NATURE

"To the solid ground
Of nature trusts the Mind that builds for aye."—Wordsworth

Vol. 146, No. 3706 SATURDAY, NOVEMBER 9, 1940 ONE SHILLING

OWING TO DIFFICULTIES WHICH MAY ARISE FROM GOVERNMENT REGULATIONS AND WAR CONDITIONS IT MAY BE NECESSARY TO OMIT OR CURTAIL CERTAIN FEATURES IN FUTURE ISSUES OF "NATURE".

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CONTENTS

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CAMOUFLAGE IN MODERN WARFARE

THE science and art of camouflage is playing, and will continue to play, a great part in the present struggle. Much progress has been made during the past twenty-five years in the establishment of certain well-defined principles of camouflage, based on research in biology and psychology. But as pointed out in NATURE of June 22, p. 949, the authorities in the various Service Departments concerned have been slow to make the most of this scientific progress ; in fact, the history of war camouflage up to that time had provided a very convincing example of the ineptitude of the system then existing, so far as science was concerned.

After examining the personnel engaged at the Civil Defence Camouflage Establishment, one could scarcely feel reassured concerning the future prospects. Of the sixty-five technical officers, all but four were either professional artists or art students. There was no biologist. It was scarcely to be wondered at, therefore, that, since there was little recruitment of authorities on biological and psychological principles, failure to achieve effectiveness was the rule rather than the exception.

This deplorable situation was also emphasized in "Science in War" (Penguin Special, S74. 6*d*. ; see also NATURE of July 27, 1940, p. 112). But after this, the scientific spirit began to show signs, though somewhat tardily, of coming into its own ; and we were glad to print evidence of this from "J. S. H." after a visit to the Civil Defence Camouflage Organization (see NATURE of October 12, p. 482). There, the experimental work is under the direct supervision of Prof. W. E. Curtis, who is assisted by a technical staff of artists, engineers, architects, chemists, physicists, photographers and a botanist.

It is useless crying over spilt milk, yet one cannot resist deploring this important enemy of efficiency—delay. Now that the research branch of this all-important problem has been accorded better foundations, the two immediate aims for the future must be still further improvements in scientific personnel and research, and the quick recognition of their value and application of their findings by all Service authorities to whom such findings may prove of even the smallest value.

So far as the first aim is concerned, it might be of advantage to the Civil Defence Station if it ensures that it is exploring all psychological principles that have an important role in camouflage, for, as Dr. H. J. Eysenck points out on p. 620 of this issue, no specialist in psychology is apparently employed at the Station. It is possible that some, if not all, of those scientific workers already employed at the Station are fully aware of such principles and have a sufficient working knowledge of psychology to apply them ; all the same, if a good specialist interested in the psychology of perception is available we suggest that he should either be placed on the research staff or invited to serve as a consultant. However, so far as the Station is concerned, it is gratifying to note, as "J. S. H." pointed out, "The art of camouflage has in the last six months gone far in utilizing scientific knowledge and scientific methods".

The second and equally important aim, namely, utilization and application of scientific method by the Services, and also co-ordination among themselves, has not hitherto been so reassuring. But the fourteenth report from the Select Committee on National Expenditure (H.M. Stationery Office. 2*d*.) which deals with this subject goes far to convince us that the Services now

realize the seriousness of the situation and that many major changes are already overdue.

It is now recognized that camouflage is both an art and a science. The discovery of means and elaboration of technique are scientific; the execution of schemes are matters requiring visual training and artistic knowledge. Men of both kinds of knowledge are therefore now being employed in research. The report, however, emphasizes chiefly that the organization of the scientific side of the matter appears to require the more urgent attention. This is due to the fact, no doubt, that until comparatively recently men of science have neither been employed nor consulted.

Several Departments are now concerned, to various degrees of urgency, with camouflage. The Ministry of Home Security is concerned with the camouflage of factories, mines, public utility undertakings, etc. This Ministry now refers to the Civil Defence Camouflage Establishment.

The Directorate of Works in the Department of the Member of the Air Council charged with supply and organization is responsible for the camouflage of aerodromes and Air Ministry buildings, and the work is administered from the Air Ministry. This branch is directed by a chief engineer with a designing staff of nine, and its work approved by the inspector of camouflage assisted by a personal assistant and two technical officers. One camouflage officer is stationed at each of fifteen Works Area Headquarters. The Royal Aircraft Establishment at South Farnborough is responsible for research. Schemes are adopted for aircraft after various tests by the Royal Air Force in consultation with the Royal Aircraft Establishment. The actual work of camouflaging aircraft and road vehicles is the responsibility of the Ministry of Aircraft Production.

The Directorate of Engineers and Signals Equipment (of the Ministry of Supply) is responsible for the camouflaging of Royal Ordnance factories, Ordnance depots and War Department buildings, guns, machine-gun posts and vehicles. Those directly responsible are two officers under the direction of the Assistant Director, who has other duties unconnected with camouflage. The Directorate refers its research to the Civil Defence Camouflage Establishment.

So far as the Admiralty is concerned, one camouflage officer is in charge of the camouflage of naval establishments. The Air Ministry is responsible for Fleet Air Arm bases. Research is referred to the Civil Defence Establishment.

The camouflage of ships has been abandoned. No doubt there are good reasons for this. The rapid development of aircraft reconnaissance at sea and the increased utilization of heavy smoke screens may have been largely responsible for rendering ship's camouflage unnecessary and, indeed, useless; yet it is to be hoped that the Admiralty authorities realize that "half the battle in science consists in asking new questions which the non-scientist cannot be expected to think of", and thus keep an open mind on, and still remain receptive concerning, this problem.

Advice on camouflage required by the Army in the field is provided by a special staff of camouflage officers attached to Corps and Divisions. The officers have been drawn from the Army and civil occupations and include two assistants from the Civil Defence Camouflage Establishment.

Even the layman has often been heard to remark that many existing examples of Service and civil camouflage are useless almost to the degree of absurdity. This is obviously fully realized now by the Services and reiterated by the Sub-Committee's report. The broadening of research now taking place will ensure that at any rate there shall be no excuse for the continued utilization of such absurd methods. But any intelligent layman, after reading the report, would also recognize the lack of organization and collaboration extant throughout the Services. The above details of the various Services' work in this connexion should dispel any doubts. The position is far from satisfactory, and the Sub-Committee admits it.

Now that the report openly states that the execution of camouflage and research into its problems are closely bound up with each other, we are entitled to expect that complete co-ordination between research staffs and the Services will soon take effect. Each camouflage department will no longer maintain its own research staff; it is now recommended that the four departments which are responsible for the design and execution of schemes of camouflage should be concentrated in a single camouflage department with its own research staff. This is obviously all to the good, but it has the added advantage that the knowledge resulting from research would be more readily available to the executive staff. At last, the responsible authorities realize the indubitable advantages of co-ordination of research and organization, as already exemplified in scientific research by such developments as team work in universities and research associations in industry.

WELL-BEING OF MUNITION WORKERS

The Health and Efficiency of Munition Workers
By Dr. H. M. Vernon. (Oxford Medical Publications.) Pp. vii+128. (London : Oxford University Press, 1940.) 8*s*. 6*d*. net.

THE Oxford School of Physiology, founded by Burdon Sanderson, and adorned by his successors, Gotch, Sherrington, and John Mellanby, has produced many eminent men of science whose researches have benefited mankind. To industrial hygiene the contributions of the late J. S. Haldane have been important, while for many years Dr. H. M. Vernon has brought physiological knowledge and experience to bear upon the health problems of the industrial worker.

During the War of 1914–18, as investigator for the Health of Munition Workers Committee, Dr. Vernon shared in the high standard of work achieved by Prof. Major Greenwood, E. L. Collis, and others, which ameliorated the lot of the munition worker. Afterwards, he continued and extended his investigations for the Committee's successor, the Industrial Health Research Board. His studies have covered many subjects in this field, such as industrial fatigue and efficiency, the output of munition workers in relation to hours of work, alcohol and industrial efficiency, ventilation and heating in factories, etc., all studies which are not only of scientific interest, but also are of vital importance to employers and those employed in industry.

Last year, Dr. Vernon garnered the fruits of these years of patient investigation in a volume entitled "Health in Relation to Occupation" (see NATURE, July 6, p. 6). This work showed that, as a rule, ill-health is due only in a moderate degree to the direct effects of occupation. "Social environment, including nutrition," he writes, "has much more powerful effect, whilst hereditary influences, especially intelligence, are also very powerful." Dr. Vernon admitted that it was still a difficult problem to ascertain the relative degrees of importance to be attached to the three factors mentioned, but he rightly claimed that his book summarized existing knowledge and pointed out the directions in which further information is required. To-day, we are once more in the thick of a great war, and are again dependent—and with the advance made in destructive instruments of warfare even more dependent than twenty-five years ago—upon munition workers for our national security.

It is fortunate and timely, therefore, that Dr. Vernon has followed up his more general book of last year with a monograph devoted to "The Health and Efficiency of Munition Workers". His extensive knowledge of the subject makes this book an important contribution to national effort. Every day for the last six months come demands for more aeroplanes, more guns, more tanks, more ammunition, more destructive weapons of all kinds. Factories spring up like mushrooms all over the country, and workers flock into them whose enthusiasm must be guided and controlled by skilled training and direction, and, above all, by the rules of health. Otherwise, there will be waste of effort, diminished efficiency and output, and wastage of man-power due to accidents and ill-health.

The conditions under which munition industries are conducted should be so arranged that the workers can retain their fitness and vigour. As Dr. Vernon observes, the workers' sense of patriotism undoubtedly stimulates them to work harder than in peace-time. This incentive must, however, be applied with discretion, both by the employers and the employed, for otherwise it will defeat its chief object. Grievous errors made in this respect in the earlier stages of the War of 1914–18 had to be remedied and overtaken by the recommendations of the Health of Munition Workers Committee, and although much time has been devoted in the intervening years to studying the best ways of promoting industrial health and efficiency, as recent experience has shown, it cannot be assumed that the past errors will be altogether avoided without due care and foresight. Many employers and managers of industrial establishments have no special knowledge about industrial health and its maintenance, and they need to be reminded of the precautions which ought to be taken.

The present little book covers succinctly the essentials of the problem. It treats of hours of work, work spells and rest pauses, and shift systems, including day and night shifts. Dr. Vernon wisely drives home the lesson, which employers of labour have been slow to learn, that to over-drive the human machine damages the health of the individual worker, and is bad business for the employer, because the worker's output and efficiency deteriorate with long hours of labour. Yet so far back as 1816 Robert Owen discovered that when he ran his New Lanark mills for $10\frac{1}{2}$ hours a day instead of the usual 15–16 hours a day, output did not fall sensibly below its previous level.

The more medical chapters of the book discuss sickness and absenteeism, and accidents and injuries. This brings up the question of rehabilitation of the industrial worker, to which

considerable thought is being given at the present time.

There is a useful chapter on the ventilation, heating, and lighting of factories, and the influence of noise on efficiency. The book concludes with a concise account of welfare and labour management.

We have two points of criticism. One is that the author might have emphasized more strongly the importance of linking up the medical and care work of the factory with the national health services, for the munition worker has a social environment as well as an occupational one. Although Dr. Vernon devoted considerable space to this matter in his previous book, a reminder here would have been advantageous. The other point is that this book with such a wide appeal might have been published at a lower price, even in these difficult times. It should be read by every employer of munition workers, and a copy should be placed in every works library.

A. S. MACNALTY.

MARXISM IN HISTORY EXPOSED

The Materialist Conception of History

A Critical Analysis. By Karl Federn. Pp. xiv+263. (London: Macmillan and Co., Ltd., 1939.) 10*s*. 6*d*. net.

THIS is the most admirable exposé of the fallacies of the materialist conception of history that I have ever come across. The author, who is a Viennese in exile, has taken the trouble to go through the fifteen propositions in the introduction to Marx's "Criticism of Political Philosophy" written in London in 1859 and other Marxist writings, and tried to sift out any grains of truth there may be in them. Dr. Federn is a historian apparently familiar with both ancient and modern times, and he writes with impartiality and in a clear and very attractive style. The style indeed is so good that one wonders that any foreigner should have been capable of writing it. But, as no name of a translator is given, one supposes that the author is as perfect a linguist as he is undoubtedly a wide and accomplished historian.

It is much to be hoped that the book will be largely circulated, for the fallacies which it exposes are much in vogue with the non-historical younger part of our people at the present moment, and the serious historian rarely turns out of his path to expose them. That is why we should be particularly thankful to Dr. Federn for having done it, and done it so conclusively that no one who takes the trouble to read the book and can understand the meaning of a simple sentence, would ever again be confused by the sophistries of material dialecticism.

One can only give in a few sentences the general gist of the book. Marx maintains in one of the fifteen propositions referred to above that the "conditions of production", namely, the economic structure of society, determine all the superstructure, that is, the laws, the science, the religion, the art of every age. Dr. Federn's answer comes briefly to two propositions. One, that in every age the conditions of production, that is, how mankind at that time make their living, will undoubtedly have some effect on the way they think and act in other matters, but that this influence is only one of a mass of influences on our thought which are too numerous and subtle to be summarized in any such statement. Indeed to find the relations of the economic and other conditions in any one historical period is often more than the work of a lifetime. Second, that the Marxist view derives almost entirely from a consideration of the last hundred or two years. The farther back we go the less clear is the connexion and the more inadequate is Marx's knowledge of what has been discovered. Thus prehistory does not exist for him, and he sweeps all the hundreds of thousands of years of human history before the civilization which he calls "Antique" into the one incomplete and misleading formula, that the conditions of production, that is, the economic side of history, determine everything.

Dr. Federn really disposes of the whole sophistical structure in one of his earlier sentences: "Discovering a new productive force as well as finding out a method of applying it are mental acts. If this were not the case, if there were no need of intelligence to discover and employ the forces of nature, the animals would discover and employ them also and the inferior races would develop a civilization as quickly as the higher".

The moral is, what generations of better historians than Marx have long known and explored, that mind and not matter rules the world. The use and charm of Dr. Federn's book is that a deeply read historian has traced the fallacy through all the main stages of human civilization without writing a dull or unnecessary word.

It is much to be wished that the book in some form should become available for all students and teachers of history.

F. S. MARVIN.

FARMING AS A BUSINESS

Farm Management
In-going and Out-going, Insurance, Income Tax, Credit and Farm Records. By K. W. D. Campbell. Pp. 156. (London: English Universities Press, Ltd., 1940.) 8*s*. 6*d*. net.

THIS book is frankly a disappointment, for a good text-book dealing with the principles of farm management has long been needed.

Farming has been called a science, an art, a business and a way of life. In fact, as Prof. Scott Watson says in his foreword, it is all of these. But it is only within the last twenty years that the importance of teaching the business side of the subject has begun to be realized. There was a time when it was thought sufficient to teach the agricultural student science and science only, ignoring the art. But it soon became evident that a purely scientific training was wholly inadequate, and in spite of much of what had once been exclusively an art having been converted to a science, yet a great deal of the art still remained and showed no sign of ever being reduced to scientific form. Science can be taught in lecture room and laboratory, but the practical art of husbandry can be taught only on the farm itself. Hence the necessity for university and college farms. But the matter did not end here, for it appeared that even a combination of science and art were not enough. No amount of scientific knowledge will compensate for a lack of business ability, and no amount of technical skill will ensure the success of a farm judged as a business. Hence the growing recognition of the need for including teaching in the business aspects of the subject in the agricultural student's curriculum.

One of the difficulties of developing this side of agricultural education has been the want of suitable text-books. It is therefore most unfortunate that the first book of the kind should be published at such a time as this, for the book under notice was planned, as the author explains, only as the first part of a comprehensive work on the subject of farm management, a task the completion of which the advent of the War made impossible. But it is incomprehensible why for the first volume the author should have singled out the particular aspects of farm management that he has. In-going and out-going, insurance, income tax, credit, etc.; the list is not inspiring, and includes subjects a knowledge of which is certainly desirable, but few of which can be said to have much educational value.

