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

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THURSDAY, OCTOBER 28, 1915.

THE UNIVERSITIES AND WAR ECONOMY.

MUCH anxiety has been caused in the educational world by the circular of date July 28 from the Lords Commissioners of the Treasury to those universities and similar institutions in Great Britain which are in receipt of Government grants. In consequence partly of this circular, and partly of the general need for economy in the expenditure of public funds, a letter of date August 26 has been addressed to the joint secretaries of the Committee on Public Retrenchment by the Vice-Chancellors of the four northern universities (Leeds, Liverpool, Manchester, and Sheffield).

The danger which threatens our universities is the more imminent because the Treasury circular appears to take a quite reasonable view of the situation. In consequence of the loss of students due to their enlistment, the colleges have suffered from a serious reduction both in the size of the classes and in the income received from fees. To compensate for the latter loss special supplementary grants were given to them last year. It is pointed out by the Treasury authorities that if these special grants are to be continued throughout the war, however prolonged, and all the institutions so aided are to be allowed to remain open, however low the attendance of students may be, the burden on public funds—which would increase progressively as young men continue to enlist—might prove ultimately to be very great and out of all proportion to the educational benefits conferred on the community. Acting on this assumption, the circular foreshadows a possible very considerable reduction in the amount which Parliament is to be asked to vote in the future. It is suggested that savings might be effected not only by leaving all vacancies unfilled (we understand that the University of London is to remain without a Principal on this account), but also by temporary suspension of institutions, classes, departments, or hostels where the attendance falls below a certain level, the staff thus released being provided with suitably remunerated work of some other kind more directly useful in the present emergency. The colleges are also asked to submit an estimate of their probable expenditure and revenue, and to point out the directions in which they are able to effect further savings.

If the efficiency of universities could be measured by the number of students that they turn out, there might be a valid justification for the opinions expressed in the Treasury circular. But the war by which Germany now seeks to cripple Great Britain, and the successful war which Germany has been waging against our commerce for the last quarter of a century without opposition, have placed on our Universities a burden of national responsibility which cannot be measured by mere numbers of students. There has probably been no period in the history of our country when so great a demand existed for enterprise and activity in our universities as during the present national crisis.

The letter of the northern universities affords a conclusive reply to the Treasury circular. It is accompanied by a statement of the active work which the colleges have undertaken in connection with the war. This statement is of a confidential character, but it may here be safely stated without any risk of assisting the enemy that it includes practically every branch of pure and applied science. In addition statistics are given as to the numbers of staff and students serving with the colours or engaged in munition work.

It used to be said that England's battles were won on the playgrounds of the great public schools, and it is still true that these are largely responsible for the magnificent performance of our men in the trenches. But it is equally true that Germany's war against the allied European Powers has been waged in the laboratories of the German universities. It is now being recognised that this is a war of brains and science. It is sufficiently unfortunate if the supply of scientifically trained students be reduced at the present juncture, but it will be still more unfortunate if a check is placed on their future activities, which would probably have a permanent and cumulative effect on our national development. If England is to win this war, England must also be prepared to maintain a struggle for power, which will certainly not cease with the conclusion of hostilities. We have heard much talk about "silver bullets," but Germany's silver bullets have to a large extent been supplied by Great Britain in exchange for chemical and optical goods and dyestuffs.

The contingents of the Officers Training Corps of the northern universities have already contributed more than 1000 officers to the Forces, and similar contingents have been furnished by other modern universities. It has been abundantly shown by the statements received from past students that they have found their university training of the greatest possible value in the field. There can be no better preparation for the exigencies of modern warfare than a first-year course in physics, chemistry, and mathematics, varied in some cases by medical and biological studies, and if this course can be followed by a second-year course including physical applications of the infinitesimal calculus, so much the better. It is true that we have military colleges, but the instruction in these would appear to be carried on by rule-of-thumb methods to a greater extent than in our universities, and therefore less calculated to produce the type of individual who can think and act in an emergency.

But all modern university colleges are largely attended by women, and with a growing demand for women's work in posts hitherto occupied by men, some increase in the numbers of these students may be anticipated. In any case, it would be a fatal misfortune if anything were done which could in any way interfere with this side of the university work.

Even if our colleges were entirely depleted of their students, there would still be grave objections to a proposal for disestablishing and disendowing them. The claims of the professor who lectures only six or eight hours a week and devotes the rest of his time to research are very well put forward by Prof. Grant Showerman in the *Popular Science Monthly* for June, 1915, in an article entitled "The Liberal Arts and Scientific Management." A professor may receive fourteen dollars for every hour that he is down to lecture in the time-table, but it is pointed out that his connection with his work never ceases throughout the day or the year, and when this is taken into account his princely salary reduces to about 1.2 dollars per hour for expert service in a profession requiring unusually protracted preparation and involving social relations with the best paid classes of the community.

As soon as lectures are over, the average professor devotes his attention to research, and not only does he receive no remuneration for this work, but he frequently pays the cost of apparatus or publishes books at his own expense. Not only in the northern universities, but also in nearly every other university in the kingdom, laboratories and college staffs have been generously placed at the disposal of the Government. While the nation is paying high wages for unskilled labour, it is not only paying nothing for assistance the value of which may be reckoned in millions, but it is even receiving income tax and other dues from the donors at a rate calculated in many cases to place considerable anxiety on their shoulders.

