse, and "fed" it on breadcrumbs. Needless to say, it died within two days, after laying an egg. A few days later the unfortunate survivor was caught and killed by a cat.

DR. B. H. RANSOM contributes to the Proceedings of the United States National Museum (vol. lvii., pp. 527–73, 33 figs., 1920) a synopsis of the Trematode family Heterophyidæ, with descriptions of a new genus and five new species. This family is composed of a number of genera of small Trematodes, usually not more than 2 mm. long, parasitic in the intestine of mammals and birds, usually fish-eaters. Two of these flukes, *Heterophyes heterophyes* and *Metagonimus Yokogawai*, occur in the small intestine of man—the former in Egypt, China, and Japan, and the latter in Formosa, Japan, and Korea. These occur also in the dog and cat, and five other flukes of this family have been recorded from these animals. The author gives a key to the characters of the nine genera which he recognises as valid, and also supplies the necessary keys to the species.

THE first annual report of the Industrial Fatigue Research Board (H.M. Stationery Office) contains an interesting record of work completed or in progress. Of the four reports already issued that of Dr. Vernon dealing with the influence of hours of work and ventilation on output in the tinplate industry is the most extensive, while the report by Mr. Major Greenwood and Miss Hilda Woods upon the incidence of industrial accidents (the statistical theory of this investigation has been further developed in a paper by Messrs. Greenwood and Yule published in the March, 1920, issue of the Journal of the Royal Statistical Society) suggested some important problems which the Board proposes to study further. Mrs. Osborne's paper on the output of female munition workers and Dr. C. S. Myers's analysis of the results obtained in a factory after the introduction of motion study are also of interest. Amongst investigations not yet completed, that on the relation between length of shift and fatigue in the iron and steel industry, entrusted to Dr. H. M. Vernon, is almost ready for publication, and progress has been made with inquiries into special conditions affecting the cotton, boot and shoe, and silk industries. The Board has a large number of tasks in hand, and it is yet too early to decide which are likely to be most remunerative. It is, however, clear that careful thought has been devoted to the organisation of research, and we have no doubt that the outcome will be of the greatest benefit to both employers and employed.

COPIES of new editions of several pamphlets in the Economic Series published by the Natural History Museum have come to hand. No. 1 on the house-fly (*Musca domestica*) by Major Austen is in its third edition, and has been enlarged and almost entirely rewritten. It deals with the house-fly under normal conditions in the British Isles; those who desire further information, including Army requirements, should consult the larger pamphlet, No. 1A, in the same series. The illustrations are exceedingly clear, and several of these, along with the letterpress, will help to distinguish the commoner house-frequenting flies from the true house-fly, which they closely resemble. *Musca autumnalis* is a case in point; it frequently enters houses, etc., and hibernates therein during the winter, giving rise to the popular belief that the winter habits of *M. domestica* are well known. The latter feature, however, is one concerning which we need much more extensive observation than has been accorded to it in the past. The breeding habits of the house-fly are also dealt with, and simple remedial and preventive measures against this pest are enumerated. No. 3, by Mr. J. Waterston, deals with fleas and their relation to man and domestic animals. It is noteworthy that eleven species have up to the present proved capable of transmitting plague. Five of them are common in Britain, while the plague-flea *par excellence* (*Xenopsylla cheopis*) is occasionally introduced. No. 4, on mosquitoes, is written by a recognised student of the family, Mr. F. W. Edwards. The relation of these insects to disease and the control measures in vogue are clearly explained. No. 6, by Mr. H. Hirst, deals with scorpions, mites, ticks, spiders, and centipedes in so far as they may be injurious to man. Nos. 3 and 6 are reprints, without alterations, of their predecessors, and No. 4 differs from its original edition only in a few small additions to the letterpress.

AN interesting account of the development of the mica industry in Eastern Transvaal during the last ten years is given by Mr. A. L. Hall in Memoir 13 of the Geological Survey of the Union of South Africa (1920). The "books" of mica that are of economic value occur as constituents of coarse-grained pegmatites which cut the older granite of the Pietersburg district. The memoir gives a review of the uses of mica and of the qualities and occasional defects that must be considered from a commercial point of view.

MR. SEITARÔ TSUBOI has published a complete study, structural and petrographical, of the island volcano of Oshima, the largest of the "Seven Islands" group south-west of the Bay of Tokyo (Journ. Coll. of Sci., Imp. Univ. Tokyo, vol. xliii., May 10, 1920). Incidentally, he introduces a method for the determination as nearly as possible of the maximum and minimum refractive indices of minerals represented by minute crystal grains, by using a large number of grains immersed in various liquids above a Nicol. The great crater-ring formed by ancient ejecta is now dominated by the recent central cone of Miharayama, which is still active. The author is not afraid of technical terms, and concisely describes the volcano as consisting of "double homates—a somma and a central one," and as "built up of numerous layers alternately accumulated of rheumatitica and clasmatica of basaltic nature."

MR. H. VALENTINE DAVIS sends us a copy of his "Little Book about Snowdon," published by him at Wistaston, Crewe. This is illustrated with sketches, sketch-maps, and sections drawn to the same vertical and horizontal scale, which should do much to interest the visitor to Llanberis in the many features of scientific interest that are so well displayed on Snowdon. It is a forerunner of a larger guide-book, and hence only the Llanberis path is treated as a route to Y Wyddfa. Without being didactic, Mr. Davis introduces the right touches at the right points, and gives just enough to make the reader think. The section showing the descent of the erratic maen d'ur arddu from the back of the cwm contains a lot of glacial lore, and might well be enlarged as a typical diagram of cirque-formation for the class-room. This alone is worth the sevenpence charged (8*d*. post free) for this unassuming but effective little pamphlet. Will Mr. Davis consider in the quiet of "Noddfa" whether he or his printers are responsible for "Grib Goch" (regularly repeated), "ffynon," and "carreg"?

THE latest issue of the Journal of the Royal Statistical Society (vol. lxxxiii., part iii.) contains an interesting paper by Mr. M. S. Birkett, statistical officer of the National Federation of Iron and Steel Manufacturers, on "The Iron and Steel Trades during the War," which brings out very clearly the efforts made by this industry to produce the enormous supply of munitions of war that were needed for the great struggle. The author makes it clear that it was the character rather than the quantity of material produced that had to be modified. Thus in 1913 the total production of pig-iron was about 10,250,000 tons, which had fallen in 1914 to just under 9,000,000 tons, and remained approximately stationary at that figure throughout the war. The classes of pig-iron used essentially for steel-making, namely, hæmatite and basic, had, however, risen from 58 per cent. to 72 per cent. of the total, by far the biggest increase being in the latter class, the output of which in 1918 was 50 per cent. above that of 1914. There was a corresponding increase in the output of steel, which reached 9,500,000 tons in 1918, an increase of 1,700,000 tons over 1914, the bulk of the increase again being in basic steel, of which there was above 50 per cent. more made in 1918 than in 1914. It is interesting to note that there were employed on the blast furnaces 39,200 men in July, 1914, as against 54,900 in July, 1919, so that the efficiency of the men employed had gone down very considerably. The total numbers employed in the industry at those two dates were 304,000 and 376,300 respectively, or, deducting those employed on blast furnaces, ironfounding, and tinplate manufacture, which are given separately, 178,400 and 235,700 respectively, an increase of nearly one-third; by far the larger number of these were undoubtedly engaged in steel manufacture. The paper deals also with the production of iron and steel in France and in the United States, and includes an interesting table of the production and export of iron and steel in the chief iron-producing countries of the world, which shows strikingly the amount of loss that the war has inflicted upon the German iron and steel industries.