The book imparts a mass of information on a number of incredibly dull subjects, information which no doubt is correct to-day but all of which may be changed to-morrow. It deals with facts rather than with principles; it is informative rather than educational. It is a book that may be of value to the farmer and even to the agricultural student for reference purposes, but it is certainly one that will never be read from interest.

Parts of the book, however, indicate that the author is capable of other and better things, and that if only he would deal with the fundamental principles of farm management rather than with detail, a book of permanent value might result. The chapter on choosing a farm is an example, though even this chapter is open to criticism, for the author draws no clear distinction between inherent fertility and condition. This is the more important in that the two are always liable to be confused in the student's mind.

Let us hope that when the second part of the book comes to be written the author will deal with the subject in a different way, a way in which he has already shown himself to be capable.

WILFRID MANSFIELD.

THE HISTORY OF JERICHO

The Story of Jericho
By John Garstang and J. B. E. Garstang. Pp. xv+200. (London: Hodder and Stoughton, Ltd., 1940.) 8*s*. 6*d*. net.

IN Old Testament history the fall of Jericho is the culmination of a long drawn-out drama which has impressed itself upon the imagination of most generations of men—and not Israelites alone. In archæology the excavations on the site of the city which have been carried out by Prof. John Garstang over a period of years have set the development of early civilization in Palestine in a new and arresting perspective. Not only do we now see the beginning of those relations with the two great empires lying on either side which were to have a decisive effect on the growth and influence of Palestine in history, but we also are carried back unexpectedly to the earliest known settlement of man in Palestine, or it may be indeed as Prof. Garstang remarks, one of the oldest "in the whole world". In the north-east corner of

the walled enclosure the remains of late stone age buildings deep below the foundations of the walled city proved to be the latest of a series of neolithic deposits which led down, stage by stage, to a further depth of 23 ft., evidence of a long and peaceful occupation and development. Beneath these, at a depth of 6 ft. below the Bronze Age walls of 3000 B.C., were evidences of the earliest settlers in the form of primitive and, generally, pygmy flint implements, seemingly characteristic of the mesolithic period, and as such comparable with the culture of the inhabitants of the caves of Mount Carmel discovered in her excavations by Prof. Dorothy Garrod. To this early settlement a tentative dating of some period before 5000 B.C. is assigned. The earliest or lower neolithic falls at 4500 B.C., contemporary with the Proto-Chalcolithic period of Mersin in Cilicia, recently also excavated by Prof. Garstang himself. He points out that while these early neolithic settlements are to be regarded as of local origin and growth, in Palestine as at Mersin there is an early development of architectural features. Especially noteworthy at Jericho is the appearance of a megaron-like temple and the practice of burnishing the plastered walls and floors. It is also worthy of special remark that pottery first appears in the Middle Neolithic period, and in forms which Prof. Garstang interprets as pointing to independent invention. This period, which is purely stone age, is contemporary with the early Chalcolithic of northern Mesopotamia. It has distant cultural affinities with Tepe Zawra, Ras Shamra and the Fayoum, but shows a characteristic time lag.

In the six seasons of excavation which were devoted to the examination of the site, evidence of four successive cities was brought to light. Of these the earliest dates from the Early Bronze Age of 3000 B.C., pre-dynastic Egyptian object appearing beneath its foundations, but with Babylonian art and religious influence dominant within its period. In the Middle Bronze Age (2000 B.C.) the Canaanites appear, but later (1750 B.C.) it becomes a Hyksos fortress until 1600 B.C. when the city was totally destroyed at the time the Egyptians drove out the Hyksos and established the New Empire. Thenceforth until the fall of the city, which Prof. Garstang argues must have taken place in the reign of Amenhotep III, *c.* 1390 B.C., Palestine was under Egyptian domination, although there is evidence to show that at the period of the Hebrew invasion it was passing through a phase of decadence.

Prof. Garstang in this review of the material upon which he has reported in detail from time to time elsewhere, has in view the interests of the reader to whom the appeal of the archæological data is subservient to the solution of the problem presented by the Biblical narrative—"Why and how did Jericho fall?" When all the evidence to be gathered from examination of the site has been presented in outline, Mr. J. B. E. Garstang takes up the story and shows how all the different classes of evidence which can be brought to bear converge to show that the Exodus, including the Plagues, the drying up of the Red Sea, and the incidents of the sojourn in the wilderness, as well as the fall of the walls of the city, is to be attributed to a period of intense volcanic activity culminating in a violent earthquake, to which the records show that the rift in which Jericho is situated has always been subject. The latest serious recurrence which reproduced features mentioned in the biblical narrative took place so recently as 1927.

PROBLEMS OF THE VIRUS

The Virus

Life's Enemy. By Kenneth M. Smith. (Cambridge Library of Modern Science.) Pp. viii + 176 + 9 plates. (Cambridge: At the University Press, 1940.) 7*s.* 6*d.* net.

THE present time is ripe for a general review of the problems of virus diseases elucidated during the last decade, and Dr. Kenneth Smith has recognized the opportunity by writing this volume. He is an accepted authority on plant viruses, but this latest work does not confine its allegiance to the plant kingdom. It is a conspectus of virus phenomena, and draws authoritative illustrations with equal facility from animal and plant diseases. One good effect of this is to show the essential similarity of virus upon both types of host; a worker in plant viruses investigates the same principles which present themselves from the animal side. The first part of the volume discusses the nature of virus; how it was discovered, how it is studied, and what is its nature. Part 2, "The Virus in Action", discusses methods of infection and the action of virus upon the living cell. It is this section, and that which outlines a range of the more important virus diseases, which justify the volume's sub-title "Life's Enemy". A chapter on control of these maladies is also added, and Dr. Smith's specialist studies of the entomological implications of virus diseases make fascinating reading, for the relations of a virus with its insect vector have a tantalizing complexity.

The range of diseases outlined in the volume is necessarily not extensive ; it is the author's design to parade the various types of host before the reader, and accordingly typical diseases of man and domestic mammals, of birds, fish, plants and bacteria are described. A very interesting discussion is given of the relations of viruses with malignant tumours, and it is good to see that scientific investigation is again directed to this possibility. The peculiar action of virus upon living cells is considered. The parasite can stimulate or destroy the cell, and it may vary in its effects, even to the production of a new type of disease. Nineteen excellent plates portray symptom-complexes which are relatively common.

Dr. Smith considers that the virus is probably rather more inanimate than living, because of the recent work upon the crystalline nature of virus protein. He is, however, perhaps a little too definite when he says, in answer to the question "Are viruses living or non-living ?" that "This starts a hare which can never be caught" (p. 37). The question is indeed difficult ; but is not impossible of solution. Evaluation of all incompletely determined phases of the problem is quite fair, however, and the author takes pains to give both sides of the question, where two exist.

Clarity and simplicity of expression render this treasury of information available to the general reader. This is a book which could only have been written by a master of the subject ; it is rich in the intangible value of background ; it can be read with pleasure in its expression, for it is a contribution to general culture, but it has also the full merit of an exact scientific review.

J. Grainger.

CHEMICAL CHANGE

The Kinetics of Chemical Change

By Dr. C. N. Hinshelwood. Pp. vii+274. (Oxford : Clarendon Press ; London : Oxford University Press, 1940.) 15*s*. net.

Prof. Hinshelwood's first book on chemical change appeared in 1926 and later ran into three editions. There is little doubt that a fourth edition would have been welcomed as eagerly as its predecessors were ; but the author has adopted the heroic course of writing a new book instead of expanding the old. It would be an under-statement to state that the result is satisfactory—that was to be anticipated ; the treatment of the subject in the present volume is by far the most satisfactory and interesting that has yet been written.

In the kinetics of chemical change the energy of activation is the fundamental factor that is involved, and is at present the one quantity which has to be determined by experiment, although in simple cases, as shown by Eyring and by Shermann, it is possible to calculate the value from molecular dimensions and band spectra values.

Apart from this problem of the energy of activation, there are in general three methods of approach to gas reactions : the kinetic, the statistical and that of the transition state. It is important to realize the assumptions which have to be made or are tacitly assumed in each method of treatment so as to obtain formal agreement both with each other and with the experimental data. It is a much more difficult matter to decide whether they all do, in fact, portray the same molecular mechanism of reaction and, if so, that the one they do describe is the correct one. For example, we might regard the mechanism of reaction between two molecules as involving on one hand a steady but decelerated mutual approach during which the valency bonds undergo any necessary continuous change in orientation before the quasi-equilibrium of the transition state is attained, or on the other hand we might regard the mechanism as more akin to the dropping of a glass object on a hard surface—at a critical velocity of impact with the correct orientation the glass breaks. As an alternative simile we might contrast a photochemical change at the threshold of the continuous spectrum with one in which a jump to a new level of excitation is involved.

Some four chapters are devoted to gas reactions, and although these comprise only one hundred pages of text, there is scarcely a point of interest or importance which has been left out. It is admittedly difficult to distinguish experimentally between a unimolecular reaction obeying the Lindemann mechanism and one involving short chains. To accept the usual criterion of change in the velocity constant with the pressure is dangerous when more than one reaction mechanism is involved ; thus to account for the decomposition of azo-isopropane on the unimolecular basis it must have at 150° C. a specific heat of some 40–50 calories. This seems a large value, and further work on specific heats of this and similar substances is clearly desirable.

In contrast to the reactions in homogeneous phases, the author devotes only some fifty-five

pages to heterogeneous reactions. Whilst the difference between chemi-sorption and physical or van der Waals' adsorption is mentioned, it is debated whether there is a true distinction between the two kinds. Many now would take the view that catalytic reactions function because both kinds of adsorption are involved and that the act of catalysis involves a switch-over of the 'adsorbed' constituents from one type to another.

In the last chapter several general aspects of chemical change are discussed, of especial interest being the section on a comparison of reactions in the gaseous state with those in solution.

The author is to be congratulated on a magnificent achievement. In the preface he states that it is written for anyone who cares to read it; the reviewer might add, anyone who cares to read it will read it again and again. ERIC K. RIDEAL.

HISTORY OF LABORATORY APPARATUS

The Tools of the Chemist

Their Ancestry and American Evolution. By Ernest Child. Pp. 220. (New York: Reinhold Publishing Corporation; London: Chapman and Hall, Ltd., 1940.) 21*s*. net.

IF it be true, as has often been emphasized, that scientific progress is associated with the development of new laboratory methods and technique, then the story of laboratory apparatus becomes a part of the history of chemical education. This is a special branch of historical chemistry so it requires close contact with the instrument business for its investigation; the author, long associated with Eimer and Amend of New York, has proved fully capable of discharging his self-assumed task. Though limited to American chemistry, Mr. Child has necessarily gone back to European origins so as to place his picture in its proper setting. The resulting story, briefly told in an attractively produced book, makes the most pleasant reading: we would recommend its perusal to our colleagues.

Sellers of scientific apparatus are not to be regarded as mercenary and tainted with commercialism. The great Gay-Lussac founded with Collardeau a firm for the manufacture of the burette, vapour density and other apparatus he had originated. Accum, a gentleman of whom there are two opinions to-day, declared "that he who establishes a place of fabrication of an article of use to the sciences is a benefactor to the public".

American chemists, like the British, were too dependent, prior to 1914, upon Continental manufacturers and dealers for much of their scientific equipment. Hundreds of chemists who became future leaders studied in Continental laboratories and on their return home naturally ordered the apparatus with which they were familiar. The implications of this sentence might well be pondered over for the future: Britain must see to it that after the War she attracts students from both the Americas, the Dominions, the East, and even from the Continent, that besides teaching them science they are also inculcated with British ideals and the habit of buying British. This form of propaganda is both necessary and justifiable, and might properly form an activity of the British Council.

America, of course, owes much to its emigrants, skilled mechanics from England, Holland and France, while as a result of the political disturbances of 1848 many glassblowers and instrument makers came from Germany.

The text is divided into three sections, the first headed "People and Events", the second entitled "Ancestry and Development", whilst the third gives the history of the distributors of apparatus in America. The first recorded importation of apparatus and chemicals into North America was made by John Winthrop in 1633; the cradle of American laboratory apparatus was in Philadelphia, where thermometers and hydrometers and "glasses for Philosophical Experiments" were made so far back as 1785.

Mr. Child has a happy knack of mixing past and present, and is clever in selecting his illustrations and quotations.

In days when there is serious discussion in the columns of NATURE of curtailing the practical course in school training in science, it is worth while quoting a philosophy expressed in the eighth century by Jābir ibn Hayyān, the great chemist of Islam. "The first essential in chemistry is that thou shouldst perform practical work and conduct experiments." This is as true to-day as when it was written; it applies above all to schools. We fail to-day because we are not a practical nation; nine tenths of us in the towns are unable to use our hands. We are trained to fill in forms and not to work lathes, so that most of us are helpless when emergency arises. The same philosopher also says, "But thou, oh my son, do thou experiment so that thou mayest acquire knowledge". It is in the laboratory that progress is made; the chemist must look to it that his tools are ready.

We thank Mr. Child for a delightful book.

E. F. ARMSTRONG.

SCIENCE AND RELIGION*

By Prof. Albert Einstein, For.Mem.R.S.

IT would not be difficult to come to an agreement as to what we understand by science. Science is the century-old endeavour to bring together by means of systematic thought the perceptible phenomena of this world into as thorough-going an association as possible. To put it boldly, it is the attempt at the posterior reconstruction of existence by the process of conceptualization. But when asking myself what religion is, I cannot think of the answer so easily. Even after finding an answer which may satisfy me at this particular moment, I still remain convinced that I can never in any circumstances bring together, even to a slight extent, all those who have given this question serious consideration.

At first, then, instead of asking what religion is, I should prefer to ask what characterizes the aspirations of a person who gives me the impression of being religious: a person who is religiously enlightened appears to me to be one who has, to the best of his ability, liberated himself from the fetters of his selfish desires and is preoccupied with thoughts, feelings, and aspirations to which he clings because of their super-personal value. It seems to me that what is important is the force of this super-personal content and the depth of the conviction concerning its overpowering meaningfulness, regardless of whether any attempt is made to unite this content with a Divine Being, for otherwise it would not be possible to count Buddha and Spinoza as religious personalities. Accordingly, a religious person is devout in the sense that he has no doubt of the significance and loftiness of those super-personal objects and goals which neither require nor are capable of rational foundation. They exist with the same necessity and matter-of-factness as he himself. In this sense religion is the age-old endeavour of mankind to become clearly and completely conscious of these values and goals, and constantly to strengthen and extend their effects. If one conceives of religion and science according to these definitions, then a conflict between them appears impossible. For science can only ascertain what is, but not what should be, and outside its domain value judgments of all kinds remain necessary. Religion, on the other hand, deals only with evaluations of human thought and action; it cannot justifiably speak of facts and relationships between facts. According to this interpretation, the well-known conflicts between religion and science in the past must all be ascribed to a misapprehension of the situation which has been described.

For example, a conflict arises when a religious community insists on the absolute truthfulness of all statements recorded in the Bible. This means an intervention on the part of religion into the sphere of science; this is where the struggle of the Church against the doctrines of Galileo and Darwin belongs. On the other hand, representatives of science have often made an attempt to arrive at fundamental judgments with respect to values and ends on the basis of scientific method, and in this way have set themselves in opposition to religion. These conflicts have all sprung from fatal errors.

Now, even though the realms of religion and science in themselves are clearly marked off from each other, nevertheless there exist between the two strong reciprocal relationships and dependencies. Though religion may be that which determines the goal, it has, nevertheless, learned from science, in the broadest sense, what means will contribute to the attainment of the goals it has set up. But science can only be created by those who are thoroughly imbued with the aspiration towards truth and understanding. This source of feeling, however, springs from the sphere of religion. To this there also belongs the faith in the possibility that the regulations valid for the world of existence are rational, that is, comprehensible to reason. I cannot conceive of a genuine man of science without that profound faith. The situation may be expressed by an image: science without religion is lame, religion without science is blind.