The reason why the college professor engages in research, even at the risk of stinting himself and family in the necessities of life, is that he cannot help himself. He has an object to perform, and his happiness depends mainly on its accomplishment. It is certain that a falling off, should such occur, in the amount of class work would lead to an increased amount of research at a time when that research is urgently needed by the Government—more urgently needed than the Government or any similar body can possibly appreciate. Not only are mathematics, physics, and chemistry needed in connection with such varied applications as aeroplanes, wireless telegraphy, poisonous gases, periscopes, and explosives, but entomology, leather-making, economics, modern languages, botany, law, and history all have their uses in connection with the war.

The suggestion that certain members of the college staffs should be released and that they should be asked to find temporary paid work elsewhere, is one that ought only to be carried out with extreme caution. At the present time many professors and lecturers have undertaken temporary military or other duties, and the colleges are already effecting savings by the amounts of the salaries thus set free. It would thus appear that the system has already been adopted on a voluntary basis by the college staffs themselves. It is not evident from the circular whether, and if so how far, the Treasury contemplates the possibility of exercising pressure in the same direction, but we should be sorry to think that it has any desire to do so. Such an attempt would necessarily involve one of two alternatives, either "putting a round man into a square hole"—in which case good-bye to all the usefulness of his work, perhaps an irreparable loss to the community—or payment for research.

Now it would undoubtedly be of great advantage that persons engaged in valuable investigations should receive some compensation for the loss of income they may incur in carrying on the work. But it would be quite impossible for any Government at the present time to carry through any scheme which Labour leaders would distort into a proposal to put money into the pockets of the "idle rich." Even if this difficulty were overcome, payment for research would be sure to be made conditional on a clear statement being made as to the results aimed at and the practical uses to which they were to be applied. Now the main essence of research is that something has to be found out, the result of which is unknown, and it cannot be possibly anticipated at the outset what practical applications may arise. Any attempt to place this work under a system of Government control and inspection would involve the exclusion of the important class of investigations which leads to the most novel and far-reaching results.

Our universities are straining their resources to the utmost in the effort to keep down expenditure. Where members of their staffs have gone on active service (in some departments to the extent of above fifty per cent.) their work is being cheerfully taken over by their colleagues. Not only are building operations being suspended (and this is probably a wise precaution for many reasons), but the purchase of books and apparatus is being reduced to the bare minimum.

The extra work undertaken by the remaining members of the staffs is only reduced in a very slight degree by the falling off in students. So long as a certain number of *classes* have to be held, a difference in the numbers of each class does not make a great difference in the work. The strain is bound to make itself felt sooner or later. But there are noticeable cases in which the effort to secure economy appears to have been carried too far. It cannot be desirable in the public interest that vacancies in two such important departments as physics and chemistry should remain unfilled, and we believe that it is in the interests of the Government, instead of bringing pressure on the universities to effect further economies, rather to exert its influence in checking them from going too far.

The four Vice-Chancellors of the northern universities are to be congratulated on the strong case they have made out. The matter is, however, one which affects all the modern institutions of university rank, and several of the statements in this article have been derived from independent sources. We hope that the action which is now being taken will prevent a mistake being made which must inevitably lead, sooner or later, to the realisation of the ideals of German militarism at the expense of Great Britain.

OLD-FASHIONED NATURAL HISTORY AND NEW-FASHIONED BOTANY.

(1) *The Hundred Best Animals.* By Lilian Gask. Pp. 304. (London: G. G. Harrap and Co., 1914.) Price 7*s.* 6*d.* net.

(2) *True Stories about Horses.* By Lilian Gask. Pp. 266. (London: G. G. Harrap and Co., n.d.) Price 3*s.* 6*d.* net.

(3) *The Human Side of Plants.* By Royal Dixon. Pp. xix+201. (London: Grant Richards, Ltd., 1915.) Price 7*s.* 6*d.* net.

(1) THE stories of a hundred animals of distinction are told to two children by a veteran who had been a mighty hunter in his day, and good stories they are. He talked mostly about mammals—lion and tiger, seal and walrus, elephant and ape, camel and llama, antelope and deer, sloth and ant-eater, kangaroo and duckbill. But, like Solomon, the veteran spake also, in the last five of the twenty-nine chapters, "of fowl, and of creeping things, and of fishes." We are not sure that Solomon would always have agreed with him; for instance, about the water reservoirs in the camel's stomach; or as to the advisability of telling children that wise folk think the tallest animal in the world has lengthened out its neck by so much reaching; or that "squirts out" is the right word to use in regard to the exudation of toad's poison. But there is no doubt that the book is one which children will thoroughly enjoy and also profit by.

The talks are natural, interesting, instructive, with fresh news to tell, and with no tiresome "writing down." Just now and again the old Nimrod nods a little; for instance, on the last page when he says, in a way quite unlike himself: "We come to understand the highest examples of the different animals—call them best if you will—by comparing them with others of the same species below them in the scale, whether of physical strength and beauty or intelligence." He was also nodding when he said that the heron "is very scare in England now." But these are trivial matters; the important fact is that this is a thoroughly sound and successful book to be cordially recommended. It is adorned and illumined by a hundred excellent illustrations—often strikingly alive—from original photographs by A. F. W. Vogt.