HONG-KONG Royal Observatory has recently issued its report for the year 1919, under the directorship of Mr. T. F. Claxton. The report deals mainly with meteorology, but it includes in a general way the magnetic elements and time services, with the necessary astronomical observations for the latter. In the description of the various meteorological instruments in use a doubt is thrown on the relation between the temperatures in the thermograph shelter and the hourly readings by the rotation thermometers, and it is stated that the difference is not constant throughout the day. Details of the comparison would be useful and interesting. In addition to the automatic records, eye observations of the same elements are said to be made each hour; perhaps less frequent eye observations would be sufficient, and time thus saved might with advantage be devoted to a discussion of clouds, the character and direction of which are said to be observed every three hours. Attention is directed to the large departures from normal from month to month in atmospheric pressure, temperature, and wind. A typhoon on August 22 occasioned a squall at the rate of 84 m.p.h., although the centre of the disturbance passed about 150 miles to the south-west of Hong-Kong. The greatest rainfall in twenty-four hours was 4·80 in. on July 5, and the greatest in one hour was 1·35 in. between 5 and 6 a.m. on October 1. The total rainfall for the year at the observatory was 76·14 in., of which 49·92 in. fell in June, July, and August; and in these months, in the heaviest rains occasioning floods, 38·79 in. fell in 186 hours. Seventy-one per cent. of the daily weather forecasts are said to have been completely successful. Meteorological logs were received from eighty-one ships operating in the Far East, representing 2587 days' observations. It would be a valuable asset for aeronautics if observers could be encouraged to give especial attention to cloud observations; marine and aeronautic meteorology are becoming closely interlocked.

THE June issue of *Terrestrial Magnetism and Atmospheric Electricity* contains Capt. J. P. Ault's preliminary results of the magnetic observations taken on the United States Magnetic Survey ship *Carnegie* during her voyage from Buenos Aires to St. Helena in February and March last. According to the new measurements, the deviation of the compass and the dip as given on the most recent British Admiralty Chart No. 3775 are in many cases 1° out in the deviation and 2° or 3° out in the dip. The most serious differences are to be found in the region between 45° south latitude 329° east longitude, and 36° south 354° east, where the British chart gives the deviation to the west too small by about 1°; while over the region 33° south 2° east to 16° south 8° east the dip is given between 2° and 3° too small. The horizontal intensity given on the chart is everywhere too large by about one unit in the second decimal place of the value in C.G.S. units.

THE Journal of the Torquay Natural History Society, vol. ii., No. 6, has just reached us. Among other interesting papers is one on the scientific correspondence of Charles Kingsley and William Pengelly. An account of the life of Charles Kingsley is given, together with extracts from letters written by him between 1867 and 1870 to William Pengelly. Points of natural history, mostly of a geological nature, were raised in these letters. Another paper of interest is "Mendelism and Selection." The results of recent experiments by Prof. Castle are discussed in terms of germ-plasm with the view of reconciling Mendelism with selection. In yet another paper some account is given by Mr. H. G. Lowe of the origin of the needle; its history is traced back through three needle-like implements which have been found while excavating in Kent's Cavern. The view taken is that the discovery of the needle marked the first step in man's struggle from a purely animal state of existence.

MESSRS. GAUTHIER-VILLARS, of Paris, are publishing a series of works of great men of science entitled "Les Maîtres de la Pensée Scientifique," with the object of making the original works known to scientific students. We have received four volumes containing writings of Lavoisier, Huygens, and Spallanzani, each including a short biographical note on its author. "Mémoires sur la Respiration et la Transpiration des Animaux," by Lavoisier, is a collection of four papers read to the Académie des Sciences between 1777 and 1790. The text is taken from the Mémoires of the society for the appropriate years. "Traité de la Lumière," by Huygens, is reprinted from the original work published in 1690, with some necessary alterations in spelling and punctuation. The two volumes entitled "Observations et Expériences faites sur les Animalcules des Infusions," by Spallanzani, are copies of a translation of the original work by Jean Senebier published at Geneva in 1786. The diagrams included in the translation are not reproduced. When the series is completed it will serve as a ready means of access to the works of men prominent in the history of science, and it should be particularly valuable to the student by giving him an opportunity of learning at first hand the methods and arguments by which scientific knowledge has been advanced.

MESSRS. SIFTON, PRAED, AND CO., LTD., promise for the autumn publishing season an illustrated volume by Miss Gardner King on the present condition of the inhabitants of the Fiji Islands, based upon the author's experiences among them shortly before the war. Miss King lived much among the natives in their own homes, and should therefore have an interesting story to tell.

Our Astronomical Column.

TEMPEL'S COMET.—M. Fayet has given a very probable explanation of the discordance of the Kudara observation of this comet on May 25. He finds that its true R.A. on that day was exactly 2h. greater than the Kudara one, the declination being correct. Hence the alteration of a single figure in the announcement, which may have been set down wrong by inadvertence in preparing the message for telegraphic transmission, will make everything accordant, and further explain the fact that whereas Mr. Kudara stated that the comet was visible in a small telescope, many European observers searched in vain round the position indicated. The calculated daily motion on May 25 is +3m. 34s., N. 8′, which agrees fairly well with the observed value +3m. 4s., N. 8′; the latter was probably deduced from observations extending over an hour or two. The following positions have been announced:

	G.M.T. d.	h.	m.	App. R.A. h.	m.	s.	App. S. decl. °	′	″	Observer	Place
May	25	7	10·0	22	55	7·0	4	53	0	Kudara	Kyoto
July	20	14	5·6	1	52	49·48	1	17	0·7	Michkovitch	Marseilles
	21	13	55·4	1	55	14·44	1	18	58·5	,,	,,
	21	13	12·9	1	55	8·60	1	18	43	Mundler	Königstuhl
	22	14	35·8	1	57	37·5	1	21	2	Polit	Barcelona
	24	13	40·7	2	2	10·63	1	26	5·2	Mundler	Königstuhl

The first R.A. is conjecturally increased by 2h.

The following is a continuation of the ephemeris for Greenwich midnight:

		R.A. h.	m.	s.	S. Decl. °	′	Log r	Log Δ
Aug.	20 ...	2	48	26	3	55	0·1866	9·9466
	24 ...	2	52	36	4	29		
	28 ...	2	56	1	5	5	0·1987	9·9428
Sept.	1 ...	2	58	38	5	44		
	5 ...	3	0	28	6	24	0·2112	9·9400
	9 ...	3	1	29	7	5		

M. Michkovitch noted that the coma appeared round, the diameter exceeding 1′. There was a well-defined nucleus of magnitude 9·8. Dr. Palisa noted that this was eccentrically placed in the coma.

STONYHURST OBSERVATIONS IN 1919.—The annual volume of the results obtained at Stonyhurst Observatory last year contains an interesting summary by the director, the Rev. A. L. Cortie, of the solar observations. The mean spot areas for 1917–18–19 are 12·1, 7·9, and 8·4 respectively, while the mean daily magnetic declination ranges in the same years are 11·8′, 12·4′, and 12·7′. The year 1919 probably represents the hump on the downward curve, which is frequently shown both in sun-spots and variable stars. Father Cortie associates the delayed maximum of magnetic—as compared with sun-spot—activity with the declining mean latitude of sun-spots, which increases their magnetic efficiency, since it makes them cross the sun more centrally.