Though I have asserted above, that in truth a legitimate conflict between religion and science cannot exist, I must nevertheless qualify this assertion once again on an essential point, with reference to the actual content of historical religions. This qualification has to do with the concept of God. During the youthful period of mankind's spiritual evolution, human fantasy created gods in man's own image, who, by the operations of their will, were supposed to determine, or at any rate to influence, the phenomenal world. Man sought to alter the disposition of these gods in his own favour by means of magic and prayer. The idea of God in the religions taught at present

* From a written communication to the Conference on Science, Philosophy and Religion recently held at the Jewish Theological Seminary of America, New York.

is a sublimation of that old conception of the gods. Its anthropomorphic character is shown, for example, by the fact that men appeal to the Divine Being in prayers and plead for the fulfilment of their wishes.

Nobody, certainly, will deny that the idea of the existence of an omnipotent, just and omnibeneficient personal God is able to accord man solace, help, and guidance ; also, by virtue of its simplicity the concept is accessible to the most undeveloped mind. But, on the other hand, there are decisive weaknesses attached to this idea in itself, which have been painfully felt since the beginning of history. For example, if this Being is omnipotent, then every occurrence, including every human action, every human thought, and every human feeling and aspiration is also His work ; how is it possible to think of holding men responsible for their deeds and thoughts before such an Almighty Being ? In giving out punishment and rewards He would to a certain extent be passing judgment on Himself. How can this be combined with the goodness and righteousness ascribed to Him ?

The main source of the present-day conflicts between the spheres of religion and of science lies in this concept of a personal God. It is the aim of science to establish general rules which determine the reciprocal connexion of objects and events in time and space. For these rules, or laws of Nature, absolutely general validity is required —not proven. It is mainly a programme, and faith in the possibility of its accomplishment in principle is only founded on partial successes. But scarcely anyone could be found who would deny these partial successes and ascribe them to human self-deception. The fact that on the basis of such laws we are able to predict the temporal behaviour of phenomena in certain domains with great precision and certainty, is deeply embedded in the consciousness of the modern man, even though he may have grasped very little of the contents of those laws. He need only consider that planetary courses within the solar system may be calculated in advance with great exactitude on the basis of a limited number of simple laws. In a similar way, though not with the same precision, it is possible to calculate in advance the mode of operation of an electric motor, a transmission system, or of a wireless apparatus, even when dealing with a novel development.

To be sure, when the number of factors coming into play in a phenomenological complex is too large, scientific method in most cases fails us. One need only think of the weather, in which case prediction even for a few days ahead is impossible. Nevertheless, no one doubts that we are confronted with a causal connexion the causal components of which are in the main known to us. Occurrences in this domain are beyond the reach of exact prediction because of the variety of factors in operation, not because of any lack of order in Nature.

We have penetrated far less deeply into the regularities obtaining within the realm of living things, but deeply enough nevertheless to sense at least the rule of fixed necessity. One need only think of the systematic order in heredity, and in the effect of poisons, as, for example, alcohol on the behaviour of organic beings. What is still lacking here is a grasp of connexions of profound generality, but not a knowledge or order in itself.

The more a man is imbued with the ordered regularity of all events, the firmer becomes his conviction that there is no room left by the side of this ordered regularity for causes of a different nature. For him neither the rule of human nor the rule of Divine Will exists as an independent cause of natural events. To be sure, the doctrine of a personal God interfering with natural events could never be *refuted*, in the real sense, by science, for this doctrine can always take refuge in those domains in which scientific knowledge has not yet been able to set foot.

But I am persuaded that such behaviour on the part of the representatives of religion would not only be unworthy but also fatal. For a doctrine which is able to maintain itself not in clear light but only in the dark will of necessity lose its effect on mankind, with incalculable harm to human progress. In their struggle for the ethical good, teachers of religion must have the stature to give up the doctrine of a personal God, that is, give up that source of fear and hope which in the past placed such vast power in the hands of priests. In their labours they will have to avail themselves of those forces which are capable of cultivating the good, the true, and the beautiful in humanity itself. This is, to be sure, a more difficult but an incomparably more worthy task. (This thought is convincingly presented in Lord Samuel's book, "Belief and Action".) After religious teachers accomplish the refining process indicated, they will surely recognize with joy that true religion has been ennobled and made more profound by scientific knowledge.

If it is one of the goals of religion to liberate mankind so far as possible from the bondage of egocentric cravings, desires and fears, scientific reasoning can aid religion in yet another sense. Although it is true that it is the goal of science to discover rules which permit the association and foretelling of facts, this is not its only aim. It also seeks to reduce the connexions discovered to the smallest possible number of mutually independent conceptual elements. It is in this striving after the rational unification of the manifold that

it encounters its greatest successes, even though it is precisely this attempt which causes it to run the greatest risk of falling a prey to illusions. But whoever has undergone the intense experience of successful advance made in this domain is moved by profound reverence for the rationality made manifest in existence. By way of the understanding he achieves a far-reaching emancipation from the shackles of personal hopes and desires, and thereby attains that humble attitude of mind towards the grandeur of reason incarnate in existence which, in its profoundest depths, is inaccessible to man. This attitude, however, appears to me to be religious in the highest sense of the word. Thus it seems to me that science not only purifies the religious impulse of the dross of its anthropomorphism, but also contributes to a religious spiritualization of our understanding of life.

The further the spiritual evolution of mankind advances, the more certain it seems to me that the path to genuine religion does not lie through the fear of life, and the fear of death, and blind faith, but through striving after rational knowledge. In this sense, I believe that the priest must become a teacher if he wishes to do justice to his lofty educational mission.

MOLECULAR FIELDS OF FORCE: RETROSPECT AND SUGGESTIONS

By Prof. Sydney Chapman, F.R.S.,

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In the nineteenth-century development of the kinetic theory of gases, the molecules were at first usually treated as solid spheres like billiard balls, differing in size and mass. This molecular model, though it furnished a conveniently simple picture of many gas phenomena, nevertheless represented a retrogression from the model discussed long before by Boscovich[1], who regarded atoms as centres of force, varying with the distance r both in intensity and sign.

Maxwell[2], in 1867, made a partial return to the Boscovich model, when he gave the first mathematically accurate theory of the mean free-path phenomena of gases (namely, viscosity, conduction and diffusion), for a gas whose molecules interact according to the inverse fifth power of the distance, r^{-5}. This special law was chosen because its consequences are relatively easy to work out, within the brilliantly conceived framework of Maxwell's general method; not until 1915 was it found possible to adapt this framework so that any law of variation of the force $f(r)$, with the distance r, could be dealt with[3]. Soon afterwards the same results were achieved by Enskog[4], who overcame equal difficulties in generalizing a method due to Boltzmann, itself inspired by the work of Maxwell.

Meanwhile, in 1873, van der Waals[5] improved the solid-sphere molecular model by adding to it a field of attractive force; on this basis he developed his famous equation of state, the first great advance on the ideally simple Boyle-Charles law. Sutherland[6], in 1893, used the same model in connexion with the theory of gaseous viscosity.

Enskog and I, in our general theories of the mean free-path phenomena, dealt particularly with the simple force-law $f(r) \propto r^{-n}$, and with the van der Waals model. Lennard-Jones[7] first applied the theory to molecules of the Boscovich type, by taking $f(r) = Kr^{-m} + K'r^{-n}$; the first term represents the repulsive forces at short distances, and the other (if $K' < 0$) the attractions at long distances. He also calculated the equation of state for a gas composed of such molecules, and used both types of data (and others) to determine the force constants K, K' and the force indices m, n. He found that except in the case of hydrogen and helium neither the equation of state nor the viscosity determines the molecular field uniquely; for other gases the two methods permit a range of possible models (or values of K, K', m, n), and other methods have to be used to narrow this range.

The ambiguity of the models inferred by Lennard-Jones extends even to the sign of K', that is, it remains uncertain whether the distant field is attractive or repulsive[8]. Hence for many gases his formula for $f(r)$ may be regarded only as a means of indicating a change of the index of the repulsive field at moderate distances, instead of as representing the undoubted attraction at larger distances. If n itself is taken to be a function of r, any function $f(r)$ may be expressed as Kr^{-n}, over any range of r for which f has a constant sign; and $n = -d \log f(r)/d \log r$. For a particular temperature or range of temperature the important range of r at collisions will correspond to certain

average values of K and n, and these values can be found as described, using formulæ based on the law $f(r) = Kr^{-n}$ (n constant); but K and n as thus determined will in general vary with the temperature.

Such methods of determining molecular fields of force, though based on accurate mathematical theories, are empirical in the sense that the theories merely indicate the observable consequences implied by the adoption of particular molecular models, and thus enable us, by comparing the theoretical results with experimental data, to infer more or less satisfactory models consistent with the data.

A more fundamental approach to the study of intermolecular fields is possible, by calculating them from the electronic structure of the molecules. The first step in this direction was taken in 1927 by Heitler and London[9], who applied the quantum theory to calculate approximately the interaction between two hydrogen atoms. Their theory accounted for the repulsion at small distances; in 1930 Eisenschitz and London[10] carried the calculation to a further approximation, and accounted also for the van der Waals force at large distances. The magnitude of this force was found with great accuracy, but the value of $f(r)$ for *atomic* hydrogen has comparatively little practical importance. The same methods have been applied also to helium atoms, and in this way Slater and Kirkwood[11], and later Buckingham[12], have obtained results in good agreement with one another and with the form of $f(r)$ determined empirically by Lennard-Jones. Calculations have also been made for other atoms, in reasonable agreement with observation.

For molecules the task is much more difficult; Massey and Buckingham[13] have made a beginning by calculating the long-range forces between hydrogen molecules. These forces will depend both on the distance r between the molecular centres, and on the orientation of their two axes relative to the line of centres, because the hydrogen molecule is not spherically but axially symmetrical. But Massey and Buckingham point out that in hydrogen at ordinary temperatures the time of complete revolution of a molecule is of the same order as the time of a collision, so that it is reasonably legitimate to average the interaction over all orientations; this gives the function $f(r)$ effective in gas kinetics, as if the molecules were spherically symmetrical.

Massey and Buckingham express the hope that they will be able to extend their calculations on the hydrogen molecule to include also the short-range forces, and thereafter to calculate the equation of state of hydrogen, and its viscosity, without recourse to empirical methods. But the day still seems far distant, as Fowler and Guggenheim remark in their "Statistical Thermodynamics" (p. 276), when such calculations will be a practical possibility, at least for molecules other than hydrogen. Hence our knowledge of molecular fields must for the present rest largely on their empirical determination from observed data.

An avenue to such knowledge, different from that followed by Lennard-Jones, and hitherto but little unexplored despite its promise, is afforded by the phenomenon of thermal diffusion[4,7], which is particularly sensitive to the nature of the molecular interaction. When a mixture of two gases (1, 2) is enclosed in a vessel, of which different parts are maintained at different (absolute) temperatures T, T', small differences of relative concentration are set up. The concentration difference is given approximately by $k_T \log_e(T'/T)$, where k_T, the thermal diffusion ratio, depends in a complicated way upon the mass-ratio and concentration-ratio and the three laws of interaction between either type of molecule (1,1 or 2,2), or between the two types (1, 2). Experiments in which k_T is determined have been made for many gas mixtures, by Dootson, Ibbs[14], Elliott and Masson, Lugg, Blüh, Nier and other workers; but the inferences drawn from these experiments, mainly as to the nature of the interaction between the unlike molecules, have hitherto been rather rough, partly owing to the complexity of the theoretical expression for k_T. It seems desirable, and through the great advance in our knowledge and use of isotopes it is now possible, to apply thermal diffusion more simply to the elucidation of intermolecular forces; this would also enable the considerable amount of existing thermal diffusion data to be interpreted better than is yet possible.

It is generally supposed, and the view is reasonably consistent with experimental data on viscosity, that the law of interaction $f(r)$ between two like molecules M is the same as that between M and an isotopic molecule M', or between two such molecules M'; for example, M may be H_2 and M' may be D_2, or M may be $C^{12}H_4$ and M' may be $C^{12}H_3D$ or $C^{13}H_4$. If this be so, the force-index n in the approximate expression $f(r) = Kr^{-n}$ may be determined from the equation of state or from the temperature variation of the viscosity; but a more delicate way of determining n is by thermal diffusion experiments on a mixture of the isotopic molecules, as has been done for $C^{12}H_4$ and $C^{13}H_4$ by Nier[15]. After n has been thus determined —and this can be done to a fraction of an integer, instead of with an uncertainty of one or more whole integers (as when viscosity data are used)—the corresponding value of K can best be determined from viscosity data at any particular temperature.

There is scope for a large amount of useful experimental work of this kind, especially in cases where more than one isotope is available, and particularly when one or more of these is radioactive. As an example, the case of hydrogen may be cited; it has two non-radioactive types of atom, H^1 (or H) and H^2 (or D), and one radioactive isotope H^3. O'Neal and Goldhaber[16] have lately shown that the half-lifetime of H^3 is 31 ± 8 years, so that this isotope is conveniently long lived. From these three isotopes six types of hydrogen molecule may be formed, namely, H_2, HD, D_2 (all non-radioactive), and HH^3, DH^3 and H^3H^3 (all radioactive); the last of these, however, is at present unlikely to be available in sufficient quantity for use in experiments. The remaining five types of hydrogen molecule provide ten different possible isotopic hydrogen mixtures, namely, (*a*) H_2–HD, (*b*) H_2–D_2, (*c'*) H_2–HH^3, (*d'*) H_2–DH^3, (*e*) HD–D_2, (*f'*) HD–HH^3, (*g'*) HD–DH^3, (*h'*) D_2–HH^3, (*i'*) D_2–DH^3 and (*j''*) HH^3–DH^3. The accent (') in this enumeration indicates radioactivity in one or both components of the mixture; in such mixtures the radioactive molecules can at present be available only as very rare constituents, and therefore the last mixture, (*j''*), in which both constituents are rare, may be excluded from consideration. This leaves nine hydrogen mixtures available for thermal diffusion experiments. Those containing a rare radioactive constituent are very suitable for this purpose, as I pointed out in 1929[17], because of the delicacy of radioactive estimations; the difficulties which led to a high probable error in the half-lifetime of H^3, in the determination by O'Neal and Goldhaber, would not arise in thermal diffusion experiments; the temperature conditions can be maintained steady for a long time, and long-continued Geiger counts would permit the ratio of the concentration of the rare constituent in the two regions at different temperatures to be determined with considerable accuracy.

The nine hydrogen mixtures include one pair, (*h'*), or D_2–HH^3, in which the molecular masses are almost exactly equal; any thermal separation found for this pair (subject to a minute correction for the proportionate mass-difference $m \equiv (m_1 - m_2)/(m_1 + m_2)$, which is 5/8055) must be due to a slight inequality of the interactions between the D_2–D_2 and D_2–HH^3 molecular pairs; this provides a very delicate test of the supposition, already mentioned, that the force fields are identical for isotopic molecules.

For two pairs of the nine gas mixtures, namely, (*b*) and (*c'*), and (*e*) and (*f'*), the proportionate mass-differences m are almost identical, namely, $\frac{1}{3}$ and $\frac{1}{7}$ respectively; hence their thermal separations should be the same if the force fields are identical, and again this provides a delicate test of this identity; since in this case one mixture of each pair has no rare radioactive constituent, the thermal separation can be determined for a variety of concentration ratios, and an estimate made of the limiting value of k_T for a small concentration ratio of the heavier constituent (corresponding to the concentration of the radioactive constituent in the other mixture of the pair).

If these tests bear out the identity of the fields of force between different isotopic molecules, the interpretation of thermal separation data for other isotopic pairs is simplified, but in any event a complete set of such data, for these nine mixtures, in which the proportionate mass-difference m ranges from 0 to $\frac{3}{7}$, can be used to determine three constants[18], A, B, C, which appear in the formula for k_T, and which depend on the law of force at collisions between the *unlike* molecules of each mixture. If the force-law is $f(r) \propto r^{-n}$, these three constants are all known functions of n, and n can be inferred from any one of the three constants; if it were found that A, B, C do not all correspond in this way to one value of n, it would be proved that the force law is not of this simple form, and an indication would be gained as to how $f(r)$ diverges from this simple law.