(2) The second book from the same pen is also intended for young readers. It contains many well-told true stories about horses. We are told of the doctor's horse that defended its sleeping master; of the horse that fought and defeated the wolves it had been left to satiate; of an Arabian horse that twice saved a soldier's life; of a number of mares, some past foaling, which combined for six hours to lift the foals above the level of a flood; of a Shetland pony that saved a child from drowning; of a horse that kept a long vigil over a dead soldier; of another that lifted a little child out of harm's way, and of many more besides. As will be seen from the examples cited, the stories are of a homely, old-fashioned type, and we

are not surprised to find no reference to the "thinking horses" of Elberfeld. There are effective illustrations, and the printing of both books is such as suits both young and old eyes.

(3) Mr. Dixon has the courage of his anthropomorphism, which is of the deepest dye. For he maintains that plants "see, hear, taste, feel, walk, swim, run, fly, jump, skip, hop, roll, tumble, set traps, and catch fish; decorate themselves that they may attract attention; powder their faces; imitate birds, animals, serpents, stones; play hide and seek; blossom underground; protect their children, and send them forth into the world prepared to care for themselves—indeed, do all those things which we ourselves do. We now know that plants have even minds and souls, with which to think and to worship."

This is partly a rebound from a *hortus siccus* botany, partly an uncritical vitalism, and partly a somewhat saddening illustration of the lack of critical balance. Saddening, we call it, because the author has a fine series of most interesting facts to set forth concerning the intense vitality of plants, their movements, their sensitiveness, their adaptations, and their purposiveness (we do not say purposefulness), and yet he has gone and queered his pitch with an intolerably anthropomorphic and sentimental phrasing.

No one can be very enthusiastic over the botanist's terminology of chemotaxis, heliotropism, nyctinastic movements, and the like, but there should be some middle way between this and talking, as Mr. Dixon does, about the activities of plants as if they were on a plane with our own. We do not blame the author for regarding plants as psycho-physical beings—which seems to us a position which can offer a strong defence—nor even for speaking, if he wishes, about their senses (seven in number) and experiments, their "mentality and spirituality"; we blame him for leading the unwary to think that plants tackle the business of life on anything like human lines. For this will have to be unlearnt. Theirs is certainly *another way*, even farther from our understanding than instinct is.

TEXT-BOOKS OF PHYSICS.

(1) *Elements of Optics for the Use of Schools and Colleges.* By G. W. Parker. Pp. iv+122. (London: Longmans, Green and Co., 1915.) Price 2*s.* 6*d.*

(2) *Elementary Experimental Statics.* By I. B. Hart. Pp. vii+200. (London and Toronto: J. M. Dent and Sons, Ltd., 1915.) Price 2*s.* 6*d.*

(3) *Introduction to Heat.* By A. R. Laws and P. W. Todd. Pp. x+212. (London: Mills and Boon, Ltd., 1915.) Price 2*s.* 6*d.*

(4) *Experimental Harmonic Motion: a Manual for the Laboratory.* By Dr. F. G. C. Searle. Pp. x+92. (Cambridge: At the University Press, 1915.) Price 4*s.* 6*d.* net.

(1) IN Mr. Parker's "Elements of Optics" the subjects of reflection, refraction, mirrors and lenses, simple optical instruments, and dispersion are dealt with in four chapters. The book is intended for beginners, and no further mathematical knowledge is required for its perusal than an acquaintance with elementary geometry, simple algebraic equations, and the trigonometrical ratios. The text consists chiefly in the derivation of the usual formulæ of geometrical optics, the deviation method being employed for mirrors and lenses. The statements are accurate and concise, and the diagrams clear. Many teachers will regard the book as being too sparse and somewhat uninteresting owing to the absence of experimental matter. The inclusion of experiments to verify the laws and results by the aid of simple and inexpensive apparatus, would have enhanced the value of the book considerably. Numerical exercises are interspersed in the text, and answers are supplied.

(2) "Elementary Experimental Statics," by Mr. Ivor B. Hart, is written for pupils beginning the subject of mechanics. The mathematical knowledge assumed does not extend beyond an acquaintance with simple algebraic equations. The author deals with parallel forces, centres of gravity, inclined forces, friction, and the simple machines. The chief elementary facts are impressed on the pupil by a series of simple experiments. Full directions for the performance of these experiments are given, and the method of recording the results is indicated. It is better to insist on the tabulation of actual observations than results obtained after a mental calculation, as in col. 5 of the table on p. 45. The book is provided with a large number of questions and numerical exercises. The pupil who performs the experiments and works the examples in this book will have laid a good foundation for further study in experimental science.

(3) "Introduction to Heat," by Messrs. Laws and Todd, may be used both as a class and laboratory text-book in schools. The aim of the authors has been to introduce many phenomena from everyday life, and by appealing to the ordinary experiences of the pupil to awaken an intelligent interest in the subject. The order of treatment is somewhat different from that usually adopted in text-books of this character. The opening chapter

deals with conduction and convection of heat, and this is possible because at such a stage only a descriptive treatment of these subjects can be attempted. Other sections of the book deal with the barometer and thermometer, expansion, evaporation and condensation, hygrometry, fusion and solidification, specific heat, radiation, heat and work. Certain paragraphs are to be omitted on first reading.