The most remarkable spot group of 1919 was a triple group which was on the disc from August 13 to 25 (central about August 19). A very violent magnetic storm occurred on August 11–12; if this was connected with the spot group the discharge must have been directed tangentially, not radially, from the sun. The spot group persisted through four rotations, being last seen on December 7.

The report also gives the result of a comparison between the drawings of faculæ and the photographs of calcium flocculi. A close correspondence in position is found, so that every prominent flocculus has an accompanying facula.

A research is also in progress with the view of tracing the flow of faculæ in regions of long-continued spot activity. It is anticipated that this flow will prove to be connected with the cyclonic movements that produce the magnetic field in sun-spots.

THE STRUCTURE OF THE UNIVERSE.—*Science* for July 23 contains a lecture on this subject by Prof. W. D. MacMillan, of the University of Chicago. Prof. MacMillan dwells on the numerous analogies between the microcosm of atoms and electrons and the stellar universe. For example, he shows the close analogy between the two electrons of the hydrogen atom and the sun-Neptune system, the relation between their diameters and mutual distance being about the same. He gives the number of atoms in the solar system as 6×10^{55}, and the volume of the sun's domain in the stellar universe as 20 cubic parsecs, or 6×10^{56} c.c. So that, on the average, there is 1 atom to 10 c.c., which would put the atoms about as far apart relatively to their diameter as the stars.

It will be remembered that Prof. Eddington and others have recently made the suggestion that the annihilation of atoms through collision and the consequent release of their stores of energy may be going on in the hottest stars, and thus add enormously to the duration of their output of light and heat. Prof. MacMillan endorses these speculations, and adds the suggestion that the radiant heat of the stars in its passage through space may perform the converse transformation and build up matter once more from the products of such atomic collisions, restoring to them the property of mass which they had lost. He claims as a result of these agencies to have constructed a universe that is infinite, eternal, and unchangeable. But he can scarcely claim that this conclusion is based exclusively on known facts. Many of his postulates are doubtful, and rest on analogy only.

Textile Industries and Technical Education in Canada and the United States.

PROF. ALFRED F. BARKER, of the Textile Industries Department of the University of Leeds, has written an interesting report[1] of nearly 130 pages of text, accompanied by numerous photographic illustrations, of a visit paid in the summer of 1919 to Canada and the United States. In the course of the report he discusses, among other matters, the vast resources in water-power of Canada, which, used directly or in the development of electrical energy, render to manufacturing industry an immense service, and also education and educational institutions, housing, work and wages, and industrial enterprise as they came under his observation in both Canada and the States; and he offers interesting comparisons with the conditions which prevail in the United Kingdom. Prof. Barker is, however, chiefly concerned with the extent, variety, and progress of textile manufacture connected with the production of cotton, wool, and silk goods. He was everywhere given the fullest facilities for his inquiries and investigations, with the result that his observations cannot fail to be of the highest interest and value to producers and merchants engaged in these industries.

Almost all the cotton mills in the Dominion are in the province of Quebec, attributable, Prof. Barker observes, possibly to climatic conditions, to the manipulative skill and cheap labour of the French Canadian, or to some combination of all these causes with

1 "A Summer Tour (1919) through the Textile Districts of Canada and the United States." By Prof. A. F. Barker. Pp. xi+197. (Leeds: Printed by Jowett and Sowry, Ltd., n.d.)

other causes not so much in evidence. Many of the cotton mills are quite extensive in their buildings and equipment, and almost without exception are controlled by British or British Canadian managers, some of whom received their training in Lancashire textile schools or in those of the States. It is a unique feature of Canadian mills, as distinguished from those of Lancashire and Yorkshire, that every operation from the yarn to the finished cloth, even including the dyeing and printing, is carried out in one and the same factory, which obviously makes it much more interesting to visit than that of a similar works in this country. The woollen industry is mainly centred in Ontario, and is far less well organised than that of cotton, but the hosiery mills are in evidence in every textile district of the Dominion, and a great future lies before the industry, since the equipment and staff of workers are of the most efficient character (Fig. 1).

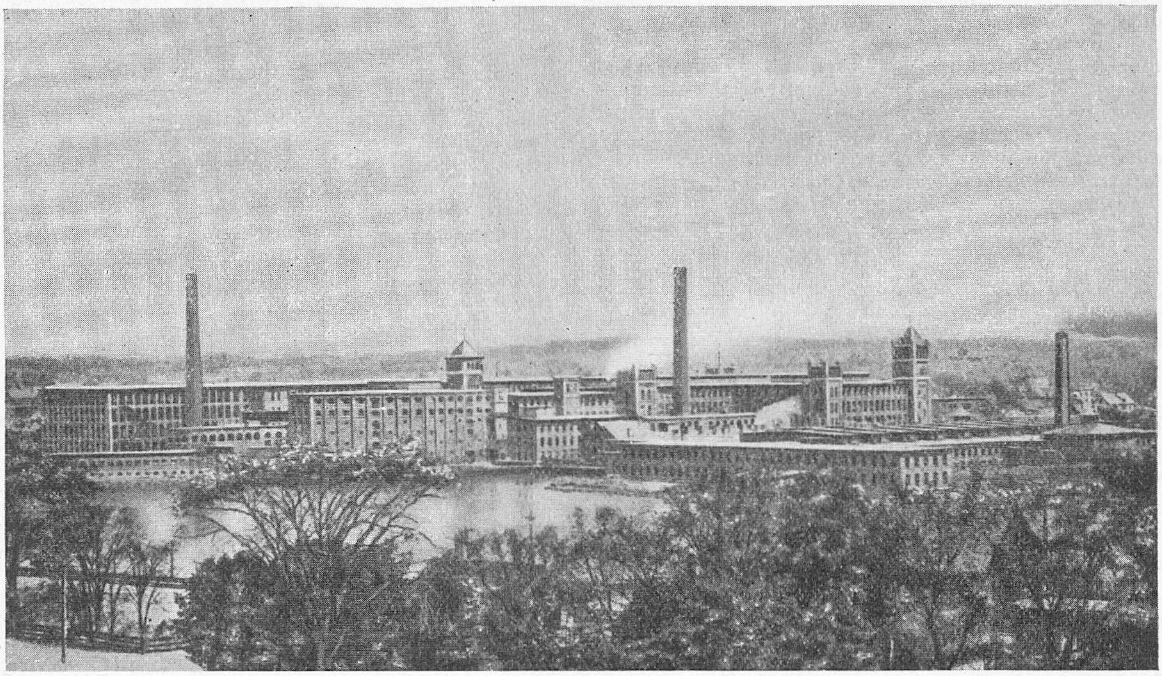

FIG. 1.—The Arlington mills, consuming 200,000 lb. of greasy wool per day.

Referring to textile manufacture in the States, Prof. Barker remarks that fine wool yarns are now spun there which cannot be beaten in any European country, but that neither in Canada nor in the States did he see a fine cotton yarn approaching that produced by Lancashire mills. On the other hand, he visited a mill in New Jersey which produced finer and better finished dress fabrics than Bradford, and in New York he was shown worsted fabrics impossible to exceed in beauty of texture and colour.