The interpretation of such thermal separation data may require some extensions of the theoretical formula for k_T, offering no great difficulty. The combination of such theoretical and experimental work should lead to much more precise empirical knowledge of the field of force of hydrogen molecules than we now possess, and would be of value in testing further fundamental theoretical work on the hydrogen molecule.

Similar experimental studies might be made also on numerous isotopic mixtures for many other chemically elementary or compound gases, and would lead to a useful extension and a much increased precision in our knowledge of their fields of force.

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SCREENED DUST AND ITS USES

By William B. Strain,
Inspector of Cleansing, Ayr

THERE is an old saying in agricultural circles in Scotland that you only take out of the soil what you have put in. To a greater or lesser degree this is correct, having regard to the elements necessary for supporting and maintaining the germination and growth of each particular plant.

Many factors contribute to the growth of a plant and most plants have their idiosyncrasies, as conversely there exist ideal conditions peculiar to the natural growth of particular plant life. Thus we have some districts of the country where potatoes grow best, others are better for carrots, beetroot, hay, oats, hops, and so forth. It therefore follows that in dealing with the fertilizer and its effects on plant life we must take into account the chemical and bacteriological condition of the soil, its physical characteristics, climatic conditions, etc. Nevertheless there are certain factors which must be present in all cases of plant cultivation, and of these, certain chemical elements are essential to plant growth.

When considering the use of screened dust therefore as a means of increasing soil fertility, we do not claim that it will grow any kind of plant, but at this particular time, when there is a need of fertilizers, screened dust forms a very useful, cheap and abundant means of conserving the better-known manufactured fertilizers specially suited to specific plants.

Conservation of Fertilizers

There is almost certain to be a shortage of imported fertilizers, and many manufacturers are searching around for some means of augmenting the anticipated shortage. Next year's crops must be raised and fed. Greater crops than ever must be grown by our own efforts. We cannot afford to risk importing either the fertilizer or foodstuff if the wherewithal to produce or grow them is already in our hands.

In almost every industry, business concern, farm and household throughout the length and breadth of the country we have in the past twenty years attained a sense of squandermania which is nothing short of sinful. Easily handled bags of fertilizers arrive on the farm which has been robbed of its organic requirements all these years. Many of the constituents of this fertilizer have been imported from foreign lands, thousands of miles distant; yet lying to hand, we have permitted city, town and country to dissipate organic matter and chemical elements amounting to millions of tons per annum. What then is the answer to waste? It comprises one simple word—utilization. Everything must now be utilized and returned as raw or basic material to the particular industry requiring it. Manures or fertilizers are available in Great Britain in our so-called waste materials to the extent of hundreds of thousands of tons.

We must forget the economic aspect where the production of our food is concerned, as a sufficient quantity of food to meet war-time needs cannot be grown unless manures and fertilizers are produced from previously untapped sources within the confines of our own borders. Everything of manurial value should be utilized, and the following are a few sources with which I have experimented: (1) Sea wrack or sea-weed. Hundreds of thousands of tons of this valuable material go to waste annually. (2) Leaves from trees. There must be vast quantities of this material in the woods and forests of Great Britain. In my own town, forty tons were collected from the streets last autumn and the tonnage was only representative of trees overhanging public roadways. (3) Garden refuse. If separated into two classes (*a*) hard, and (*b*) soft, the former can be burned and valuable potash secured whilst the latter can be made into an excellent organic compound. (4) Damaged fruit. (5) Fish waste. (6) Night soil or sewage mixed with screened dust or other binding material. (7) Slaughter-house offals. (8) Existing refuse coups or tips where the household refuse has been disposed of for many years to an almost unbelievable extent. (9) Screened dust.

From these nine sources alone, hundreds of thousands of tons of valuable material can be obtained and rendered suitable for growing our foodstuffs either by one of the many manufacturing processes already existing or by the aid of Nature herself. A great deal of study and progress

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In this new edition of an outstanding zoological text-book, with its change of type and format, considerable alterations and additions to the text and illustrations have been made, and certain parts which appeared no longer to serve a useful purpose have been omitted.

The changes made in Vol. I include the re-writing of the chapter on the "General Structure and Physiology of Animals" and in so doing its scope has been enlarged. All chapters dealing with classification have been thoroughly revised. The volume was reviewed in NATURE by Prof. C. H. O'Donoghue, who said of it: "The present volume is still easily recognizable as 'Parker and Haswell' and so characterized by straight-forward, concise but nevertheless readable text and it is illustrated by clear, illuminating text-figures. On the technical side it maintains or rather exceeds the high standard set by the first edition, and those who are familiar with the latter will recognize that this is indeed praise. On the whole a praiseworthy judgment has been exercised in what has been included and what omitted, and also between the old 'Parker and Haswell' and the changes necessitated by more modern ideas in zoology."

In Vol. II recent advances in palæontology which have changed earlier views on the evolution of many vertebrates, have been introduced, but so far as possible the general plan of the book has not been altered. A new classification of fishes is used. Treatment of the Amphibia and Reptilia has been somewhat modified. In the section on mammals there is a fuller treatment of the orders and brief accounts of extinct forms.

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has been made in the past few years and the authorities concerned could easily be brought together to organize the collection, treatment, and disposal to agriculture of these so-called waste materials which are lying dormant. To illustrate what can be done with so-called waste material, I undertook research work in collaboration with the Hannah Dairy Research Institute, Ayr, on the subject of a very lowly material now well known as screened dust. This material consists of the very fine riddlings of household refuse which will pass a 5/16 riddle.

For many years it had been used for opening up heavy clay soils or mixed as a binder with slaughter-house offals in many parts of the country, but there was a lack of information obtained under the control or direction of competent authorities. The experiments were therefore undertaken to discover the true value of the material, and a fascinating period of study revealed that the grey dusty material had many very interesting characteristics peculiar to it.

To begin with, it was discovered that screened dust is comprised almost entirely of fine ash from household coal, which is only partly burned out because of the lamentable inefficiency of the everyday household fire. It therefore retains a good number of the qualities of coal itself.

Source of Supply

Screened dust is obtained from the household refuse and has to be riddled through a 5/16 and $\frac{1}{4}$ in. screen to obtain it free from glass. The refuse should also be passed over a small magnetic separator so as to eliminate the possibility of foreign matter such as pins, nails, razor blades, etc. The household fire is therefore the homely source from which we receive screened dust among the household ashes. It is very finely divided, for the greater part less than $\frac{1}{4}$ in., and much of it is a very fine powder of particle size. It can be mechanically riddled to a fine consistency of good appearance.

Application to Farmlands

Applications of five tons per acre or slightly more give excellent results on sandy soils, loams, clay loams, heavy clay, and even poor sandy soil, and particularly on land which has a tendency to acidity. The material is usually broadcast by a shovel from a cart; but some farmers now desire to spread screened dust by a manure-sowing machine. An alternative method is the use of a road gritting machine.

The material acts both mechanically and chemically on soil—opening up heavy land, allowing aeration and supplying food to the plant.

Crops which will Benefit from Screened Dust

Timothy, rye grass, cocksfoot, backward clovers and mixed hay crops are improved by the use of screened dust. The straw or stem is of a much harder and better keeping quality than similar crops manured with farmyard manure. In some cases timothy hay has been observed to grow twice to three times more hay than with the normal dressings. Where seeding of timothy and rye grass hays have taken place, the seeds have been well filled and much heavier by weight than in other or the same fields on the farms concerned which had been manured by other means.

Pasture land and clover respond well to screened dust. Oat crops treated with screened dust withstand heavy weather much better if in an exposed position. Some excellent crops have been grown in this way. Turnips, cabbage, mangold, potatoes, lettuce and like crops grow well when screened dust is applied to the soil. Last year's experiments with mangold showed that the seeds sown in screened dust itself, laid to a depth of five feet with no soil present, saw a good crop of mangold through all the stages of growth. Thus it was proved that screened dust itself has all the properties present to propagate and support plant life without assistance of any other soil or fertilizer. This can be safely vouched for, as evidenced by the very vigorous growth of all kinds of plants in a field near Ayr which is covered to a depth of one foot with screened dust.

Temperature Increase of Screened Dust

A considerable increase of temperature takes place when screened dust is laid in a heap of three feet deep. The temperature over a period of four to six days after screening may attain 150° F. to 160° F. Thus a certain degree of sterility can be assured if the dust is allowed to lie in heaps for six days after being screened.

Presence of Organic Matter

The percentage of organic matter present in screened dust is surprisingly high and varies between 13 and 35 per cent, and if the recommended dressing of five tons per acre is adhered to, a liberal amount of organic matter will be applied, much of which seems readily available for plant food.

Trace Elements

An examination of screened dust was undertaken by the Macaulay Institute, Aberdeen, to which I am indebted for the information contained in Table 2.

The importance of the trace or minor elements in agriculture has been stressed during the past few years both in Great Britain and abroad. In any manurial treatment of soil for crops it is essential that, together with the application of such well-known fertilizers as the nitrogenous, phosphatic, potassic and lime varieties, attention must be paid to any possible minor element deficiency, otherwise unsatisfactory crops may be obtained. Such crops may be unsaleable, give an uneconomic return, or have a serious effect on animals fed with them.

Of the minor elements perhaps most importance has been laid on boron, iron and cobalt. It seems evident from well-controlled experiments that the disease of turnips, known as 'raan', can be eradicated by the application of dressings of small amounts of boron to the soil. Further, in cases where raan was not found to any large extent, an increase in the total weight of turnips per acre was noted. Similarly, with sugar beet, the yield was markedly improved and the incidence of heart rot was considerably lowered when boron compounds were applied before sowing the seed. With cobalt the effect of a deficiency is not apparent in the plants, but becomes evident when these are fed to animals.

In Australia and New Zealand certain sheep diseases, which eventually result in the death of the animals, have been shown to be due to a deficiency of cobalt in the soil and plants. More recently in Great Britain a cobalt deficiency disease of live-stock has been discovered, a disease which can be effectively eradicated by the application of cobalt salts to the pasture on which the animals graze. Similarly with every one of the minor elements, we find that at least a trace is essential for the production of good land, sound, healthy crops, and healthy live-stock. As will be seen from Table 2, screened dust supplies all the known important minor elements in considerable quantity and the others in smaller amounts. Screened dust, therefore, is about the only fertilizer in use to-day which supplies all these elements in one dressing.

For the removal of decayed grass known as fog or the elimination of moss on lawns, screened dust is of great assistance. Good results have been obtained in kitchen gardens, potting and carnation growing. Many more fields of exploration are open, such as application to golf courses presently being used for grazing sheep and so forth. Amateurs and professionals alike can profitably experiment with the ash, direct from the household fires and passed through a ¼ in. riddle.

For potting or framework, one part screened dust to six parts soil can be recommended for opening up a stiff soil.

Table 1. Analysis of Dust.

Sample No.	Nitrogen	Water	Organic matter	Ash	Analysis of ash expressed as percentage of total sample				
					SiO_2	$Fe_2O_3+Al_2O_3$	CaO	P_2O_5	Sulphur
A	0·374	18·9	20·1	61·0	32·7	11·7	6·58	0·28	2·09
B	0·434	9·8	17·7	72·5	39·7	9·2	10·66	0·27	2·02
C	0·428	8·4	18·8	72·8	38·5	9·3	9·05	0·27	2·02
D	0·419	16·2	24·8	59·0	37·6	9·4	7·79	0·18	0·86

Table 2. Trace Elements. Spectrographic Examination of Sample of Refuse Dust.

Present in quantity	Present in small quantity	Present in large trace	Present as trace	Present as slight trace	Not observed
Silicon	Manganese	Boron	Germanium	Arsenic	Cadmium
Aluminium	Vanadium	Lead	Tin	Rubidium	Mercury
Iron	Potassium	Copper	Molybdenum	Caesium	Gold
Carbon		Zirconium	Silver	Zinc	Ytterbium
Phosphorus		Beryllium	Chromium		Antimony
Titanium		Cobalt	Gallium		Bismuth
Calcium		Nickel			Indium
Magnesium		Barium			Thallium
Sodium		Strontium			Scandium
		Lithium			

OBITUARIES

Dr. C. H. Merz

OUR deepest sympathy goes out to Mrs. Merz on the tragic death of her husband, Dr. C. H. Merz, and their son and daughter who were victims of recent enemy action ; a maid and chauffeur, who had been their devoted servants and loyal friends, died also in this attack.

Charles Hesterman Merz was born at Gateshead-on-Tyne in 1874. He was the son of the late Dr. J. Theodore Merz, the learned author of the "History of European Thought in the Nineteenth Century". His mother was Alice Mary, daughter of Mr. Edward Richardson, of Newcastle-on-Tyne, who belonged to a well-known Quaker family. He was educated at Bootham, York, and received his technical training at Armstrong College. Electric power and railway traction schemes all over the world bear witness to his work. In 1898, after training and experience at Newcastle, Lincoln, London, in Ireland and other places, Merz acted as engineer for the promotion of a Bill for supplying electric power to works and shipyards on Tyneside. This was the first of the 'power bills'. Afterwards he acted as engineer for the first company to use three-phase distribution in England at the then high pressure of 6,000 volts. In 1900 the company amalgamated with the Newcastle-upon-Tyne Electric Supply Company, and the combined undertaking (now the North Eastern Electric Supply Co., Ltd.) expanded during the succeeding eight years, until it covered Northumberland and Durham and parts of Yorkshire. This involved the first large-scale use of 20,000-volt underground cables, and the first extensive use of high-voltage overhead lines in Great Britain. Neptune Bank Power Station, which Merz designed, was commissioned in 1900, and was the first to use large Parsons turbo-alternators. About this time Merz took into partnership William McLellan, who had been associated with him in all his work at Tyneside ; this partnership continued until McLellan's death in 1934.

In 1907 Merz visited Australia to advise the Victorian Government on the introduction of electric traction. He laid down the basis of the legislation and organization adopted for the control of the power industry in Victoria. In 1909 he visited the Argentine and reported on the adoption of electric traction in the neighbourhood of Buenos Aires. In 1913 he visited India on the invitation of the Government of Bombay and reported on the electrification of the suburban railways. He was retained in an advisory capacity by the Commonwealth Edison Co. of Chicago, and was responsible for large railway electrification schemes, including the conversion of the South African railways and the Great Indian Peninsular Railway. He compiled the technical report for the Weir Committee which investigated the question of main line electrification in Great Britain.

During the War of 1914–18, Dr. Merz was director of Experiment and Research to the Admiralty, and within the same period served on the Haldane and Williamson Committees, which recommended the appointment of the Electricity Commissioners. In 1925 Merz put before these Commissioners a memorandum which resulted in the appointment of the Weir Committee, the report of which led to the Act of 1926 setting up the Central Electricity Board and to the construction of the Grid. At Sir Andrew Duncan's request, Dr. Merz was to have placed gratuitously his great and varied experience at the service of the Ministry of Supply from October 28 of this year.

In 1913, Merz married Stella A. P. Byrne, daughter of Mr. Edmund de Satur, of Dublin, and had one son and one daughter. He was a vice-president of the Institution of Electrical Engineers during 1912–15, and was awarded the Faraday Medal in 1931. In 1932 he received an honorary D.Sc. from the University of Durham. He was a member of the Institution of Civil Engineers and various other technical societies and was also a fellow of the American Institute of Electrical Engineers. All who knew him feel that one of Britain's great men has been taken from us, and those who knew him best feel it most.

ALEXANDER RUSSELL.