Speaking generally, the authors have succeeded in producing an interesting text-book, but in many places the statements are loose and not characterised by that precision of language which it is so essential to inculcate in the mind of a beginner. Thus on p. 19 the authors speak of the pressure due to 60 c.c. of water, and on p. 88 define the British unit of heat as "the quantity of heat required to raise 1 lb. of water 1° F." This omission of "the temperature of" is a common occurrence in the text. Again on p. 20 we have an experiment "To determine how much 1 c.c. of air expands when heated." In this the temperature of 160 c.c. of air is raised from 15° C. to 85° C., the amount of expansion being 40 c.c. The calculated expansion of 1 c.c. is $40/(160 \times 70) = 1/280$. The authors then state: "an accurate and at the same time convenient result is 1/273." On p. 140 paraffin-wax is not a suitable material to illustrate melting point by the curve of cooling. In the diagram on p. 40 the pressure gauge should be connected to the inner cylinder of the hypsometer. The book contains a large number of questions and numerical exercises.

(4) Dr. Searle's "Experimental Harmonic Motion" is written on lines very similar to his well-known manual on "Experimental Elasticity." The subject-matter dealt with, however, is not so wide as the title would seem to imply. The first part of the book is devoted to the elementary theory of harmonic motion, and is apparently carried only so far as is necessary to understand the experiments described in the second chapter. There is no discussion of damped vibrations, composition of harmonic motions, or the analysis of periodic curves. The experiments described in the second chapter (fourteen in number) are such as are performed in the author's classes at the Cavendish Laboratory. They include oscillation methods for comparing moments of inertia, determinations of the acceleration due to gravity, the experimental study of a pendulum with yielding support, and an investigation of a system with two degrees of freedom. A theoretical discussion of each experiment is given, and there are full practical details for the design of the apparatus to ensure satisfactory results. Each experiment is furnished with a typical series of data obtained in an actual experiment. The exposition is clear, and the book may be profitably read by university students. Many teachers will welcome a book of this kind on account of the precise details for the setting up of the various experiments.

LABORATORY WORK ON COAL AND COAL-PRODUCTS.

Laboratory Work for Coal-mining Students. By J. Sim and A. M. Wylie. Pp. viii + 136. (London: E. Arnold, 1915.) Price 2*s*. 6*d*. net.

THE difficulties associated with coal analysis are determined in part by the fact that a material which is consumed in tons has for convenience of manipulation to be tested in grams, and in part by the variety of uses to which coal is applied. The first necessitates merely extreme care and method in sampling, but the second requires a diversity of tests demanding the greatest skill and experience. The most satisfactory way of conducting a test is obviously to submit a large sample of the material to the special process to which it is subsequently to be applied. This is frequently done; but it is not described in the present volume, which is concerned with laboratory methods only.

The difficulties attending coal analysis may be realised when one considers the variety in composition as well as the chemical sensitiveness of the substance. Coal is no sooner exposed to the air than it begins, especially when in powder, to absorb oxygen and to evolve carbon monoxide and dioxide. The sulphur which is present, partly as organic sulphur and partly as pyrites, also undergoes oxidation. Then, again, the nature of the products and by-products, upon which its value in the gas and coking industry depends, is determined by the character of the coal as well as by the temperature at which these products are extracted or distilled. For example, it has been shown recently that extraction with pyridine removes considerable quantities of paraffins, that distillation *in vacuo* gives rise to a series of naphthenes (cycloparaffins), whilst ordinary destructive distillation at high temperatures produces the coal-tar hydrocarbons. It would appear from this that the original hydrocarbon of the coal passes through various stages in the process of heating. Finally, a knowledge of the thermal value of the coal when used as fuel is essential. It will be seen that the investigation of a sample of coal is not a simple affair.

The present volume has been written with the object of facilitating the laboratory work of a coal-mining student, that is, one who is studying the scientific basis of the industry from every point of view. It is divided into five chapters, the first two being concerned with the coal itself, the second two with the products, namely, oil tests and gas analysis, and the final chapter with fan and ventilation tests.

The volume has evidently been put together with great care by its authors, who have had practical experience of their subject. The description of the apparatus and methods is clear and concise, and illustrated by diagrams and by actual examples, so that the student should have no difficulty in carrying out the different operations. J. B. C.

OUR BOOKSHELF.

Some Frontiers of To-morrow: An Aspiration for Europe. By Prof. L. W. Lyde. Pp. viii + 120. (London: A. and C. Black, Ltd., 1915.) Price 2*s.* 6*d.*

In this small volume Prof. Lyde makes suggestions for the settlement of European frontiers after the war. Three considerations are laid down as of vital importance: (1) that the frontier should be associated, not with war, but with peace; (2) that the unit of area should have some direct relation to national sentiment; (3) that inability to assimilate should disqualify any Power for territorial expansion. The first suggestion is the most important. Prof. Lyde maintains that frontiers should be identified with features related to the meeting of people in the ordinary routine of peaceful intercourse. If this be true, it follows that a navigable river makes the best frontier. A defensive frontier—the type of frontier of the past—will never put an end to conflict between neighbours, but may even promote it. An inhabited, in contrast to an uninhabited, frontier belt encourages contact between adjoining people, discourages racial and cultural antagonism, and so minimises the chance of friction, and promotes civilisation. Prof. Lyde is always stimulating, even if he fails to convince at times. His book is crammed with ideas from beginning to end, which should attract the attention of statesmen. But it will be hard to convince those who have treaty making in their hands that accurate scientific knowledge is a real asset in the matter, and that the geographer is the expert who has the knowledge and should be consulted.