Much space is given in the report to the subject of education and educational institutions alike in Canada and in the States. In the province of Quebec there is to be found well-equipped agricultural schools and agricultural research stations designed to serve the farming interests, whilst in Montreal, the largest city of Canada dominated by industry and commerce, there is the splendid McGill University, with its magnificently equipped engineering school; and in Toronto, the capital of Ontario, there is the University, beautifully situated in the park-like centre of the

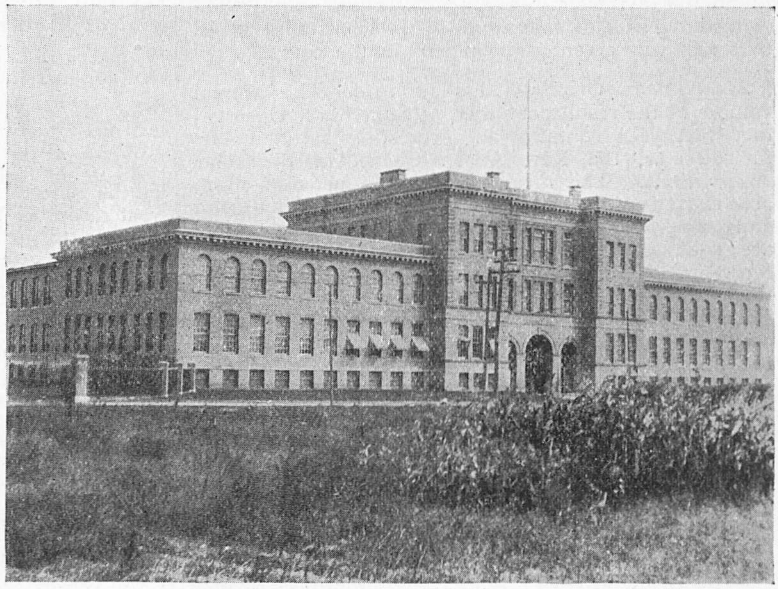

FIG. 2.—Lowell Textile School.

city, noted for its strong Faculty of Applied Science, and not less is the city celebrated for its fine Technical High School, wherein industries and industrial processes are made to serve the highest educational purposes for its three thousand day students. At night the school is attended by six thousand apprentices in the various trades the equipment covers. In short, Canada, in proportion to its population, is well provided with institutions of university rank, and in the near future she will have educational facilities second to no other country in the world. Prof. Barker is also not less loud in his praise of the educational activities and institutions of the States, especially of the Massachusetts Institute of Technology, in many respects one of the finest institutions in the world. wherein nothing is spared to make the courses good and experimental and research work so efficient that it cannot be left out of the industrial sequence, with the result that the institution is simply flooded with students who are inspired with the possibilities of discovery. He speaks highly of the provision for textile training and education, and especially of the fine school at Lowell (Fig. 2), which represents for the textile industries what the Institute of Technology of Boston represents for mining and engineering. The report is full of apt observation upon educational and industrial aims and methods.

Sunshine in the United States.[1]

THE United States *Monthly Weather Review* for January, 1920, contains a discussion on "Sunshine in the United States" by Mr. J. B. Kincer, Meteorologist attached to the Weather Bureau, Washington, from observations mostly for the twenty years from 1895 to 1914.

Data are given showing the actual amount of sunshine in hours and tenths and the percentage of the possible amount, both methods having their special advantages. Charts and diagrams show the mean solar time of sunrise and sunset, and the average length of day, sunrise to sunset. The seasonal and annual distributions of sunshine are given in percentages of the possible amount, and a table shows for each month and for the year the percentage of possible amount of sunshine for all stations where records are made.

Some dissatisfaction is expressed at the records of the automatic instruments available, as they in no way indicate the different degrees of sunshine intensity—an anomaly shared by all other countries. In describing three forms of sunshine recorders in use, the Campbell-Stokes, the Jordan, and the electrical thermometric recorder, which is said now to be in general use by the Weather Bureau, the *Review* states: "The Campbell-Stokes burning recorder, consisting of a lens or burning-glass which scorches, during bright sunshine, a trace on a strip of cardboard placed at the proper focal distance and adjusted by clockwork to revolve with the sun"; this description seems open to objection, as the card is stationary, and the sun revolving impinges its image on the card bearing the time-scale.

Distribution of sunshine with geographical position is well treated. For the year as a whole the least amount of sunshine occurs along the North Pacific coast, where it is only 40 per cent. of the daylight hours. The maximum amount in the United States occurs in the south-west; in the Lower Colorado River valley the duration of sunshine is 90 per cent. of the total number of hours from sunrise to sunset. July is the month of maximum amount in nearly one-half of the country, including all the northern districts.

Data are given showing the average annual percentage of days clear, partly cloudy, and cloudy. Dealing with diurnal variations in sunshine, it is stated that the amount is least during the early morning hours, with a secondary minimum in the late afternoon. The greatest amount occurs near midday.

Prof. R. de C. Ward, of the Harvard University, contributed an article to the U.S. *Monthly Weather Review* for November, 1919, bearing the title "Bibliographic Note on Sunshine in the United States." Foreseeing the issue of a series of new sunshine charts for the United States, a brief account is given of previous sunshine charts issued.

Reference is made to work done by van Bebber in 1896 and by Gläser in 1912, and it is mentioned that "the available material was confessedly very inadequate." In charts prepared by Prof. A. J. Henry in 1898 the percentages of sunshine were obtained by subtracting the mean annual cloudiness from 100, and a map of normal annual sunshine compiled from observations at the Weather Bureau stations from 1871 to 1908 inclusive seems to have been obtained in the same way. The system seems open to serious objection, and is far less satisfactory than using the records of the automatic sunshine instrument.

C. H.

[1] From U.S. Monthly Weather Review, January, 1920, vol. xlviii., pp. 12–17 and charts i–iv; November, 1919, vol. xlvii., pp. 794–95.

The Peat Resources of Ireland.

THE Fuel Research Board has issued as a Special Report (No. 2) a lecture on the above subject delivered by Prof. P. F. Purcell before the Royal Dublin Society last year. The importance of using the lower grade fuels has been greatly enhanced by the enormous rise in the price of our higher grade staple fuel, coal; and Sir George Beilby, in his introductory remarks to the Report, ascribes the revival of interest in peat as a fuel not only to the general scarcity of fuel, but also to the great and apparently permanent increase in the cost of coal.

The peat resources of Ireland are of paramount interest in that country, where the bogs cover one-seventh of the area, and Prof. Purcell estimates that the peat reserves in these bogs are more than ten times those of the *proved* coal reserves of that country. The estimated "anhydrous peat" is 3,700,000,000 tons, equivalent to 5,000,000,000 tons of average air-dried peat. Sixty-two per cent. of the farmsteads are entirely dependent upon peat fuel, and it is estimated that the annual consumption is between 6,000,000 and 8,000,000 tons.

The problem of the utilisation of peat is, as is well known, one of the economical removal of excess water, the average content of which is about 90 per cent. The effect of water is, perhaps, best emphasised when it is stated that "with 89 per cent. present, the 11 per cent. of dry peat will just be sufficient to evaporate the 89 per cent. of water." In the natural process of air-drying peat, difficulties of a practical and economic nature are met with; thus the drying season is only from five to six months. In winter, water freezing in the blocks causes their breaking down, and the whole year's supply has to be won in the limited dry season of the year. "It thus happens that a great number of hands are required for a portion of the year, and few for the remainder," and these considerations furnish a very strong incentive to the invention of economical methods of artificial drying.