Dr. M. Mathisson

THE death of Dr. Myron Mathisson on September 13 at the early age of forty-three has cut short an interesting line of research. Mathisson had been engaged for many years in studying the general dynamical laws governing the motion of a particle, with possibly a spin or a moment, in a gravitational or electromagnetic field, and had developed a powerful method of his own for passing from field equations to particle equations. The subject is of particular interest at the present time, as it has now become clear that quantum mechanics cannot solve the difficulties that arise in connexion with the interaction of point particles with fields, and a deeper classical analysis of the problem is needed. It is much to be regretted that Mathisson's death has occurred before the relations between his method and those of other workers on the subject have been completely elucidated.

Mathisson carried out his work at the Universities of Warsaw and Kazan and at an institute which he started in Cracow, and, since the spring of 1939, at Cambridge.

P. A. M. DIRAC.

WE regret to announce the following deaths :

The Rev. W. G. Ivens, an authority on Melanesian languages.

Sir Herbert Wright, treasurer of the Imperial College of Science and Technology, an authority on tropical agriculture, especially rubber, on October 28, aged sixty-six.

NEWS AND VIEWS

Mr. Franklin D. Roosevelt

The election of Mr. Roosevelt as President of the United States for a third term of office, though by no means unexpected, will be accepted by onlookers as the strongest endorsement of the policy he has followed in the present world conflict. Not only has he consistently pledged the American people to full support of the Allied cause in the interest of the democratic ideal, but also he has secured that practical effect should be given to that pledge by bringing the vast material resources and industrial power of his country to bear upon the problem of supplying the needs of the Allies for the munitions of war, so far as compatible with the requirements of America itself for purposes of defence. It cannot be doubted that in casting their vote for Mr. Roosevelt, notwithstanding that no president hitherto has served more than two terms of office, the American people have been profoundly affected by their appreciation of the necessity of placing beyond question continuity of policy in the assistance afforded the Allies. On one hand, the President's reiteration that America's effort shall be the maximum, short of war, secures, as Mr. Joseph Kennedy has pointed out, that supplies shall suffer no diminution through arming American forces on a basis other than for purposes of defence. On the other hand, Mr. Roosevelt has so framed his policy and that of the political party of which he is the leader and the representative as to secure, both now and possibly even more in the future, a maximum of co-operation between the democratic peoples of the Americas outside the United States with those who are now engaged in a life and death struggle for the continued existence of democracy in the Old World.

German Culture in Czechoslovakia

The Czechoslovak National Council has just issued a publication, "German Cultural Oppression in Czechoslovakia" (London: Allen and Unwin, 6*d.*), outlining the position in the protectorate of Bohemia and Moravia. Oppressive measures began after the Munich "agreement" of 1938, whereby a million Czechs in the ceded territories lost their scientific and technical institutions and places of higher education and culture. Pressure was simultaneously brought to bear upon the still nominally independent Czech Ministry of Education to eradicate Jewish and other "undesirable" elements in the universities. After the German entry into Prague in March 1939, all cultural work and scientific research came to a standstill. All Government departments and local administration passed into German hands and since that time the *furor teutonicus* has raged against all the intellectual activities of the nation. A Nazi censorship spent months purging libraries of every book or journal containing any reference distasteful to its narrow doctrines. Concurrently with this, books and valuable apparatus were removed from Czech universities, scientific institutes and museums and were either sent to Germany or wantonly destroyed.

These activities were followed by the massacre of Prague students in November 1939, an act attributed to the students' own disturbances, which "necessitated" the closing of all Czech universities, medical schools and establishments of higher education. It is established that a hundred and fifty students were executed, whilst the total deaths (including university lecturers and secondary schoolmasters) amounted to more than a thousand. In addition, no fewer than seventy thousand intellectuals, students, authors, etc., were imprisoned or sent to German concentration camps. Those who escaped arrest have been persecuted in other ways. All contact with the rest of the world was prohibited, and at best these savants have lost their means of livelihood through the closing of the universities. These activities form but a small part of the systematic Nazi oppression in countries now under German rule, but they cannot be passed over in silence. Men of science and learning throughout the world will condemn heartily such conduct towards a courageous people whose high intellectual standard may be inferred from the fact that theirs is the lowest percentage of illiterates in the world.

Egyptian Bird Observations

The extension of the theatre of war for the winter campaign in Egypt with the presence of a large Allied Army in the Nile valley affords much opportunity for ornithologists on active service in all ranks in the Near East, and recalls the numerous and important field observations on British birds and migrants in Egypt made by Army men during the War of 1914–18. Since von Heuglin surveyed Egyptian bird-life in his epic work on north-east Africa, and Shelley produced his book on Egyptian birds, Colonel Meinertzhagen in 1930 produced under the authority of the Egyptian Government a two-volume collection of Nicolls' records of birds of Egypt. The Giza Zoological Gardens where Nicolls worked and collected are still visited by waterfowl like the shoveller. Demoiselle and great cranes gather by the thousands on the banks of the Nile. Jack snipe from northern Europe are winter visitors, while great egrets, wood ibis, sandpipers and numerous ducks and waders complete the bird-life of the Nile valley. Curlew, redshank, grey plover, dunlin, spur-winged plover, shoveller, mallard, teal, pied kingfishers, kestrels and marsh-harriers are among the bird-life of the royal estate at Dahshur.

In winter and early spring, huge congregations of birds are always to be seen beside the White Nile and south of Khartoum. White- and blue-headed wagtails are very numerous, along with wheatears, shrikes, pipits and a wealth of raptorial birds such as peregrines, red-footed falcons, hobbies, Montague's harrier,

etc., and of waders like godwits, stilts, green-, wood- and curlew-sandpipers, Kentish plovers and of duck such as pintail, garganeys and a few widgeon. There are common, purple, squacco and night herons, spoonbills, storks, glossy ibises, singly or in great flocks, trips of ruffs by the water, swallows, house-martins, sand-martins and swifts over the water. Most of these birds may be seen passing through Egypt by the Nile or down the Suez Canal, where the Kentish plover nests on the marshes. In north Egypt in winter may be seen such British birds as song thrushes, robins, blackbirds, starlings, skylarks and lapwings in some numbers.

Earthquakes in Rumania and Turkey

On October 22 earthquakes shook many districts in Rumania and Turkey. Earthquake tremors of medium intensity were registered in Bessarabia, Kieff, Kharkoff and elsewhere in the Ukraine, apparently coming both from the Carpathians and the Caucasus. On the same morning about 8.30 a.m. (local time) a severe shock was felt at Barlag close to Basau near the Carpathians, where children were injured and one boy killed when the roof of a school collapsed. Many other houses were damaged, and some people were unable to stand at the time in the streets. In Bucharest the shock is said to have been the most severe for many years. It is reported to have been a double shock, of total duration according to human perception of about thirty seconds, and to have caused considerable cracks in several stucco buildings besides breaking windows and shaking movable objects (modified Mercalli scale VII). No one was injured in the capital.

Apparently about the same time as the Rumanian shocks the Turkish port of Smyrna was rocked by a severe earthquake, though no serious damage or casualties have been reported. It appears unlikely that the shakings in Rumania and Turkey were due to the same earthquake as surface waves of moderate intensity are soon damped out. Further information from the seismological observatories is awaited before the exact times and epicentres of the shocks can be worked out. Earthquakes in all these regions are not uncommon. Prior to being affected by the great Anatolian earthquake of December 26, 1939, Smyrna was seriously damaged by earthquakes on March 31, 1928, and on September 20, 1899.

Electrical Engineers and the War

In his presidential address to the Institution of Electrical Engineers delivered on October 24, Mr. J. R. Beard, of Messrs. Merz and McLellan, gave first a short account of the war-time activities of electrical engineers, and then made many thoughtful comments on the planning of the post-War world. He said that in this War, engineering, technological and scientific problems are playing a greater part than ever before, and that the many branches of electrical engineering have all been directly or indirectly engaged in war activities. The Institution of Electrical Engineers has now the largest membership of any British professional institution. During the past year, the membership has exceeded 20,000 and its responsibilities are correspondingly great. He mentioned particularly the strenuous work undertaken by those engaged in the light current branches. These include such vital services as communications and broadcasting, and the design and manufacture of the apparatus for them and of the similar apparatus for the rapidly expanding needs of the Royal Navy, the Army and the Royal Air Force. In particular, those engaged upon research and development in the multifarious new applications of wireless deserve special record.

Some 1,285 members of the Institution are on active service with His Majesty's Forces, but, unlike the position in the War of 1914–18, almost all of these are engaged in a technical capacity which makes use of their specialized knowledge. The bitter experience of 1914–18, when so much technical talent was wasted through trained men being drafted from productive work into non-technical units, was fortunately taken to heart in good time. Some time before the War broke out, the Ministry of Labour organized the schedule of reserved occupations. On the whole, this has functioned admirably. The Institution has always taken pride in the number of its overseas members, which now amounts to one fifth of the total membership. For many years there have been local centres in the Argentine and China, and there are sixteen local honorary secretaries and twelve overseas committees in many parts of the world. These are an invaluable liaison between distant members and headquarters. Much attention has been given to increasing these contacts with the engineering institutions in the Dominions and India. At a time when the joint defence of our liberties in face of the assault on all free peoples is forging still closer the links of the British Commonwealth of Nations—and indeed of all English-speaking peoples—Mr. Beard reminded members of the Institution overseas that their share in the war-time activities of our various countries is in no way less important than the work of members at home, and that this is recognized and appreciated. Plans for yet closer collaboration after the War are eagerly anticipated.

Early Harbour Engineering

In his presidential address to the Institution of Civil Engineers delivered on November 5, Sir Leopold Saville said that since the branch of engineering with which he had been principally associated was harbour engineering, he proposed to deal with harbours from the dawn of written history to the early days of the Roman Empire. He reviewed first the development of the four harbours of Alexandria, namely that of A-ur, about 3000 B.C.; the great harbour of Pharos, soon after 2000 B.C.; the harbour of Alexander the Great, begun in 332 B.C.; and the modern harbour, A.D. 1870. He then turned to the pre-Hellenic harbours of Tyre. By 1400 B.C. the renown of the city was widespread, and by 1100 B.C. its seamen had passed Gibraltar and had dared the Atlantic. It was probably about that time the Sidonian harbour was built; Hiram, king of Tyre (970–936 B.C.), built the

Egyptian harbour. In Greece, deep bays and long arms of the sea made excellent natural harbours; moreover, Greece was divided into many small States, each with its own port. Athens used first the broad open bay of Phalerum, where ships were beached in sight of the city. That arrangement, however, had several strategical and navigational disadvantages, and in 493 B.C. Themistocles persuaded the Athenians to develop the fine natural harbour of Piræus. At some places artificial harbours had to be constructed, of which that at Eleusis was typical.

The Romans had to face difficult technical problems when their growing commerce demanded effectual shelter. They introduced many new methods, the most outstanding of which were the use of the arch, the cofferdam, hydraulic cement (pozzuolana), and the driving of piles in deep water. The Roman ideal plan was an artificial harbour having the two incurving breakwaters of the Greeks, with the Roman addition of a short protecting mole or island breakwater in front of the entrance. The sand problem caused considerable trouble, and silting drove the Romans from Antium and the Tiber and caused the failure of the harbour of Ostia. Trajan accordingly took measures to provide a new harbour for Rome higher up the coast, which under its modern name of Civita Vecchia is now the principal port of Rome. The Roman Empire was followed by more than 1,000 years of acquiescence, or even retrograde action, in harbour engineering, and it was not until the engineering revival in about the middle of the eighteenth century that such ambitious schemes were again attempted.

Electric Fan Ventilation

The necessity for air-raid precautions and for black-outs has introduced several problems besides that of lighting which have to be studied. In the *Electrician* of October 11 a discussion is given of some important considerations with respect to electric fan ventilation. One attendant result of most of the measures taken for black-out and sandbagging against the effect of bombing is the restriction of the natural air-flow and an increase in the heat dissipation due to augmented lighting. Since it is known that a relatively high proportion of carbon dioxide can be permitted without any ill-effects, in big ventilation systems a large percentage of the air is recirculated in order to conserve the heat. Hence where the volume of air relative to the number of persons concerned is large, an air disturber serves a useful purpose in both summer and winter. In smaller places the most usual method of ventilation under ordinary peace conditions is by exhaust, but it is now common to take into consideration the presence of gas from enemy action, and for such eventualities it is necessary to take in a supply of clean air by means of an intake placed so as to be above the level likely to be contaminated. Complete protection is afforded by first passing the air through a filter.

The number of air changes required in various public buildings is laid down by law, but for offices, shops, factories, etc., the figure depends on the work to be carried out and the types of processes involved. For the average type of office, two to three air changes an hour will be sufficient, for dining-rooms four to six, but for kitchens fifteen to twenty changes may be necessary. Where long runs of ducts are necessary for extracting from a number of rooms, the resistance of the air in the ducts may be more than a propeller fan can deal with, and a centrifugal fan should be used.

Primitive Trepanning

The surgical operation of removing a circular piece of bone from the human skull of the living is one which it has long been known was practised by primitive man with, relatively speaking, some frequency. The practice had a wide distribution in both time and space, ranging chronologically from the early neolithic period to modern times and geographically from many parts of prehistoric Europe (and in historical times in Serbia) to the Pacific. Late prehistoric or early historic examples are known from the Caucasus, Palestine and Siberia, while the practice was frequent in pre-Inca and Inca Peru and Bolivia. In the last-named region, however, there is a possibility that there has sometimes been confusion with a syphilitic lesion. The frequency of a depressed fracture in a stone age culture using the stone axe as a favourite weapon must, obviously, he held responsible for the introduction of the operation; but there is evidence that it was also employed for the alleviation of any violent pain in the head. A variant practised for the relief of headache in New Guinea is drilling with a boco-drill and flint fleam. The appearance of amulets made of circular pieces of bone taken from a trepanned skull, which are among prehistoric finds, points to the infiltration of magical ideas—never long unobserved in primitive methods of healing—and affords an explanation in part for the performance of the operation at or after death.

The uniformity in the technique of the operation, the cutting of a circular groove with a stone implement, or rarely a series of drill holes, or grooved straight lines forming a rectangle—suggests the possibility of its distribution by cultural diffusion. Mr. Stuart Piggott, however, in a study of the practice in prehistoric Europe, to which reference is made on p. 621, holds the view that in its earliest appearances when it is a remedial measure for individual injury it is to be regarded as an independent invention, but that when it becomes a cult —a justifiable reference from the evidence—we are justified in looking for links between instances in which the rite was practised. Working from the early centre of greatest frequency in the Lozère valley of southern France and ingeniously associating the rite of trepanation with megalithic building and the cult of the megalithic goddess, he traces it to the mouth of the Garonne along the line of the Bronze Age trade route along the oolite and to the Paris basin, whence it spread with the SOM culture characteristic of that area in this period.

Primitive Irrigation in South-Western U.S.A.

The south-western regions of the United States of late years have won a prominent place in archæological news as a source of evidence of earliest man, the hunter, on the American continent. It had been known for some considerable time, however, that the arid lands of Utah, Colorado, Arizona and New Mexico were the seat of the so-called Pueblo civilization, which had produced not only the remarkable cliff dwellings found in the Pueblo villages, but also that these villages are among the oldest known agricultural settlements in the United States. There sedentary farmers practised a specialized form of agriculture with maize as its main crop. Notwithstanding the varied topography of these arid regions, the farmers had a common interest and preoccupation —the problem of irrigation. So successful were their methods that, in 1540, when Coronado reached Hawikuh, the most southerly of the "Seven Cities of Cibolu", the villages were able to supply him with sufficient corn to support his three hundred and twenty men and their native carriers for a period of two years.

At this early date, the mode of life and agricultural system had been so long established that not only had early sites of settlement been abandoned on a large scale, but also one of the most important groups of Pueblo villages, that of Mesa Verde Plateau, discovered in 1888 and now a national park, had been given up so long before the coming of the Spaniards that it receives no mention in any of their narratives. The overwhelming importance of rainfall in the life and thought of the early Pueblo peoples may be gauged from the ritual and methods of present-day Hopi and Zuñi tribes, which preserve the tradition, probably with little change, while evidence of the elaborate and skilfully devised irrigation system is still available on the ground as material for a reconstruction (see Nature of November 2, p. 591).