R. N. R. B.

Liverpool Marine Biology Committee. L.M.B.C. Memoirs on Typical British Marine Plants and Animals. Edited by Prof. W. A. Herdman. xxiii. Tubifex. By G. C. Dixon. Pp. viii + 100 + 7 plates. (London: Williams and Norgate, 1915.) Price 3*s.* 6*d.*

Tubifex rivulorum is a slender Oligochæte, not more than two inches long, often found in large numbers in the mud of rivers and streams, but it occurs frequently also in brackish tidal waters, and therefore a memoir on this worm is appropriately included in a series dealing with marine animals. Of the aquatic Oligochætes, Tubifex is the type usually chosen for study in advanced classes in this country. Accounts of the different systems of organs have appeared in various zoological publications, but for figures of the worm the student has hitherto been dependent chiefly on the memoirs of d'Udekem (1855) and Vejdovsky (1884). Miss Dixon has revised and extended the previous accounts, with the result that her memoir gives a careful and reasonably full description of the structure of the worm, illustrated by seven well-drawn plates, of which the first in particular will be useful to the student.

After a few general remarks on the habits of the worm, an account is given of the external features and of the various systems of organs, the hermaphrodite reproductive apparatus being described in considerable detail, almost one-half of the memoir being devoted to this group of organs. Of considerable interest is the discovery that Tubifex possesses dimorphic spermatozoa. Both kinds of spermatozoa are of the elongate type and are tailed, but they differ in size and in the proportions of their parts. In the ordinary spermatozoa the head forms about one-sixth of the total length. The second type of sperm is about three times as long as the ordinary one, and the head forms about one-half the total length.

A good account is given of the remarkable spermatophores of Tubifex, which are moulded into their characteristic form in the spermathecal duct.

The memoir concludes with a brief reference to the parasites of Tubifex and a bibliography.

LETTERS TO THE EDITOR.

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

Distances at which Sounds of Heavy Gun-firing are Heard.

Referring to the correspondence on this subject, I have been collecting information as to places at which the sound of the firing in Belgium has been heard in this country.

I have undoubted records of its having been heard at many places throughout the south-east of England (all of them in Essex, Kent, Sussex, or Surrey), and am giving the result of my inquiries in a paper to be read before the Essex Field Club on October 30. Here, at a distance of about 125 miles from Ypres (taking that town for convenience, as a known centre), I have heard firing quite unmistakably since the beginning of the war—often all day, and for many days in succession, and frequently at night too.

So far as I have been able to ascertain, the greatest distance from Ypres at which the firing has been heard unmistakably is about 140 miles, though I have a less satisfactory record up to 150 miles. No doubt, however, it has been heard further in favourable conditions. Observations seem to show that the direction of the wind has less to do with the transmission of the sound than certain atmospheric conditions, though it is not easy to ascertain exactly what these conditions are.

My house here stands in a fairly open and elevated position, about 155 ft. O.D., with no higher ground in the immediate vicinity, or between me and Ypres. Many of my neighbours, who live in similar situations, also hear the sound, and recognise clearly what it is. It seems much less audible at lower elevations, and quite inaudible among houses. For instance, I cannot hear of its ever having been heard in the adjacent town of Chelmsford, or in any part of London.

MILLER CHRISTY.

Broom Wood Lodge, Chignal St. James, Chelmsford, October 19.

The Cumberland Earthquake of October 2.

I WAS interested to read the note in NATURE of October 21 (p. 208) referring to an earthquake in the Lake District, Cumberland, on October 2, at 3.15 a.m. My wife and I spent some weeks at Seatoller, Borrowdale, leaving on October 2. Early in the morning of that day we were awakened by a strange noise and the house vibrating. The noise and vibration were so completely similar to what occurs in my own house when the hot-water boiler is overheated and steam, condensing in the pipes, causes "hammering," that I was on the point of getting up to turn on the bath-room tap, when it ceased. As we were leaving in the morning the proprietors inquired if we had heard the noise in the night, and I replied at once that I had heard the hammering in the pipes of the hot-water system, but was told that it was quite impossible for the water to have been hot at the time. I had no idea of the true explanation until I read the note referred to. Seatoller is about 30 miles S.S.W. of Carlisle and 4½ miles N.N.E. of Scafell Pike. Possibly it may be of interest to record that at this place the earthquake was accompanied by concussions and vibrations sufficient to waken the inhabitants.

FREDERICK SODDY.

October 23.

The Etymology of "Chincough."

WHOOPING-COUGH is, or used to be, called in the south of Scotland, "chincough," but the "ch" was hard, so that it sounded kincough, or kink-cough. In Jamieson's Scottish Dictionary the word "kink" has the meanings (1) a violent fit of coughing attended with suspension of breathing, (2) a regular fit of the chincough. "To kink" is to labour for breath in a severe fit of coughing. The more purely Scottish word for whooping-cough is "kinkhost," in the Belgic language *kink-hoest*.