In Prof. Purcell's opinion, in spite of the many methods which have been tried for the removal of excess water and improvements in mechanical and industrial operations, the air-drying of peat by natural means is the only recognised commercially successful method in use to-day. Reduction of the water-content from 90 to 70 per cent. by pressure alone on the raw peat is considered by the author to be the maximum, and he does not consider that drying by artificial heat becomes a practical proposition until this 70 per cent. content is reached, "and even then it is a very doubtful financial proposition."

For use under boilers the water should be reduced to 30–35 per cent.; for gas producers it is stated that several leading manufacturers claim successful working with 60–70 per cent., but Prof. Purcell considers that the possibility of using peat with as high a moisture-content as 60 per cent. is doubtful, and quotes the Canadian authority, Haakel, in support. "If it were permissible [to use such wet peat] it would render the industry less dependent on the weather, extend the peat-winning season, and simplify the whole problem."

Prof. Purcell considers that a clear case for the extended development of the peat deposits exists from an agricultural point of view, for the reclamation of land by removal of the bog and drainage must add to the food-producing capacities of a country. But labour costs are no small difficulty, for, as Sir George Beilby points out in his introduction, the development of a bog with 20 ft. of good peat is in some respects analogous to the proposal to develop a coalfield of similar area containing a single seam of only 15 in. thickness. It is true that the peat bog entails only surface working, but the whole depth has to be worked and 10 tons of raw material excavated and handled for 1 ton of dry peat. J. S. S. B.

Past and Present Sewage Systems.

TWO Chadwick public lectures recently delivered at Colchester by Mr. A. J. Martin dealt with the nature and treatment of sewage. Since the very earliest days there have been codes of sanitary laws, but all kinds of readjustments had to be made as soon as men began to congregate in large cities. These crowded conditions seem to be met most satisfactorily by the water-carriage system, by which the clean water supplied to a town returns ultimately to the sewers charged with all manner of pollution. When sewers were first laid the sewage was discharged straight into the rivers. The results were, of course, disastrous, and successive Royal Commissions were set up to find a remedy. The whole problem of sewage purification was obscure, and very little progress was made for a whole generation. Great hopes were centred in sewage farms as a method of disposing of the sewage, and the various local authorities hoped at the same time to reap a profit from the cheap manuring of the land. Sewage farms, however, rarely pay in a humid climate such as ours, for the land cannot deal with the huge amounts of water brought down from the sewers. Many other methods were tried, but in all of them the investigators failed to recognise the existence of the tiny scavengers which Nature provides to deal with our waste products.

The modern method of sewage purification was evolved after Pasteur's discovery of the bacteria which induce fermentation, and after the work of Warington and of Winogradsky on the nitrifying bacteria in the soil. The purification is carried out in two stages. The first stage is treatment in the "septic tank," through which the sewage passes extremely slowly. The solids sink to the bottom, where they are attacked by anaerobic organisms flourishing there, and ultimately either liquefied or turned into gas. The second stage of the process consists in the oxidation of the dissolved polluting matter. This matter has to be brought into contact with a large supply of atmospheric oxygen in the presence of certain small organisms which are able to oxidise the organic materials. This contact may be effected in the soil, in a specially constructed filter, or in a large volume of water. When soil forms the contact bed, purification is brought about either by "filtration," when the sewage percolates downwards through the soil, or by "broad irrigation," when the sewage merely passes over the soil surface. The method chosen depends on the openness or otherwise of the soil and subsoil. When suitable land is not available, artificial filters are made of broken clinker, destructor slag, etc. These materials provide a home for the nitrifying bacteria. The sewage is allowed to trickle slowly through, and with a good filter a purification of 80–90 per cent. is effected. When purification is allowed to take place in water, the volume of the water into which the sewage flows needs to be about five hundred times greater than the volume of the sewage.

Engineers had just settled down to the septic tank and trickling filter as the standard method for sewage purification when the "activated sludge" process was introduced by Drs. Fowler and Ardern. In this process the whole purification is completed in a tank provided with particles of activated sludge to serve as homes for the nitrifying bacteria. The sludge (*i.e.* solid deposit from the sewage) is activated by being submitted to currents of air for several days. It is then placed in the tank with the sewage, and air forced through for some hours until purification is effected. The drawback of this method is the great bulk of the resultant sludge, and the problem now is to find an economical way of disposing of the sludge so that the plant-food which is contained in sewage shall not be wasted.

Experimental Cottage Building.

IN view of the present housing difficulties, considerable interest has been centred in the results of the experiments in cottage building which have been carried out on the Ministry of Agriculture's Farm Settlement at Amesbury. These results are published in the Weekly Services for May 15 and 22, where we also learn that on Wednesdays for two or three months competent guides have been available to show visitors the experiments actually in progress. The present scheme includes thirty-two cottages, sixteen of which are for comparison purposes, and are built of brick on normal lines of construction, while the other sixteen are more directly experimental. Each cottage consists of parlour, living-room, scullery, bath-wash-house, larder, fuel store, etc., on the ground floor, with three bedrooms on the upper floor. Experiments in building in chalk include a cottage with cavity walls built of blocks made of chalk and cement, one with walls of chalk and cement rammed between shuttering, one with walls of chalk alone (chalk pisé), and one with walls of chalk and straw (chalk cob) built without shuttering. There is also one cottage of monolithic reinforced concrete and two concrete-block cottages with hollow walls. These two cottages are being erected under contract by two proprietary firms; for all the other experimental cottages direct labour is employed. The experiment also includes a pair of timber-framed cottages faced with elm weather-boarding and two Army huts converted into permanent bungalows. With regard to the latter experiment, results show that no economy is effected by using these huts. Another cottage has walls of clay and gravel, while two single and one pair of cottages are being erected in pisé-de-terre. One of the single pisé cottages is now being roofed—this is the first two-storied pisé house erected in England.

Pisé-de-terre walls are built by ramming nearly dry soil between movable shutters arranged as a temporary mould. The method was known in England a century ago, but had fallen into disuse, and a large number of investigations have been carried out to determine the best lines for its revival. All soils are not suitable for pisé work, for not only must the particles cohere firmly when rammed and dried, but also there must be no excessive shrinkage in the drying process. Calcium carbonate helps to reduce shrinkage, while organic constituents are particularly liable to shrinkage, and therefore weaken coherence in the soil as a whole. The amount of water present in the soil at the time of use is an all-important factor. Generally speaking, this water should be between 7 per cent. and 14 per cent. of the weight of the dried earth. The most suitable method of shuttering and the best form of rammer have been decided, while experiments are also being made to find the most satisfactory material and method for rendering the exterior face of the wall. Pisé building can be carried out in the winter if there is sufficient protection from severe weather, but consideration of the expenses involved in providing tarpaulins, screens, etc., makes it evident that it is not sound economy to undertake pisé construction in the winter months. When building in pisé the foundations have to be of brick or concrete; the pisé work may be started only at about 9 in. to 1 ft. above the ground-level. This is an important factor in the consideration of the cost of pisé building, which, however, will probably prove to be a considerably cheaper process than building in brick.

Cotton Growing.