Cancer in an Oil Refinery

The issue of *Public Health Reports* for August 23 contains an interesting paper by William M. Gafafer, senior statistician, and Rosedith Sitgreaves, of the United States Public Health Service, on disabling morbidity and mortality among the male employees of an oil refining company with reference to age, sex and duration from 1933 to 1938 inclusive. During this period a total of approximately 60,000 years of membership for male employees yielded 70 cases of cancer of which 46 were fatal. These cases included five which began in 1932 and ended in 1933, but excluded four which began in 1938 and were carried over into 1939. The cases which did not end in death terminated in recovery or sufficient improvement to return to work. The employees of the oil refinery showed relatively more cancer of the digestive tract than occurred among the total population, while the proportion of cancer of the genito-urinary tract was much less. The two sites—stomach and other abdominal organs—accounted for more than half the cases, and each specific site showed increases with age with respect to both frequency and mortality. For all ages the ratio of cases to deaths was less than 1·2 in three sites, namely, the œsophagus, stomach and other abdominal organs. Cancer of the lung showed the largest average case duration as well as the largest average duration of non-fatal cases.

Vitamin B_1 in Bread

The Minister of Food has appointed the following committee, which includes representatives of the flour milling industry and the baking trade, for consultation with the Ministry on the administrative and technical questions associated with the introduction of synthetic vitamin B_1 and calcium into white flour: Mr. H. D. Vigor (chairman), Mr. Edmund B. Bennion, Mr. W. Bloor, Prof. E. C. Dodds, Mr. T. H. Hodgson, Prof. R. A. Peters, Mr. J. Arthur Rank, Mr. Arthur Robinson and Dr. J. Sword.

Announcements

Prof. D. L. Savory, professor of French and Romance philology, was returned unopposed in Belfast on November 2 as Unionist member for Queen's University in the British House of Commons in succession to Colonel Thomas Sinclair, who resigned after holding the seat since 1923.

Ministry of Transport returns show that 578 persons were killed in road accidents last July as compared with 554 in July 1939. Only 115 of these deaths occurred during the black-out hours, and adult pedestrians and cyclists were mostly affected, 132 and 107 deaths respectively being registered in these groups.

At the annual statutory meeting of the Royal Society of Edinburgh held on October 28, the following officers were elected: *President*, Prof. E. T. Whittaker; *Vice-Presidents*, Dr. Leonard Dobbin, Mr. J. A. Inglis, Prof. R. Stockman, Prof. James Ritchie, Dr. G. W. Tyrrell and Prof. C. T. R. Wilson; *General Secretary*, Prof. James P. Kendall; *Secretaries to the Ordinary Meetings*, Prof. R. J. D. Graham and Prof. W. M. H. Greaves; *Treasurer*, Dr. E. M. Wedderburn; *Curator of the Library and Museum*, Dr. J. E. Mackenzie.

The Council of the University of Leeds, on the recommendation of the Brotherton Collection Committee, has gratefully accepted a bequest by the late vice-chancellor, Sir James Baillie, of his private note-books consisting of twelve volumes of philosophical reflections written during 1894–1937 and entitled "Privatissima", together with other unpublished manuscripts, printed papers and a rare photograph of Hegel. In accordance with Sir James Baillie's expressed wish, the papers will be deposited and kept in the Brotherton Collection Rooms, and no part of the contents of the "Privatissima" will be published within ten years from the time when they came into the possession of the University.

In the paragraph headed "Trephining in Great Britain" in Nature of September 28, p. 433, the reference to a paper on trephining in New Britain is incorrect; the correct reference is "Rev. J. A. Crump and V. Horsley, *J. Anthrop. Inst.*, **31**; 1901".

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. They cannot 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.*

IN THE PRESENT CIRCUMSTANCES, PROOFS OF "LETTERS" WILL NOT BE SUBMITTED TO CORRESPONDENTS OUTSIDE GREAT BRITAIN.

Terminology of Relative Growth-Rates

FOR many years past, biologists have been interested in the rates of growth of parts of organisms in relation to the whole or to other parts. Such ratios were termed by Huxley[1] *constant differential growth-ratios*, and the whole process by Pezard[2] *heterogony*. The process may obviously be either positive, if the relative size of the part increases with time (that is, grows more rapidly than the whole), or negative, if the relative size diminishes (that is, grows more slowly). If it attains an extreme degree, it might be called, in Champy's phrase[3], *dysharmonic growth*. Some authors, for example, Teissier[4] (who, with Needham[5], introduced the application of these concepts to the chemical constitution of the body) at first adopted this usage; but it has not proved acceptable, since, if we liken the organism to a piece of music, the growth of all parts at the same rate would be unison, and their growth at different rates harmony, not disharmony. Later, after the term *heterogony* had come into very general use, Huxley and Teissier[6] proposed its replacement by *allometry* on the ground that heterogony had previously for a long time been employed by sex physiologists to denote a special type of reproductive cycle.

The term allometry was considered by Huxley and Teissier to be advantageous in that it could be applied both to phenomena of growth and to phenomena of proportionate size. Since terminology, which does not distinguish between differences during growth, at any given stage of growth, or after its completion, is bound to lead to ambiguous interpretation in many instances, the advantages of an all-embracing term are doubtful. Furthermore, *heterogony* after all implied something inherent in the developmental plan of the organism, while *allometry* seems to refer only to our metrical methods. Hence we welcome a suggestion to one of us (J. N.) by Dr. Arthur L. Peck, of Christ's College, Cambridge, that for relative *growth*, in contradistinction to relative *proportions*, the word *heterauxesis* should be used, with *isauxesis*, *bradyauxesis*, and *tachyauxesis*, for the three cases formerly known as isogony and negative or positive heterogony. It is true that the terms auxesis, heterauxesis, ectauxesis, endauxesis, etc., were formerly employed in plant physiology[7], but they have long been obsolete there. On the other hand, botanists do still distinguish between *auxesis* or growth by expansion, and *merisis* or growth by cell-multiplication, a usage which enhances the suitability of the term heterauxesis for all dimensional and chemical differentiation.

Comparisons may be made between organisms of the same group differing in age, size, weight, chemical composition, etc.; this is *heterauxesis*. But comparisons may also be made between organisms of different groups (races, varieties, species, genera, and the like) differing in size or other qualities but of the same age, for example, birth or adult maturity. We suggest that the word *allometry* and its attendant *isometry* should be reserved in future for this. In many such cases the Huxley equation holds good; for example, the relation between egg-size and bird-weight (in his book[1]), or the work of Hersh[8] on titanotheres, or Lumer on skeletons of dog races[9], or that of one of us (I. M. L.) on gluathione in different races of rabbits at birth (Lerner, Gregory and Goss[10]). The word *allometry* has been used in a similar sense by Osborn[11], who thus described evolutionary changes in bodily proportions. The co-ordinate distortions of d'Arcy Thompson[12] would thus be said to represent allometric differences. The exponent in the allometric relations may be called the *limiting equilibrium constant* or *ratio* in accordance with the suggestion of Huxley and Teissier[6]. In the case of heterauxesis *actual equilibrium constant* or *growth-ratio* may be used. Similarly, *enantiometry* should be distinguished from *enantiauxesis*.

We venture to hope that these suggestions will be widely approved, and would propose that the distinctive usage of these terms be in future generally adopted. Such a practice would eliminate confusions which undoubtedly occur at present between the two types of comparison.

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Sept. 2.

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Attraction Fields *in Vitro*

In unpublished researches of Fardon, Sullivan and Andrus[1], a series of experiments were conducted showing the outgrowth of cells from traumatized sections of embryonic chicken intestine *in vitro*. It was observed at the time that the new outgrowth of cells aligned itself into uniform patterns. The nature of the outgrowth was analogous to the fields surrounding a bar magnet. This uniform distribution of cells served to indicate a force of attraction between the two portions of outgrowth.

Later, during the course of experiments with embryonic chicken heart, two fragments were introduced into the plasma drop of a slide culture quite by accident. When growth measurements were made eighteen hours later, a peculiar phenomenon was observed in the culture containing the two fragments. A very definite field of attraction was found to exist between the two pieces of growing tissue. Though this attraction field reminded us of the earlier experiments with embryonic intestine, the field itself was made visible through what appeared to be slight differences in the refractive index of the plasma clot. In some respects the rays or streamers in the plasma resembled the iron filing pattern produced by a magnet. Though some cells had already migrated from the tissue fragments, the rays visible between the two pieces of tissue were definitely not composed of elongated fibrocytes and cardiac muscle cells (see Fig. 1).

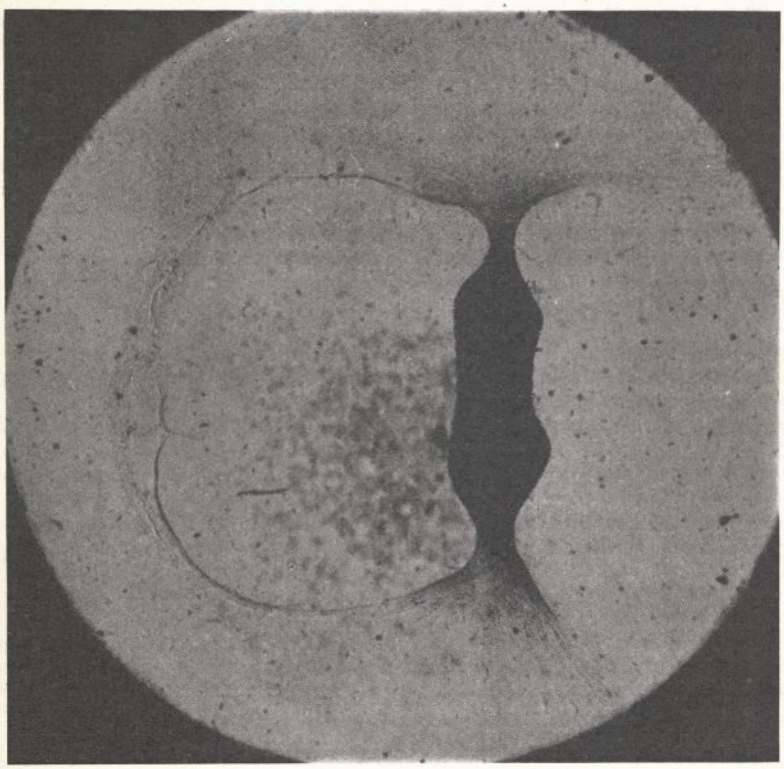

Fig. 2.

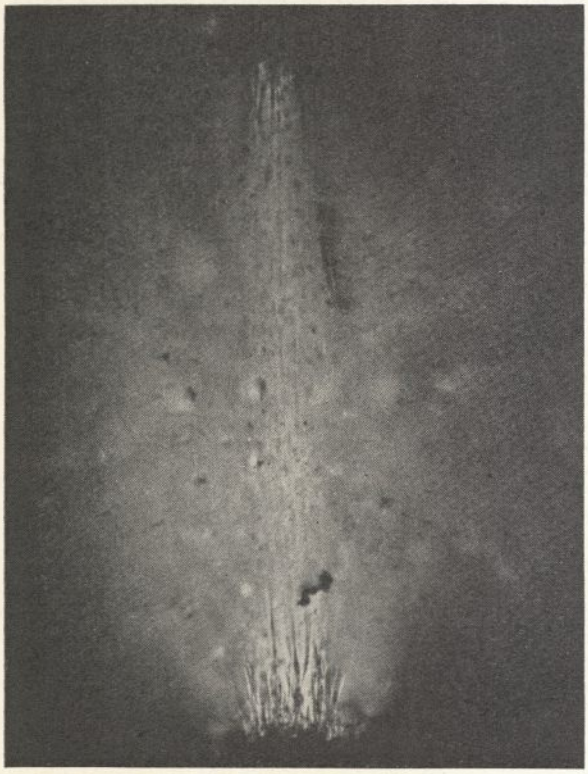

Fig. 1.

A related phenomenon of interest (in some respects similar to the outgrowth obtained with the intestine cultures) was the nature of the subsequent growth pattern within the attraction field. It is well known that isolated fragments of tissue *in vitro* usually exhibit a zone of new growth and migration in a radial fashion, that is, the cells appear to have come from the central portion of the tissue explant and continue thus into the plasma medium; however, in such cases where an attraction field was in evidence between two fragments of tissue in the plasma clot, the uniform radial growth was slightly but decidedly altered. That portion of the outgrowth which lies within the field, or from which the field seems to emanate, does not form a sector of radial growth, but is rather a bundle of elongated cells following the parallel 'lines of force'. As the cultures grow older, fibrocytes proceed from both fragments until the gap within the field is completely filled with the elongated cells.

These attraction fields have also been observed between pieces of embryo skin and liver. The fields have never been detected between a dead and a living tissue.

Though the fields were not nearly as evident nor as numerous, mouse embryo heart explanted in the same medium with chick embryo heart gave indications of a very weak field of attraction.

Though a sufficient number of cultures have not yet been prepared from which to draw conclusions, attraction fields between pieces of adult tissue have not been found.

A total of about 1,500 cultures have been prepared, and among these some 150 definite fields have been observed (Fig. 2. 113-hr. culture, 19-day chick embryo intestine. Plasma Drew).

Whether the attraction fields observed by the authors bear any relation to the plasma fibrin strands produced by Doljanski and Roulet[2] is not yet known. The experimental procedure employed by the latter investigators is quite different from our own in so far that they applied tension to plasma membranes and found cellular growths of explanted tissue oriented parallel to the fibrin strands. In our experiments, tension was not purposely applied to the plasma clot. We feel justified (for the present, at least) in ruling out any tension phenomena in the plasma clot being responsible for the observed fields. If it were a matter of tension, then it would seem reasonable to assume evidence for such in the cultures containing a dead and a living fragment of tissue. This was not found to be the case.

Further investigations are being continued in an effort to discover the true nature of these *in vitro* fields.

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[1] Fardon, J. C., Sullivan, W. A., and Andrus, Sr. M. Basilia, *Studies Inst. Divi Thomæ*, vol. 2, No. 2, 233 (1939).

[2] Doljanski, L., and Roulet, Fr., *Roux's Arch. Entwicklungsmech. Organ.*, **131**, 3, 512–531 (1934).

Occurrence of Xylans in Marine Algæ

When the red alga, *Rhodymenia palmata*, commonly known as 'dilisk' or 'dulse', was immersed in dilute hydrochloric acid for about twenty-four hours, a viscid solution was obtained and, when this solution was poured into alcohol, a white solid was precipitated from it. This substance swelled up and dissolved when put into water. After purification by three precipitations with alcohol, the opalescent solution was cleared by repeated filtration. The substance now had a specific rotation of about −87. On hydrolysis with dilute nitric acid, it yielded crystalline xylose.

This appears to be the first record of the isolation of a xylan from a marine alga, although, about seven years ago, Schmidt-Neilsen and Hammer[1] noted the high yield of furfural obtainable from *Rhodymenia palmata* and estimated the pentosan content of the plant.

Another red alga, *Dilsea edulis*, also gives a highly viscid solution on treatment with dilute hydrochloric acid; but the substance obtained from this by precipitation with alcohol was not hydrolysed to xylose. This substance appears to be an ethereal sulphate similar to those already found in other marine algæ. It yields mucic acid on oxidation with nitric acid.

These substances are being further examined and the results of the investigations will be published elsewhere.

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Average Gestation Period and $n\,\pi$

In a number of instances, average gestation periods seem to differ by a few hours only from $n\,\pi$ days. A few of the more remarkable approximations are:

n	$n\,\pi$	Average gestation period (days)	No. of pregnancies	Animal
10	31·416	31·41	64	English rabbit[1]
36	113·097	113·1 ± 0·12	203	Pig[2]
48	150·796	150·8 ± 0·13	195	Karakul sheep[3]
		150·8 ± 0·19	391	Black Forest goat[4]
49	153·938	154	?	Saanen goat[5]
92	289·026	288·9	428	Simmental cow[6]

Further data are being studied.