L. B.

October 23.

THERE can, I think, be no doubt that "chincough" is a good English word, meaning whooping-cough and nothing else. It has nothing to do with *chien* (a dog), as Mr. Hart supposes (NATURE, October 21), or with chin, although to anyone who has noticed the depression and thrusting forward of the lower jaw during a paroxysm this derivation might seem probable. The word is, according to Skeat, properly chink-cough, and in Scotland and some parts of England a paroxysm is called a kink, which, again according to Skeat, means a catch in the breath, from kik, or kuk, to gasp, an imitative word, which is also the base of cough. The term kinkhost, still in use in Scotland, resembles the German equivalent, *keuchhusten*, which is also imitative. The French *coqueluche* is more puzzling, but probably has reference to the crowing inspiration which follows the expiratory spasm.

DAWSON WILLIAMS.

London, October 22.

As your correspondent (NATURE, October 21) points out, chincough has certainly nothing to do with "hiccough"; but has it anything to do with the French *chien* = a dog, as he supposes? Chincough is the softer English equivalent of the Scotch kink-host (Dutch, *kink-hoest*). Besides, the noun there is also the verb, to kink (O. Dutch, *kinken* = to cough), and even an Englishwoman, at least in the north, who calls the disease whooping-cough, will tell one when her child began to "kink" with its cough. My dictionary compares the word with the Anglo-Saxon "cincung" = a fit of laughter, and kink is sometimes also used in that sense, or in connection with any choking inspiratory spasm. Finally, there is nothing in the sound of whooping-cough to suggest a dog, though the cough of croup might do so.

M. D.

Longitudes of Two Markings on Jupiter.

IN NATURE of October 14 the longitudes of the S. Tropical Disturbance and the Red Spot which I gave should be in each case minus 75·14°, if they are to correspond with the adopted period of System II. :—

S. Tropical Disturbance			Red Spot Hollow		
Date 1915	P. end	f. end	Date 1915	P. shoulder	f. shoulder
Sept. 11	313·1°	—	Sept. 10	—	185 1°
13	310·8°	—	12	149·5°	—
20	308·4°	—	17	149·1°	186·0°
21	—	42·6°	19	148 9°	187·6°
26	—	37·7°	27	—	185·1°
28	—	36·5°	29	—	185·1°
30	305·3°	35·3°			
Oct. 1	—	34·6°			

SCRIVEN BOLTON.

CHINESE DEFENSIVE ARMOUR.[1]

THE somewhat ponderous title of the work before us rather obscures the subject of this monograph, which is upon the origin and history of defensive armour, a theme of considerable cultural importance and here treated systematically for the first time. As a result, we have a masterly description of Oriental protective armour, and suggestive fresh light is also thrown upon certain sources of early Chinese civilisation.

The research is based primarily upon a large collection of ancient Chinese clay figures dug up (apparently by the author) from graves in the provinces of Shen-si and Ho-nan during the years 1908–1910, and deposited among the rich collections from the Far East now in the Field Museum of Natural History at Chicago, of which the author is a well-known curator and field-explorer.

The hides of the archaic Chinese cuirasses of the pre-metal age are ascribed by ancient tradition to two animals named respectively *Se* and *Si*, which are identified by the majority of sinologists with one or two species of rhinoceros. Dr. Laufer, who combines with his scientific physical training also a scholarly knowledge of Chinese, revises the Chinese texts at first hand, and appears to substantiate his identification of the *Se* as the single-horned and the *Si* as the two-horned Sumatran rhinoceros. In addition to the mass of mythological and folk-lore references to

[1] "Chinese Clay Figures." Part i., Prolegomena on the History of Defensive Armour. By B. Laufer. Field Museum of Natural History Publication 177, Anthropological Series, vol. xiii., No. 2. Pp. 69–315+64 plates. (Chicago: Field Museum of Natural History, 1914.)

these animals extracted from ancient literature and art, Dr. Laufer has elicited historical references to these animals, as royal presents and otherwise, in the official annals, which are important as indicating some chronology for the former geographical range of these animals in northern China and central Asia, where they have long been extinct. It appears that the two-horned (or Sumatran?) rhinoceros no longer existed within China proper in the first century A.D., and was only to be found to the south of the Yangtse; while the one-horned species survived in China in the Upper Yangtse valley down to the Middle Ages. In connection with the former range of these animals we would suggest that the Arabic name "*Kargadan*" is obviously cognate with the Indian title for the rhinoceros, which in the Sanskrit is "*Khadga*," which means literally "the cutter," or "sword," evidently with reference to the horn.