THE Empire Cotton Growing Committee of the Board of Trade, which presented its first report on cotton growing in the British Empire in January last (NATURE, February 26 and March 25), has now published a note on "Future Organisation," which may be regarded as an appendix to the report. While it is merely indicative of the trend of the Committee's ideas, in that such organisation is subject to the appointment of the director and his staff, it makes the situation more definite by estimating the probable expenditure upon the various branches of work contemplated.

As in the case of the original report, all the organisation proposed is for common service, since the expenditure can bring no direct return, but it should, in the Committee's opinion, indirectly bring about an increase in the cotton supplies. The Committee concludes that in order to carry out the work adequately an annual sum of approximately 200,000*l*. ought to be assured. This amount may appear large until we remember that cotton to the value of about 50,000,000*l*. is imported into this country annually.

The note sketches the proposals for finance and superior organisation, executive work, and the central office; for staff abroad; for supplementing staffs of agricultural departments oversea, and pioneering; for education and information; and for commercial handling. In the last case the setting up of semi-commercial experimental enterprises is excluded from the scope of the note. Amongst these headings the Committee proposes an initial expenditure of 20,000*l*. per annum upon its own research station abroad. It also proposes to provide for a staff of ninety men, including scientific workers and agricultural officers of different grades, for the purpose of supplementing local agricultural department staffs "after full consultation with and on invitation by the local administration."

Under the heading of "Education" the Committee makes proposals which take the initiative in a move towards obtaining co-operation between all the plant-using industries in order to increase the facilities for training men in pure science, later to be of economic value to the various agricultural services abroad. It estimates that university staffs in this country should be increased specially for this purpose by at least four professorships, fifteen lectureships, and six administrative and technical lectureships, together with a provision of twenty post-graduate studentships. The annual cost is estimated at 27,000*l*., of which it is suggested that the cotton industry should contribute 12,000*l*. as its share.

Thermostatic Metal.

THE British Thomson-Houston Co., Ltd., has sent us specimens of a new bimetallic strip for use in thermostatically controlled devices. The strip is prepared by the permanent union over their entire length of two metals with widely differing coefficients of expansion. The union between the two component metals is complete and durable, and the strip may be bent, twisted, or hammered without causing the separation of the metals at any point, and even on heating the bond will not be broken so long as the temperature remains below the melting point of the softer of the two metals. Owing to this permanency of union the metal can be formed into any desired shape, annealed after formation, and safely employed at any temperature below 500° F. The component metals do not corrode under ordinary conditions, and may be used in any reasonable situation without fear of deterioration or change in operating characteristics. The amount of deflection obtained is always the same in a strip of given length and thickness for a given temperature change, and consequently the strip provides a trustworthy basis for the operation of any thermostatic device, and may be employed for work of high precision. The deflection due to temperature change varies inversely as the thickness, directly as the square of the length, and directly as the temperature change. With a strip 4 in. long, 0·31 in. wide, and 0·03 in. thick the deflection obtained for a temperature change of 100° F. is about 0·57 in. The force exerted varies as the square of the number of degrees of temperature change and as the square of the thickness, and directly as the width, and is not affected by changes of length. For a strip of the dimensions above-mentioned the force exerted for 100° F. change of temperature is about 3 oz. weight, whereas for a strip of the same dimensions but 0·1 in. thick the force exerted is about 24 oz. weight. To produce a permanent set in a strip 4 in. long, 0·31 in. wide, and 0·03 in. thick a force of about 7 oz. weight would be required. The metal is manufactured in standard sizes ranging from 0·015 in. to 0·25 in. in widths up to 6 in. and lengths up to 36 in. It can, however, generally be supplied cut to widths and lengths to suit the purchaser, and in special cases thermostatic metal parts may be completely formed to the purchaser's specifications.

University and Educational Intelligence.

CAMBRIDGE.—Last week the large theatre of the School of Anatomy was the scene of an interesting presentation to Dr. W. L. H. Duckworth, fellow of Jesus College and senior demonstrator in anatomy, on the completion of twenty-one years of devoted service to the University as lecturer in physical anthropology. This remarkable tribute to the esteem and affection in which he is held was the spontaneous desire of every demonstrator, assistant, and student to contribute some token of appreciation of Dr. Duckworth's unfailing courtesy and ever-ready help. His sympathy and charm of manner have made him one of the most approachable of teachers, and endeared him to all who have come in contact with him during his period of service. A fine inscribed silver salver was presented to Dr. Duckworth, together with a book containing the signatures of two hundred and twenty subscribers, by Dr. D. Reid on August 13 in the presence of the staff and students of the anatomy department. In addition to his brilliant academic qualities, Dr. Duckworth has shown great capacity for organisation, especially during the past year, when the chair of anatomy has been vacant and the entire control of the anatomy department has devolved upon him.

THE Dr. Jessie Macgregor prize of the Royal College of Physicians, Edinburgh, has been awarded to Miss Lucy Davis Cripps for her work on tetryl.

THE following free illustrated lectures are to be delivered in the Canada Building, Crystal Palace, at 6 p.m., under the auspices of the Institution of Petroleum Technologists:—"Oil Prospecting," G. Howell (September 1); "Petroleum Refining," Dr. A. E. Dunstan (September 8); "Utilisation of Volatile Oils," Dr. W. R. Ormandy (September 15); and "Utilisation of Heavy Oils," Prof. J. S. S. Brame (September 22).

A PROSPECTUS of the faculty of engineering of the University of Bristol, which is provided and maintained by the Society of Merchant Venturers in the Merchant Venturers' Technical College, has just reached us. Courses of study are available at the college for persons intended to engage in civil, mechanical, electrical, or automobile engineering, and particulars of these courses are given in the prospectus. The ordinances and regulations relating to degrees and certificates in engineering subjects are included, and some particulars of the Bristol sandwich system of training engineers are also given. The prospectus can be obtained from the Registrar of the University, Tyndall's Park, Bristol.

THE Bureau of Education, Calcutta, India, has issued its Report on Education in British India for 1918–19, abundantly illustrated with photographs. The terrible epidemic of influenza which broke out at the close of the year 1918 and carried off millions of people throughout India, together with the widespread failure of the crops, caused grave dislocations in the schools and colleges, though it called forth all that was best in the life and spirit of many of these institutions. The number of pupils and students in the public schools and colleges on March 31, 1918, was 7,338,663, and in private institutions 597,914—a total of 7,936,577, or 3·25 per cent. of the total population of upwards of 241,000,000 in British India alone, which percentage is nearly one-third that of Russia, probably the most backward country in Europe. The number of pupils under instruction has risen from 300,000 in 1860 to nearly 8,000,000 in 1920, and the expenditure has advanced from 200,000*l.* to upwards of 9,000,000*l.* within the same period. In 1918–19 140,000*l.* was granted for agricultural education and 60,000*l.* for technical education of a pressing nature pending the Indian Industrial Commission's report. The schools and colleges now number 162,330. One of the principal recommendations of the Calcutta University Commission, viz. the transfer of intermediate classes to the school system, has been carried out at the Patna College. Many developments show that the universities are alive to the necessity of assisting in the commercial and industrial revival. Schools of economics have been established in the Universities of Madras, Bombay, Allahabad, and the Punjab, whilst the Benares Hindu University is opening a college of mechanical and electrical engineering. Proposals for new universities at Rangoon and Nagpur are being completed, and sites have been acquired. A Bill was introduced in 1919 for a unitary university at Dacca. New outlying colleges have been opened or proposed in Bombay, Bengal, and the Punjab. Many of the colleges are said to be overcrowded with youths unfitted for an academic career, which is also borne out in the report of the Calcutta University Commission. There is immense work for education yet to be accomplished in India.