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Oct. 10.

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Psychology and Camouflage

Perusal of the interesting article by "J. S. H." on camouflage in Nature of October 12 leaves one rather wondering why the technical staff of the organization described should include artists, engineers, architects, chemists, physicists, photographers, and a botanist, while apparently not a single psychologist is connected with this organization. Surely the problems of camouflage are problems in perception, perhaps the most advanced field of psychological study. The fundamental laws on which camouflage must be based are partly psychological (the Liebmann law, for example, which deals with the relative differentiation due to colour and brightness, or the Wertheimer laws of organization), and it seems reasonable to ask why no use is being made of the vast amount of knowledge available.

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RESEARCH ITEMS

Prehistoric Trepanning in Europe

In connexion with the record of a trepanned skull of the Beaker Period found in a group of round barrows at Crichell Down, Dorset, in 1938, Stuart Piggott discusses the distribution of the practice of trepanning in prehistoric Europe (*Proc. Prehist. Soc.*, N.S., **6**, 1; 1940). The recorded examples show a surprising range extending from Portugal to Sweden and in time from Danubian I to the Scandinavian Iron Age (3000 B.C.–200 B.C.). The great majority, however, are concentrated within a fairly restricted area and period. In the Cevennes, a date round about 1900–1500 B.C. seems likely for the main period. This undated group of megalith builders appears to have affected profoundly the neolithic peasantry of the Paris basin. With the cult of the guardian goddess of the megalith builders of the south also came the cult of ritual trepanning, the deliberate making of holes in the skull of the living for some now obscure purpose of magic or witchcraft. Another related scalp operation was the culling of the sincipital T. With the spread of the SOM culture of the Paris basin the practice of trepanation was also introduced to other regions. The primary reason for the practice was no doubt the alleviation of pain by surgical mean. In this category may be placed the early Danubian cases, those from Scandinavian dolmens, chalcolithic skulls from Portugal and the earlier examples from the Cevennes—all possibly the result of independent invention. When, however, the practice becomes a cult it is legitimate to look for links connecting centres of concentration. Hence the cult may be traced from the Cevennes to the Seine, thence to Sweden and probably to Germany, the intensity of the cult waning in direct ratio to the distance from the diffusion point. In Czechoslovakia the group may owe its origin directly to the beaker people. The English examples are at first sight difficult to fit into a Continental series as a whole. If it may be argued legitimately that the supposedly earliest example of ritual treatment, the Maiden Castle skull, is contemporary with the skull from Crichell, both though in different contexts may be regarded as of Beaker Age as also may the Bisley skull, though derivative from a long barrow, possibly as a secondary interment. The Ovingdean specimen, however, does suggest SOM examples, and having been dredged up may be derived from across the Channel.

Toxicity of Alpha and Fast Neutron Radiation

Robley D. Evans, of the Massachusetts Institute of Technology, described the results of experiments on neutron tolerance in animals in a paper at the annual meeting during April 22–23 of the U.S. National Academy of Sciences. He finds that the results cannot be accurately extrapolated to man because the relative radiation sensitivities are entirely unknown for small doses. Biological effects of neutrons are due to the secondary recoil rays which they produce in the body by collision with hydrogen, carbon, nitrogen, oxygen, and other atoms. The average specific ionization, and hence the ionic effectiveness, of the neutron recoil rays is closer to that of alpha rays than to any other radiation which has been the subject of extensive biological investigations. Data are available from studies of chronic radium poisoning, and of lung cancer produced by radon inhalation, concerning the effects of alpha rays on human tissue. Using these data, it is shown that a dosage of 0·01 r. per day of fast neutrons may be unsafe if the exposure continues over a period of about ten years.

Differential Periodic Theory of Growth

G. F. Sleggs (*Growth*, **4**, 1) derives the high synthetic power of protoplasm from a strained chemical cagework of genar lattices in rotational stagger. An explanation of a number of biological properties is offered in terms of the geometrical relationships arising in such a system; to those dealt with in an earlier paper are added persistence of cell bridges, division of spireme into chromosomes and the disturbance of pigmentation pattern upon salient surfaces. The extension of the staggered genar lattices produces an epigenetic pattern upon the hitherto maintained impossible basis of corpuscular preformation. The author considers that adaptation is an inherent property of the system, on the basis that rotational shift of genes brings morphogenetic gradient components into associations which determine equilibrium patterns; this shift is produced by the environment. The origin of the organism is attributed to the chemical union of lattices via an intermediate framework of amino-acid residues in such a way that the spacing of units does not correspond, producing a differentiated system with equipotential properties of regeneration and regulation.

Photosynthesis and Fluorescence

The rapid method of measuring rates of photosynthesis developed by Dr. McAlister has recently been used in a preliminary survey of the relation between photosynthesis and fluorescene during induction periods by E. D. McAlister and J. Myers (*Smithsonian Misc. Coll.*, **99**, No. 6; 1940). Wheat (var. Marquis) and *Chlorella pyrenoidosa* were used as experimental material. It was found that any sudden changes (in, for example, light intensity, carbon dioxide concentration) producing large increases in the photosynthetic rate cause a 'burst' of fluorescence. When the change is from darkness to high light this burst can be resolved into three parts: (1) the intensity of fluorescence rises to a value about equal to that of final equilibrium ($< 0{\cdot}01$ seconds); (2) a further slow rise (1 second) follows, to a position two or three times higher; (3) fluorescence decays from this maximum to the equilibrium value (1 minute). The simultaneously recorded rate of carbon dioxide assimilation follows a curve inversely related to this. At low oxygen pressures, the curves of fluorescence and rate of carbon dioxide uptake are in fact almost exact mirror images (as to time). In both wheat and Chlorella it appears that the changes in carbon dioxide assimilation during the induction period under normal air conditions are, however, caused by two processes, one inversely (as above) and one directly related to intensity of fluorescence. The dependence of this second type on oxygen pressure, and the observation of greater carbon dioxide uptake under low oxygen pressures, suggest that this second

type of reaction is a photo-oxidation. In Chlorella acclimatized to low carbon dioxide, the photo-oxidation type of reaction predominates. Under steady state conditions following the induction periods, a marked change in fluorescence occurs on passing from light-limiting to carbon dioxide – limiting conditions. The rate of carbon dioxide assimilation in wheat in high light and 0·03 per cent carbon dioxide is 30–50 per cent higher in 0·5 per cent than in 20 per cent oxygen. This suggests that in young wheat a reaction of large proportion opposing photo-synthesis is always active under natural growing conditions.

Smut Resistance and Interchanges in Maize

C. R. Burnham and J. L. Cartledge (*J. Amer. Agron.*, **31**, 924–933; 1939) utilize lines carrying reciprocal translocations to discover the loci of genes for susceptibility of maize to smut. Each line was crossed to a resistant line and the F_1 backcrossed to a susceptible line. Linkages were observed between smut resistance and the interchanges $T_{1\text{-}2c}$, $T_{1\text{-}6a}$, $T_{1\text{-}9c}$, $T_{2\text{-}6a}$, $T_{3\text{-}8a}$, and $T_{6\text{-}8a}$, and probable linkages with other translocations. It is probable that the locus of the translocation breaks in chromosome 2 involved in $T_{1\text{-}2c}$ is linked with smut resistance and that in the remaining cases the break-loci of one or both chromosomes is linked with smut resistance. The procedure to be adopted for analysis by means of reciprocal translocations is outlined.

Polyploids in Cotton

S. C. Harland (*Trop. Agric.*, **17**, 53–54; 1940) has doubled the chromosome number of various cotton species and their hybrids by the use of colchicine. He shows that octoploids have an increased cell size as compared with the tetraploids, but the hairs, while larger, are too weak for economic purposes. On the other hand, synthesis of allotetraploids which will cross with the forms of *G. barbadense* and *G. hirsutumn* will be useful. Since *G. Thurberi* carries immunity to Pink boll worm, the allotetraploid *Thurberi* × *arboreum* is of great economic advantage. Similarly hexaploids raised from the hybrids *barbadense* × *aridum*, *barbadense* × *Thurberi*, and *barbadense* × *Armourianum* give promise of resistance to drought, diseases and insects.

Tertiary Volcanic Rocks of Victoria

A. B. Edwards and W. Crawford have made a valuable field and petrological study of the volcanic rocks which cap the Gisborne Highlands in Victoria (*Proc. Roy. Soc. Victoria*, **52**, 281–311; 1940). The volcanic complex of Mount Gisborne is built up of a series of hypersthene-trachyandesites and hypersthene-bearing basalts in addition to a variety of normal types. The trachyandesites and associated rocks contain more or less resorbed phenocrysts of felspars and hypersthene and also numerous xenocrysts of quartz, presumably derived from the sediments through which the magma had passed. These lavas present the apparent anomaly of a 'tholeiitic process of differentiation' superimposed on the normal (trachytic) process. It is suggested that this local change in the character of the differentiation was brought about by local assimilation of sediments, whereby the parental basaltic magma became saturated with respect to silica. A similar hypothesis has already been proposed to account for the trachyandesites of the Coliban district of Victoria (*Q. J. Geol. Soc.*, **94**, 243–320; 1938). Effective comparison of the suite of volcanic rocks under discussion is made with similar suites from the Circum-Japan Sea Province, Kerguelen Island and Ascension Island.

The Imperial Valley (California) Earthquake

The Imperial Valley earthquake of May 18, 1940, has been classed as fifth in the list of destructive earthquakes in the history of America (*Earthquake Notes*, **22**, Nos. 1 and 2, September 1940). Its direct cost has been estimated at some five or six million dollars, as compared with about twenty-five million dollars for the great San Francisco earthquake of 1906. The epicentre of the recent shock was near Brawley, where considerable destruction was done to parts of the water and sewer systems, though more buildings were damaged at Imperial. Well-constructed steel and reinforced concrete buildings did not suffer so much as the poorly constructed buildings and those made of adobe. An intensity X was reached on the modified Mercalli scale (some well-built structures destroyed, ground badly cracked, rails bent, landslides, etc.). Roads and bridges were damaged and one bridge had to be closed. Direct loss of life was only nine though scores were injured, and the shock was felt over an area of 60,000 square miles. The strong-motion instrumental record at El Centro, California, indicated that the horizontal acceleration of the ground during the earthquake was approximately one third that of gravity at El Centro, though the record is incomplete as the spot of light was thrown off the paper at both sides. At one point in the area the permanent horizontal ground displacement was about 12 ft., and a vertical displacement of 3 ft. has been found. In general, where slippages occurred at the surface, the movement was north-west for the west side of the fault, a condition that generally occurs in Californian earthquakes. A surface fault apparent after the shock could be traced in an almost straight line for more than 40 miles. More than thirty-five aftershocks were felt at intervals over a period of more than a week.

Precipitation of Colloids by Electrolytes

It is known that the concentration of electrolytes required to coagulate hydrophobic sols varies with the sol concentration. Burton and Bishop suggested that the precipitating values of univalent, bivalent and tervalent ions increase with, are independent of, and decrease with the sol concentration, respectively. Ostwald introduced the rule that the activity co-efficients of various precipitating ions are constant at their precipitation values. H. B. Weiser and W. O. Milligan (*J. Amer. Chem. Soc.*, **62**, 1924; 1940) in an investigation of relatively pure sols of copper ferrocyanide, ferric oxide and arsenic trisulphide have shown that neither rule has any general validity. The slope of the precipitation value – sol concentration curve depends upon the adsorbability of the precipitating ions, the stabilizing effect of the adsorption of ions of the same sign of charge as the sol, and the purity of the sol. Burton and Bishop's rule may be restated in the form that for a given sol the *proportionate* increase in stability towards precipitating electrolytes or dilution is in general greater for electrolytes with univalent precipitating ions than for electrolytes with multivalent precipitating ions, and is greater the higher the purity of the original sol. Ostwald's rule did not apply to the observations at any concentration of sol.

PRACTICAL ASPECTS OF EARTHING

In the October issue of the *Journal of the Institution of Electrical Engineers* the important joint paper compiled by E. Fawssett, H. W. Grimmitt, G. F. Shotter and Dr. H. G. Taylor, on practical aspects of earthing, is published in full, together with the relevant discussion of the Transmission Section.

Particular attention is given to the methods of earthing the networks of supply stations so as to prevent dangerous high potentials occurring at any point. According to the definition given in the Electricity Supply Regulations, "connected with earth" means connected with the general mass of earth in such a manner as will ensure at all times an immediate and safe discharge of energy. The authors say that it is sometimes found that it is difficult to make a connexion with the general mass of earth in such a way as will ensure at all times a safe discharge of energy, depending as it does on the conductivity of the soil and the position of lakes, rivers, etc., in the neighbourhood.

In the discussion, Mr. J. F. Shipley appreciates the authors' suggestion that engineers should use geological drift maps, but points out that they have to be used with care as they are always made on a very large scale. With regard to the subject of rainfall, he said that in Great Britain it is very satisfactory from the point of view of earthing; there is plenty of it all the year round but not too much. Mr. Shipley has had experience of countries where the annual local rainfall is 400 inches and it nearly all falls within two or three months; the rain is so heavy that it sometimes completely washes the earth connexion away. The rain water is itself of very low conductivity, and as it falls in such quantity it acts as a leaching agent and washes all the conducting salts out of the soil, so that although the soil is soaked with the water in the wet season, it is still a bad conductor.

Figures are quoted bearing on this point. The condensate in a modern turbo-generating station has a conductivity figure (the reciprocal of megohms per cm. cube) of about 2. London rain water has a conductivity figure of about 390, and Glasgow water of about 120. Manchester water, one of the softest on record, has a conductivity figure of 48, and sea water a figure of 50,000. In one case Mr. Shipley found the conductivity of the water to be of the order 18; this was after six months storage in a reservoir and a five or six mile journey along a river bed. He estimates that the original conductivity figure was about 10. When, therefore, heavy rainfall occurs in atmospheres that are comparatively free from dust and pollution, the rain water is an almost perfect insulating material. He found this out in a practical way by trying to test a 6·6 kv. alternator on a testing tank. Ordinary water from the hillside was used, and it was found that with electrodes in water three feet apart there was not the slightest sign of current passing between them.

A case was also described where considerable damage was done by lightning to a lead-covered cable in the dry climate of South Africa. The cores were repeatedly damaged by discharges within the cable which coincided with lightning strokes striking the ground some distance away. In Great Britain we are accustomed to think that if lead-sheathed cable is buried in the earth, the conductor inside is safe from external discharges, but this incident shows that this is not the case. Owing to the dryness and high resistivity of the soil, the earthing secured by the cable being buried was insufficient; and the cable is now being additionally earthed at intervals by pipe-earths.

Mr. P. B. Frost pointed out that telephone cables are damaged by lightning in Great Britain as well as in Africa. In one case, a long main underground cable not connected in any way with overhead lines developed about ten faults distributed over some miles, due to lightning discharge between the sheath and the conductors.

THE ACOUSTIC AIR-JET GENERATOR

In 1916, Prof. Hartmann, of Copenhagen, while exploring with a Pitot tube the distribution of total head in a high-speed jet of air, observed that the pressure along the axis of the jet underwent a cyclic variation with its distance from the discharge nozzle. This so-called Pitot curve, shaped like a sine wave of diminishing amplitude, comprises successive wave-lengths along which the pressure is alternately falling and rising. It was found that the intervals of rising pressure were unstable. When, for example, the pressure over these regions was explored with a wide Pitot tube, unstable readings were obtained, indicating that the air in the jet alternately entered and was discharged from the tube with a regular frequency. The same phenomena occurred when the open end of a hollow vessel or oscillator' was mounted in a rising pressure of the air jet, the result with this arrangement being the production of vigorous sound waves varying in frequency according with the volume of the oscillator and the size of its open end.

In *Engineering* of October 18, it is stated that Prof. Hartmann has spent several years in developing an acoustic sound generator based on this principle. In his researches he has been assisted by three other physicists and supported financially by Danish endowments. The generator was described and demonstrated by Prof. Hartmann at the Blackpool meeting in 1936 of the British Association.