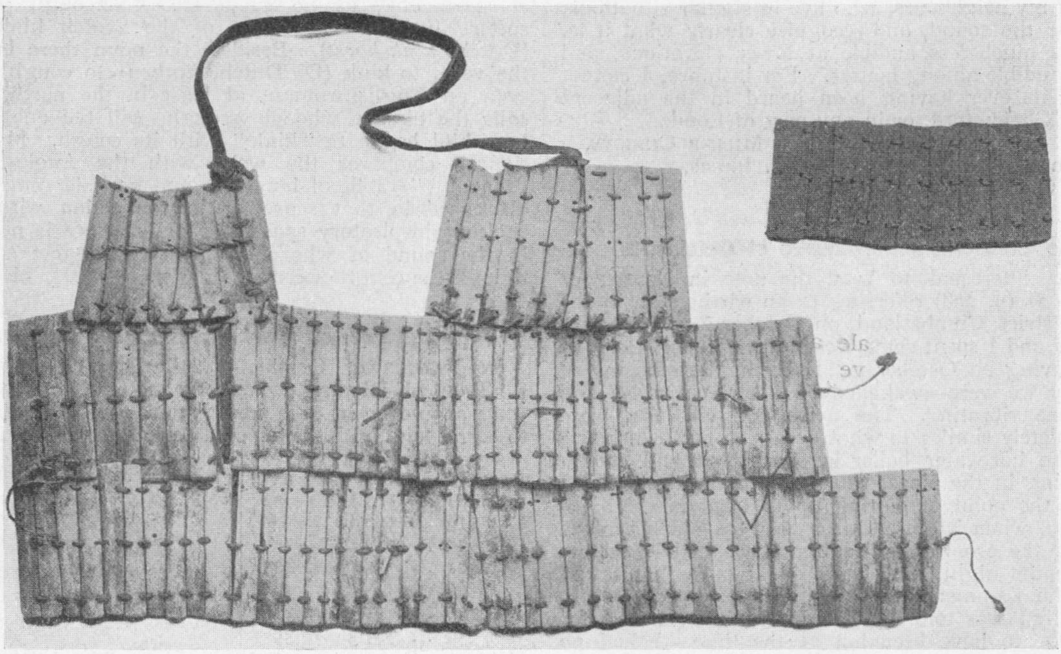

FIG. 1.—Eskimo armour of ivory plates and fragment of iron plates. From "Chinese Clay Figures."

The association of the rhinoceros with the myth of the unicorn is examined in great detail; also the mystic use of the horn as anti-poison goblets up to the present day in China. It appears to us possible that this latter use was derived from India, or at least through false etymology by confusing the Sanskrit name for "horn," namely *Vishāna,* with the Sanskrit word for "poison," namely, *Visha*; for the Chinese are known to have called the rhinoceros-horn in the eleventh century A.D. by the name *pi-sha-na* (Wylie, "Notes," 195), their version of the Sanskrit word. This false etymology would also readily lend itself to the astrological view that the horn of the rhinoceros symbolised the ascending node, and as such represents hostility to the powers of darkness, and as a poison-destroyer. In this regard it is perhaps noteworthy that there seems to us a suggestion of purity also (or is it phallic?) in respect to the armorial unicorn, which, according to the legend, was only to be caught at the lap of a virgin maid. It is clear, however, that Pliny ("Nat. Hist.," 8, 21), who must have been

FIG. 2.—The animal "*Si* resembling swine" (from the illustrated edition of *Erh ya*). From "Chinese Clay Figures."

familiar with the rhinoceros in the circus, did not identify it with his fierce *mono-ceros* or unicorn.

In connection with the use of rhinoceros hide as armour, it is recalled that it is only when the skin is dried and properly prepared that it becomes of iron-like hardness; for the skin of the living animal, notwithstanding popular hunters' tales to the contrary, is quite soft and can be readily penetrated in any place by a bullet or easily pierced by a hunting knife.

We have not space here to follow the author in his exhaustive account of the origin and development of defensive armour. He treats of this in long chapters devoted to "Defensive Armour of the Archaic Period" (B.C. 1122–255), characterised by hide cuirass and scale armour in which metal was absent; "Defensive Armour of the Han Period" (beginning in the third century B.C.), when metal (at first copper and latterly iron) scales were introduced, from Persia, Dr. Laufer believes, to form "plate" armour; "Chain and Ring Mail," also from Persia, though this was confined to the Arabs and Moghuls and Tibetans, and never adopted by the Chinese; "Plate" armour, which was much more ancient and at first formed of bone-plates; "Sheet" armour, as in the medieval West, first came into use in China in the Tang period (A.D. 618–906), and from India, the author seems to believe. A chapter is also devoted to "Horse-Armour," shedding much new light upon this interesting phase of protective armament.

A word of high praise must also be given to the illustrations, which are well chosen and significant; and the photographic plates, sixty-four in number, are beautifully reproduced.

L. A. WADDELL.

MODERN BULLETS IN WAR AND SPORT.

FOUR interesting articles appeared in the columns of *Engineering* in August of this year, contributed by Fleet-Surgeon C. Marsh Beadnell, and these have now been reprinted in the form of a thin pamphlet. The articles are full of information as to the weights and velocities of different bullets and as to the effects of bullets of different kinds when they strike various substances at different points in their trajectory. The great experience of the author as a big-game sportsman on the one hand and as having seen many cases in the South African and Philippine wars and the present war on the other give great value to his observations on the destructive or at times very slight effects produced by the modern bullet; his treatment of the dynamical and especially of the aerodynamical principles affecting the motion of projectiles is less satisfactory.