Societies and Academies.

PARIS.

Academy of Sciences, July 26.—M. Henri Deslandres in the chair.—The president announced the death of Dr. Guyon.—G. **Bigourdan**: An economical means of utilising the energy of tides.—Ch. **Depéret**: An attempt at the general chronological co-ordination of Quaternary time.—L. **Maquenne** and E. **Demoussy**: The toxicity of iron (towards plants) and the antitoxic properties of copper in presence of ferrous salts.—F. **Widal**, P. **Abrami**, and N. **Iancovesco**: The proof of digestive hæmoclasia and latent hepatism. A development of the method of detecting liver trouble described in an earlier communication. After the absorption of a glass of milk it is only necessary to determine the fall in the arterial pressure, the lowering of the number of white corpuscles, the inversion of the leucocytic coefficient, and other phenomena easily determined in the laboratory to discover the functional working of the liver. Numerous examples of the application are given, with especial reference to the disturbances caused by the administration of arsenic compounds in syphilitic cases.—A. **Perot**: Comparison of the wave-lengths of a line of the cyanogen band in the light of the sun and that of a terrestrial source. The solar wave-length is greater than the terrestrial wave-length, their difference in relative value being $(2{\cdot}22 \pm 0{\cdot}10).10^{-6}$. This difference is reduced by a correction for the descending movement of the absorbing centres to $(1{\cdot}6 \pm 0{\cdot}3).10^{-6}$. The figure calculated from Einstein's theory of generalised relativity is between the corrected and uncorrected numbers.—A. **Schaumasse**: Discovery and observations of the comet 1920*b* (Schaumasse). This comet was discovered on July 18 at the Nice Observatory. It is about the 11th magnitude, and appears as a diffuse nebulosity of 2·5′ diameter. It may be the second periodic comet of Tempel.—G. **Fayet**: Probable identity of the 1920*b* comet (Schaumasse) with Tempel's second periodic comet.—P. **Chofardet**: Observations of the periodic comet Tempel II. (Schaumasse) 1920*a*, made at the Observatory of Besançon with the bent equatorial. Three positions on July 20–21 are given. The comet was of about the 11th magnitude.—C.

Raveau: The isotherms in the neighbourhood of the critical state. The adiabatic expansion of saturated fluids.—R. **Dongier**: The point-crystal or point-metal auto-detector telephone receiver.—F. **Michaud**: The correspondence of bodies in the solid state.—A. **Pictet** and P. **Castan**: Glucosane. Glucosane was readily obtained in a pure state by heating glucose under a pressure of 15 mm. to a temperature of 150–155° C. A study of its chemical reactions leads to the conclusion that it probably has a composition analogous with ethylene oxide.—A. **Mailhe**: The catalytic hydration of nitriles. If a mixture of steam and benzonitrile vapour is passed over thoria at 420° C., benzoic acid is produced by the hydrolysis of the nitrile. The generality of the reaction has been proved by applying it to seven nitriles.—G. **Dubois**: The discovery of a fossil-bearing layer in the Flanders clay at Watten (Nord). The fauna found in this layer confirms the stratigraphical identity of London clay, Cuise sands, and Flanders clay.—A. **Carpentier**: Some siliceous fossil plants from the neighbourhood of Sainte-Marie-aux-Mines (Alsace).—L. **Blaringhem**: The heredity and nature of peloria in *Digitalis purpurea*.—R. **Souèges**: The embryogeny of the Compositæ. The first stages of the development of the embryo in *Senecio vulgaris*.—F. **Chifflot**: The gum-bearing secreting canals of the roots of the Cycadaceæ, and more particularly those of *Stangeria paradoxa*.—Em. **Perrot**: Biological notes on the Acacias producing gum, known as gum arabic, in the Egyptian Sudan.—H. **Ricome**: The action of gravity on plants.—L. **Emberger**: Cytological study of the Selaginella.—A. **Guilliermond**: New cytological observations on Saprolegnia.—G. **Truffaut** and N. **Bezssonoff**: Comparative study of the microflora and the amount of nitrogen in soils partly sterilised by calcium sulphide.—A. **Lumière**: Are vitamines necessary to the development of plants? It is generally admitted that vitamines are necessary to the growth of plants. The author, whilst admitting the accuracy of the experiments on which this view is based, considers that the experimental results have been misinterpreted. Fresh yeast, rich in vitamines and rapidly curing polyneuritic troubles in pigeons, after heating to 135° C. for one hour, completely loses all its antiscorbutic properties, but still serves for the preparation of culture fluids, giving good development of fungi. Even after heating to incipient carbonisation to 250° C. these extracts retain their fertilising properties.—A. H. **Roffo** and P. **Girard**: The effects of electrical osmosis on cancerous tumours of rats.—M. **Fauré-Fremiet**, J. **Dragoiu**, and Mlle. Du Vivier **de Streel**: The growth of the fœtal lung in the sheep and the concomitant variations in its composition.—R. **Sazerac**: Culture of the tubercle bacillus on a medium of autolysed yeast. It has been proved that both human and bovine tubercle bacilli will grow normally on this medium, the detailed preparation of which is given. It contains, in addition to autolysed yeast, 5 per cent. of common salt and 4 per cent. of glycerol.—J. **Nageotte**: Osteogenesis in grafts of dead bone.—A. **Trillat**: The influence of the presence of infinitesimal traces of nutritive substances in air-moisture on contagion.

Philadelphia.