The final account of Prof. Hartmann's work, now issued in English as No. 4 of the Ingeniorvidenskabelige Skrifter (Akademiet for de Tekniske Videnskaber ok Dansk Ingeniörforening), covers a good deal of experimental research hitherto unpublished

in English, and presents complete data and theoretical analyses immediately useful to research workers in acoustics.

It appears that the fundamentally scientific aspects of the generator and its mode of operation have been adequately covered. Except for its obvious utility as a source of controllable sound for acoustic research, the authors in this paper put forward no specific suggestions for applying it usefully in engineering or other industries, although in previous accounts they have discussed its possibilities for precipitating smoke and dust in the atmosphere and for producing supersonic vibrations which might be employed for testing the quality of materials. Its potentialities as a means of communication and for transmitting supersonic energy through the air will also warrant the closest consideration. But over the audible range of frequency the Hartmann generator is faced with the opposition of a host of already firmly established competitors. The article concludes by saying that the reticence of the inventors on new ways and means of augmenting the sufferings of a noise-tormented world has much to commend it.

FEMALE SEX HORMONES*

The Ovarian Follicular Hormones

By Prof. E. A. Doisy, St. Louis University

THE ovarian follicular hormone, manufactured in the ripening follicle of the ovary, is one of the so-called œstrogenic hormones—chemicals which cause the female to exhibit mating behaviour. In the human and in other animals the œstrogenic hormones prepare the lining of the uterus for the reception of the fertilized egg, stimulate the development of mammary glands, and at the time of birth activate the womb.

Of more practical interest, however, are the remarkable therapeutic benefits obtained with these hormones in a variety of conditions. Some of the most striking results have been achieved in ameliorating the effects of the menopause and in correcting various disorders associated with the sex cycle.

Doisy and associates were the first to isolate an œstrogenic hormone in crystalline form in 1929. The substance, which was called theelin, was extracted from human urine. Later it was isolated from numerous other sources.

While theelin is produced in the ovaries and, during pregnancy, in the placenta, the hormone is much more easily extracted from the urine. The first yield from this source was only 1·5 mgm. It was not until 1935 that Doisy, MacCorquodale and Thayer were able to extract the œstrogenic hormone from the organs themselves, and in this work they used four tons of ovaries from sows. It took two years to obtain enough of the pure compound for thorough chemical and biological characterization, for the concentration existing in the swine ovary was only 6 mgm. per ton, or about one part in 150,000,000. The pure material was named α-dihydrotheelin, differing from theelin only in the addition of two more hydrogen atoms. In obtaining the substance from human material, one worker used 702 full term placentas, which were obtained at childbirth and which weighed altogether a half ton.

Prof. Carl Bachman synthesized theelin in 1940 from simple organic compounds, an achievement which may be described as one of the outstanding accomplishments in the sex hormone field. This and other œstrogenic hormones prepared synthetically are so much cheaper than the products obtained by necessarily tedius extraction of the natural material that the therapeutic use of the compounds is increasing.

Toxic effects are, however, reported by some physicians using synthetic hormones, and it is to be hoped that chemists may be able to remove the toxicity without producing loss of the œstrogenic property.

The Gonadotropic Hormones

By Prof. P. E. Smith, Columbia University

Intensive study of the interaction between these particular members of the endocrine system, namely, the pituitary and the sex glands, began about thirteen years ago, when it was discovered that the sex glands were not independently functioning organs but were dependent upon some unknown but essential *X*-substance for their maintenance. It was next revealed that this *X*-substance which stimulated the sex glands was supplied by the anterior lobe of the pituitary gland (also known as the anterior hypophysis).

In rapid succession three rich sources of gonad-stimulating (gonadotropic) substances were found. One was the urine of pregnant women. One was the urine of women who had had their ovaries removed or who had passed the menopause. The third was the blood serum of pregnant mares. The effects of these substances were observed not only by clinical use in various disturbances of the normal cyclical behaviour of the female sex glands but also in laboratory tests upon animals—principally rats and monkeys—the pituitary glands of which had been removed.

One of the early complications in this study was the fact that all species do not react identically or even similarly. Also extracts of pituitary glands from various species of animals gave different responses on one species of test animal. These differences early gave rise to the concept that the somewhat different effects were due to the presence of more than one gonadotropic hormone in the pituitary.

In 1931, Dr. Frederick L. Hisaw and Dr. H. L. Fevold, of Harvard, announced they had obtained two gonadotropic fractions from the pituitary gland of the sheep. One they called the *FSH* (follicle stimulating hormone) and the other became known as the *LH* (luteinizing hormone). According to their theory, which was supported by several other workers, the *FSH* causes growth of the follicle in the ovary. The œstrogenic hormone of the follicle in turn influences the pituitary and causes secretion of the *LH*. When the two pituitary hormones are in proper

* Substance of a symposium held at the Bicentennial Conference of the University of Pennsylvania on September 18.

balance, ovulation occurs and then the *LH* causes formation of the corpus luteum, the yellow body which fills up the place formerly occupied by the ovum before it was extruded by the erupting follicle.

A number of recent researches have cast doubt on the existence of these two separate gonadotropic hormones of the pituitary, and suggest that the different types of response in the test animals may be due to the differing rate of absorption of the hormone.

The maintenance of the gonads is complicated even if it is effected only by a single gonadotropic hormone and if only one sex and one species of animal is considered. If it is due to two hormones the situation becomes very much more complex. Although some thirteen years have elapsed since the subject began to be intensively studied, nevertheless it appears that little more than a start has been made in securing an understanding of the many factors involved.

EXACT SCIENCE IN ANTIQUITY*

CONTACT between highly different cultures apparently gave the impetus to important developments in the early history of the exact sciences, namely, mathematics and astronomy. The development of exact science cannot be adequately described as a systematic step-by-step progress. In any event where we are able to disclose the conditions of essential new development, the contact between highly different cultures appears to give the initial impetus. On the other hand, 'culture' is in itself equivalent to tradition, which unifies large groups of populations into a common type of opinion and action. However, the same force, tradition, which defines a culture as an individual being, becomes an increasing impediment to further independent development and creates the long periods of 'dark ages', which cover by far the largest part of human history.

The mathematical texts of the First Babylonian Dynasty, that of King Hammurabi (about 1800 B.C.) treated elementary geometrical problems in a very algebraic form. This rise of the abstract representation in mathematics may be attributed to a historical event, the complete replacement of the Sumerians by the Semitic population.

The Semites, coming into the land of the Sumerians, began to write their own Semitic language with the Sumerian picture script. The Sumerians used a single sign for a single concept (ideograms). The Semites took the signs and used them in two different ways : first, in their old sense as representations of single concepts, and secondly, as pure sound symbols (syllables) for composing their own words phonetically.

Using the symbol to represent a single concept corresponds in the field of mathematics exactly to our algebraic notations. Instead of writing 'length' with six letters, for example, it was sufficient to write a single letter 'L', or instead of writing out 'plus' or 'addition', it was sufficient to use one single sign +.

Evidently the idea of this algebraic form of mathematics occurred to the Semites when they saw the single symbol or ideogram form of writing alongside their own phonetic system. We see here again how an entirely unconscious external influence caused the second fundamental invention of 'Babylonian mathematics', the 'algebraic' notation. Without such a deep linguistic difference such a powerful instrument as ideographic notation for mathematical operations would never have been introduced, as the parallel with Egypt clearly shows.

An atmosphere of general learning conducive to improvement along many lines of scholarship and science was created by the necessity of translating the language of the original occupants of this section of Mesopotamia to that of the new rulers. Systematic philological schools were created, and their existence is recorded by the large collections of word lists, grammatical rules, etc., used in the translation of Sumerian to Semitic.

Later in the history of Babylon, when it was conquered by the Assyrians, who constructed a powerful kingdom reaching from Persia to Egypt, politically powerless Babylon became an admired cultural centre of a world-wide empire, comparable to the position of Rome in medieval times. Persian priests, Jews, and Greeks lived in Babylon, and used Aramaic as an international language. There arose competition between the national cultures, for example, Zarathustra, Abraham and Pythagoras were each proclaimed as the inventor of all science and creator of astronomy, astrology, and number-wisdom, and each group asserted itself to be the oldest and consequently the teacher of mankind. This atmosphere of intellectual competition stimulated further development of Babylonian astronomy. This new astronomy was based not on old observation of miraculous exactitude, as usually pretended, but, on the contrary it reduced the empirical dates to the utmost minimum, mainly period relations, which are easy to observe and almost unaffected by the inexactitude of single instrumental observations.

Ptolemy (100–180 B.C.) was one of the greatest scholars of all times. High tribute should be paid to the supreme mastership and independent judgment exhibited in Ptolemy's "Almagest" on mathematical astronomy, his "Tetrabiblos" on astrology, and his "Geography".

The main school of geographers, however, did not follow Ptolemy, but preferred general descriptions of different regions and their population to the more fundamental problem of exact mapping, which involved astronomical observations for determination of geographical position. This tendency toward popular representation was one of the main reasons for the rapid decline of ancient exact science, and it finally created the race of commentators, who killed any kind of independent thinking with their tedious explanations of every little step.

The sexagesimal system of the Sumerians, in which the unit represented powers of 60, such as 60 itself, 3,600 or 1/60 is worthy of note. (We have a remnant or suggestion of the sexagesimal system in our clock dial of 60 seconds to the minute and 60 minutes to the hour.)

The Sumerians at first represented the units of different powers to 60 by a difference in size of the symbol, but later this careful notation was omitted, and 'place value' notation was initiated, the ancestor of our present decimal number system.

* Substance of a paper read by Dr. Otto Neugebauer at the Bicentennial Conference of the University of Pennsylvania on September 17.

WORK OF THE IMPERIAL INSTITUTE

By SIR HARRY LINDSAY, K.C.I.E., C.B.E.,
DIRECTOR, IMPERIAL INSTITUTE

DR. COLLINGE'S account, published in NATURE of October 19, p. 526, of the work of the Philadelphia Museum shows that it follows lines closely analogous to those adopted by the Imperial Institute in the display of raw materials (in our case, of the British Empire) and the 'story' of their transformation to finished goods. The Institute is also a bureau of technical information based not only on investigations carried out in our own laboratories but also on information available from technical and trade journals in all languages.

Unfortunately, our exhibition galleries and cinema have had to be closed under war conditions. We still continue, however, to send films of the Empire on loan to schools and societies throughout the United Kingdom. In place of our series of lectures on the overseas Empire, which used to attract many hundreds of school parties to our cinema, we have adopted a scheme whereby a panel of Empire lecturers is made available to primary and secondary schools in reception areas. Our latest development is to try to transfer, with the help of our artists, the 'story' of the transformation of raw materials into finished commodities from showcases in our galleries to posters which will be made available to schools together with lecture notes to accompany them.

With regard to our technical intelligence bureau, the Institute's staff includes tropical agriculturists, chemists, chemical technologists, economic botanists, economic geologists, mining engineers, mineralogists and statisticians, all of whom are expert in their particular subjects. When desirable, the Institute seeks the advice of members of its fifteen consultative committees, which comprise authoritative professional and business men. Further help is also afforded by numerous trade contacts.

The Institute also has an extensive reference library and a technical index covering most of the relevant trade and scientific publications issued during the past thirty years.

Examples of the type of inquiry dealt with at the Institute include the following: Inquiries relating to sources of supply of raw materials and semi-manufactured products whether of animal, vegetable or mineral origin in all countries; inquiries relating to the marketing of overseas products; detailed statistics of production, consumption and trade in all countries; questions concerning the normal uses of all raw materials and most semi-manufactured products and discussions concerning possible new or alternative uses; inquiries concerning the specifications as to qualities and types of raw materials necessary for various purposes; questions arising out of a desire to substitute one commodity for another; details of the methods employed in the cultivation of crops and the soil and conditions under which they have to be grown; details of the methods employed in mining, smelting and dressing minerals for the market; methods of processing and preparation for the market of animal and vegetable products, and particulars of machinery and equipment used for these purposes; details of the location and plant capacity of works at which smelting or refining or other processing is carried out; analysis and testing of samples of raw materials in the laboratories of the Institute.

FORTHCOMING EVENTS

Monday, November 11

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 3 p.m.—Dr. Dudley Stamp: "Productivity and Classification of Land in Britain".

Wednesday, November 13

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 1.45 p.m.—Dr. K. G. Fenelon: "Some Problems of Wartime Labour Management."

Thursday, November 14

PHARMACEUTICAL SOCIETY (at 17 Bloomsbury Square, London, W.C.1), at 2.30 p.m.—Prof. A. Fleming: "Antiseptics in Wartime Surgery".

Friday, November 15

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (in the Mining Institute, Newcastle-upon-Tyne), at 6 p.m.—Dr. G. S. Baker: "Vibration Patterns of Propeller Blades".

APPOINTMENTS VACANT

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

TWO GRADUATES IN ENGINEERING at the Ipswich School of Engineering—The Secretary for Education, Tower House, Ipswich (November 13).

HEAD OF THE ELECTRICAL ENGINEERING DEPARTMENT at the Chesterfield Technical College—The Clerk to the Governors, Technical College, Infirmary Road, Chesterfield (November 16).

HEADMASTER OF THE SHIPLEY ART SCHOOL AND HEADMASTER OF THE SHIPLEY TECHNICAL INSTITUTE (combined appointment)—The Secretary to the Managers, West Riding County Council, Town Hall, Shipley (November 20).

TRAINED GRADUATE ASSISTANT MASTER TO TAKE CHEMISTRY, and ASSISTANT MASTER FOR ENGINEERING SUBJECTS—The Head Master, The Modern School, Cole Street, Scunthorpe, Lincs.

REPORTS AND OTHER PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

East African Agricultural Research Station, Amani. Annual Report, 1939. (Colonial No. 180.) Pp. 26. (London: H.M. Stationery Office.) 6*d*. net. [2210

Wool Industries Research Association. Animal Fibres of Industrial Importance: their Origin and Identification. By A. B. Wildman. Pp. 28+23 plates. (Leeds: Wool Industries Research Association.) [2310

Other Countries

Indian Forest Records (New Series). Silviculture, Vol. 3, No. 8: A Note on the Artificial Regeneration of the Dry Fuel Forests of the Madras Province. By A. L. Griffith. Pp. vii+291–322. (Delhi: Manager of Publications) 1.14 rupees; 2*s*. 9*d*. [1410

Indian Association for the Cultivation of Science. Annual Report for the Year 1939. Pp. 44. (Calcutta: Indian Association for the Cultivation of Science.) [1410

U.S. Department of Agriculture. Miscellaneous Publication No. 354: A Review of the Parasitic Wasps of the Ichneumonid Genus *Exenterus* Hartig. By R. A. Cushman. Pp. 15. (Washington, D.C.: Government Printing Office.) 5 cents. [1510

Proceedings of the American Academy of Arts and Sciences. Vol. 73, No. 13: Four Hundred Word Chin Tan of Chang Po-Tuan; Three Alchemical Poems by Chang Po-Tuan; Shih Hsing-Lin, Disciple of Chang Po-Tuan and Hsieh Tao-Kuang, Disciple of Shih Hsing-Lin; The Secret Papers in the Jade Box of Ch'ing-Hua, and A Fifteenth Century Chinese Encyclopedia of Alchemy. By Tenney L. Davis and Chao Yun-ts'ung. Pp. 371–400. 1 dollar. Vol. 73, No. 14: Gyromagnetic Ratios for Ferromagnetic Substances; New Determinations and a New Discussion of Earlier Determinations. By S. J. Barnett. Pp. 401–456. 1.75 dollars. (Boston: American Academy of Arts and Sciences.) [1510

Canada: Department of Mines and Resources, Mines and Geology Branch: Bureau of Mines. Talc, Steatite and Soapstone; Pyrophyllite. By Hugh S. Spence. (No. 803.) Pp. vii+146+8 plates. (Ottawa: King's Printer.) 50 cents. [1510

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