American Philosophical Society, April 23.—Dr. A. A. Noyes, vice-president, in the chair.—Dr. D. T. **MacDougal**: The components and colloidal behaviour of protoplasm. The living matter of plants is composed chiefly of mucilages and albuminous compounds in varying proportions mixed in the form of an emulsion or as a jelly. The molecules of solid matter are aggregated into groups, which also include a number of molecules of water. Growth consists of the absorption of additional water to these groups, with more solid material being added at the same time, the process being termed "hydration." The resultant increase may be detected by determination of increased dry weight or measured as increase in length, thickness, or volume. More exact studies in growth have become possible by the establishment of the fact that mixtures of 25–50 per cent. mucilage and 50–75 per cent. albumin show the hydration reactions of cell-masses of plants. It is also found that certain amino-compounds, such as histidine, glycocoll, alanine, and phenylalanine, which are known to promote growth, also increase the hydration of the "biocolloids," as the above mixtures are called.—Prof. W. J. V. **Osterhout**: Respiration. A simple method of measuring respiration has been developed whereby determinations can be made at frequent intervals (as often as once every three minutes). The application of this method to the study of anæsthesia shows the incorrectness of the theory of Verworn, according to which anæsthesia is a kind of asphyxia, due to the inhibition of respiration by the anæsthetic.—Prof. B. M. **Davis**: (1) The behaviour of the *sulphurea* character in crosses with *Oenothera biennis* and with *Oenothera franciscana*. (2) *Oenothera funifolia*, a peculiar new mutant from *Oenothera Lamarckiana*.—Prof. G. H. **Shull**: A third duplication of genetic factors in shepherd's-purse. In the third generation of a cross between a wild biotype of the common shepherd's-purse (*Bursa bursa-pastoris*) from Wales and Heeger's shepherd's-purse (*B. Heegeri*) there appeared a small number of plants of unique type, having a more coriaceous texture than in the plants of either of the two original strains involved in the cross. This new type has been designated *coriacea*.—Prof. E. M. **East**: Some effects of double fertilisation in maize.—Dr. T. B. **Osborne**: The chemistry of the cell.—Prof. G. A. **Hulett**: The relation of oxygen to charcoal.—Prof. C. E. **Munroe**: Products of detonation of T.N.T. It is known that among the products are considerable quantities of carbon monoxide, hydrogen, and some hydrocarbons, such as methane, together with free carbon in a soot-like form. Hence T.N.T. is not suitable for use in underground work or close places, because the gas evolved is poisonous and inflammable, and can form explosive mixtures with the atmosphere in these close places.—Prof. J. W. **Harshberger**: A new map of the vegetation of North America.—Prof. A. G. **Webster**: The vibrations of rifle-barrels. (Dr. H. L. Carson, vice-president, in the chair.)—Dr. L. **Witmer**: Symposium on psychology in war and education.—Dr. J. McK. **Cattell**: Methods. The speaker reviewed the development of experimental and quantitative methods in psychology, and especially the transfer of its main concern from introspection to the study of individual differences in behaviour. By co-operation with other sciences it is possible for psychology to change the environment, and behaviour can be controlled more effectively by a change in the environment than by a change in the constitution of the individual.—Dr. R. M. **Yerkes**: Psychological examining and classification in the United States Army. The initial purpose of examining was the discovery and prompt segregation or elimination of men of markedly inferior intelligence. The uses which were actually made of results of psychological examinations were extremely varied, and covered the classification of men to facilitate military training, the selection of men of superior ability for training as officers or for special tasks, the segregation and special assignment of men whose intelligence was inadequate to the demands of regular military training, and, finally, the elimination of the low-grade mental defective.—Prof. R. **Dodge**: The relation of psychology to special problems of the Army and Navy.—Dr. J. R. **Angell**: Relation of psychology to the National Research Council. The supporting scientific societies elect representatives who compose the several divisions of the Council, and these in turn, comprising, as a rule, about twenty men selected for their eminence in their particular branch of work, come together and determine the special needs and opportunities for the improvement of research in their own fields. Special attention is paid to the possibilities of bringing about effective co-operation among research men and research agencies. Scientific investigation has hitherto been largely individualistic, and the most pressing need at the present moment is not so much the expansion of research agencies, although this is desirable, as the more effective employment of those already in existence.—Dr. B. **Ruml**: Psychological methods in business and industry.—Prof. A. J. **Jones**: The individual in education.—Prof. R. W. **Wood**: Invisible light in war and peace.

HOBART.

Royal Society of Tasmania, June 8.—Mr. L. Rodway, vice-president, in the chair.—G. H. **Hardy**: Australian Stradiomiidæ. The paper included a description of new species.—H. H. **Scott** and C. **Lord**: Studies of Tasmanian mammals, living and extinct. Part ii. The paper was divided into two sections, and dealt mainly with the skeleton of *Nototherium Mitchelli* recently obtained from the north-west coast of Tasmania. The first section gave a *résumé* of the history of the genus, and the second dealt with the osteology of the cervical vertebræ. The authors desire to show that the species was one essentially adapted for aggressive warfare. They point out that whereas the skulls of *N. Mitchelli* and *N. tasmanicum* at least (with the possibility of other species) are equally large and weighty, yet their cervical vertebræ show marked differences: one being an exaggeration of the standard of the modern wombat in about the same ratio of power (*N. tasmanicum*), while the other shows an additional power with interspinal muscles and paddings, suitable to the resisting of great shocks in the long axis of the head and vertebræ.

Books Received.

Symbiosis: A Socio-physiological Study of Evolution. By H. Reinheimer. Pp. xii+295. (London: Headley Bros.) 15*s*. net.

Ministry of Munitions. Department of Explosive Supply. Preliminary Studies for H.M. Factory, Gretna, and Study for an Installation of Phosgene Manufacture. Pp. xvi+145. (London: H.M. Stationery Office.) 15*s*. net.

Prospector's Field-Book and Guide in the Search for and the Easy Determination of Ores and other Useful Minerals. By H. S. Osborn. Ninth edition, thoroughly revised and enlarged, by M. W. von Bernewitz. Pp. xiii+364. (London: Hodder and Stoughton.) 12*s*. 6*d*. net.

The Kalahari, or Thirstland Redemption. By Prof. E. H. L. Schwarz. Pp. vi+163+xiv plates. (Cape Town: T. Maskew Miller; Oxford: B. H. Blackwell.) 8*s*. 6*d*. net.

Department of Statistics, India. Agricultural Statistics of India, 1917–18. Vol. ii. Pp. ix+118. (Calcutta: Government Printing Office.) 1 rupee.

Botanical Survey of South Africa. Memoir No. 1: Phanerogamic Flora of the Divisions of Uitenhage and Port Elizabeth. By S. Schonland. Pp. 118. (Pretoria: Agricultural Department.) 2*s*. 6*d*.

A Manual of Dental Metallurgy. By E. A. Smith. Fourth edition. Pp. xvi+285. (London: J. and A. Churchill.) 12*s*. 6*d*. net.

The Bible: Its Nature and Inspiration. By E. Grubb. Pp. 247. (London: Swarthmore Press, Ltd.) 2*s*. 6*d*. net.

Manual of Psychiatry. Edited by Dr. A. J. Rosanoff. Fifth edition. Pp. xv+684. (New York: J. Wiley and Sons, Inc.; London: Chapman and Hall, Ltd.) 22*s*. net.

Radiant Motherhood: A Book for those who are Creating the Future. By Dr. Marie C. Stopes. Pp. 246. (London: G. P. Putnam's Sons.) 6*s*. net.

Relativity: The Special and the General Theory. By Prof. A. Einstein. Authorised translation by Dr. R. Lawson. Pp. xiii+138. (London: Methuen and Co., Ltd.) 5*s*. net.

Liquid Air and the Liquefaction of Gases. By Dr. T. O'Conor Sloane. Third edition. Pp. 394. (London: Constable and Co., Ltd.) 21*s*.

Airscrews in Theory and Experiment. By A. Fage. Pp. ix+198+7 plates. (London: Constable and Co., Ltd.) 34*s*.

Smithsonian Institution, United States National Museum. Report on the Progress and Condition of the United States National Museum for the Year ending June 30, 1919. Pp. 211+7 plates. (Washington.)

Principles and Practice of Aerial Navigation. By Lieut. J. E. Dumbleton. Pp. vii+172+v plates. (London: Crosby Lockwood and Son.) 12*s*. 6*d*. net.

The Outdoor Botanist: A Simple Manual for the Study of British Plants in the Field. By A. R. Horwood. Pp. 284+20 plates. (London: T. Fisher Unwin, Ltd.) 18*s*. net.

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MACMILLAN & CO., LTD., St. Martin's Street, London, W.C. 2.

Printed in Great Britain by R. CLAY AND SONS, LIMITED, at Brunswick Street, Stamford Street, S.E.1, and published by MACMILLAN AND CO., LIMITED, at St. Martin's Street, London, W.C.2, and THE MACMILLAN CO., 66 Fifth Avenue, New York.—THURSDAY, August 19, 1920.