In dealing with the effects of bullets the author shows how the damage done depends on the energy lost by the bullet; how, for example, a bullet at a high velocity and striking properly end-on may drill a clean hole, doing the minimum of damage and losing but little of its velocity, while at a later stage of its flight when travelling more slowly, and especially if in any degree inclined to its trajectory, the destruction is incomparably greater, and the loss of energy as represented by v^2 equally so.

The following experiment will exemplify this fact:—Two skulls were filled with a substance of a consistency as near as possible to that of the brain. Against the one was fired a normal bullet at high velocity, against the other a similar bullet at low velocity, this being effected by using a quarter charge; the range in each case was 10 ft. The first skull was neatly perforated, and the bullet, unaltered in shape, was found embedded 26 in. in the wood backing; the second skull was partly disarticulated, and was fractured posteriorly, the bullet lying inside against its posterior wall. In the case of the first skull the bullet parted with but little of its energy, and that only at the actual points of entry and emergence. In the case of the second skull more of the bullet's energy, both absolutely and relatively, was expended on it and its contents.

In an experiment of this sort a good deal depends on the compressibility of the material filling the envelope. As illustrating this point it may be permitted to refer to an experiment made by the writer of this notice at the time that he was photographing bullets. In order to ascertain if it would be practicable to photograph a bullet glancing off still water, he constructed a long trough of thin wood open at the top, somewhere about 3 ft. long and 4 or 5 in. wide and deep, and on to the water in this he fired a 0·303 bullet at as near a grazing incidence as he could. The water was hit about two-thirds along the trough, and was driven out as by an explosion. The front and sides of the trough in advance of the point of striking were split into matchwood, and generally, apart from the photographic difficulties, it seemed desirable to experiment in other directions.

The author has experimented on the inclination at which the modern high-speed bullet will penetrate a skull, and found that at angles above 5° or 6° he obtained penetration, whereas Snider and Martini bullets would glance off at much greater angles. Space does not allow of reference to the numerous valuable observations of the author on the curious effects of bullets both in big game and in warfare. These will be read with the greatest interest. It is not possible, however, to follow the author in his excursions in the domain of pure dynamics, and his treatment of the action of the air on the projectile appears to the writer to be very largely imaginary and incorrect. So difficult a subject as the action of air upon a rotating projectile, whether spherical or elongated, and whether the axis of spin is in or across the trajectory, scarcely admits of any but the most rigid treatment, and in this the author might find Mr. Crabtree's admirable book illuminating. There is a statement which is new to the present writer, and it would have been well to have given the authority.

Thus, up to speeds of 790 ft. per second resistance varies as the square of the speed, between 790 and 990 ft. per second as the cube, between 990 and 1120 ft. per second as the sixth power, between 1120 and 1330 ft. per second again as the cube, and above 1330 ft. per second again as the square of the speed; above 1500 ft. per second the relationship is not known.

C. V. BOYS.

PROF. VIVIAN B. LEWES.

WE much regret to see the announcement that Prof. Vivian B. Lewes died on October 23, of pneumonia, at Mold, Flintshire, where he was to deliver one of a series of Gilchrist Lectures on explosives.

Prof. Lewes was born in 1852. His education was undertaken by his uncle, George Henry Lewes, the well-known author of the "History of Philosophy" and other works. On leaving University College School at the age of sixteen, he became assistant to Dr. F. S. Barff, and in 1870 to Prof. A. W. Williamson at University College. Later he worked under Dr. C. Graham at the Birkbeck Institute, and was appointed assistant at the Royal Naval College, Greenwich, in 1879, where he succeeded Dr. H. Debus as professor of chemistry in 1888, which post he resigned a year ago. He was appointed chief superintending gas examiner to the corporation of the City of London in 1892, and at the time of his death was chairman of the Chemical Section of the Munitions Inventions panel.

His chief scientific work was on the action of heat on hydrocarbons and the cause of luminosity of flames; papers on these subjects were published in the Proceedings of the Royal Society in 1893–1895. Lewes's acetylene theory of luminosity, whilst it has met with much criticism, has been accepted widely as the correct explanation of the main interactions giving rise to luminosity. He was also the author of papers on pentathionates.

When, in 1892, Willson, in Canada, first obtained calcium carbide on a commercial scale, a sample was forwarded to Lewes, who, at the Royal Society of Arts, in 1894, brought this substance under the notice of an English audience. Later he did much to establish the success of the new industry. No one, indeed, was more welcome or more certain of an appreciative audience at the Society of Arts, and there he delivered several series of Cantor and other courses of lectures, dealing with such subjects as coal gas, explosives, liquid fuel, etc.

As a lecturer under the Gilchrist Educational Trust he was most popular and widely known throughout the country. He was, indeed, the last of the original group of Gilchrist lecturers, the panel of which included many illustrious names.

Prof. Lewes did excellent pioneer work in connection with the University Extension lecture scheme and as a lecturer for the Technical Education Committee of the London County Council. This was the work largely of a past decade, but filled a most important place in our educational system. He laid claim justly to have instilled the desire for further chemical knowledge in numbers of young students, and contributed very greatly to the success of systematic chemistry courses in our numerous technical schools and institutions.

His connection with the Navy was naturally not without its influence on his researches, many of which formed the subject of communications to the Institution of Naval Architects (of which he was a vice-president). The institution awarded him its first gold medal for a paper on "The Formation of Boiler Incrustations and Oily Deposits." Other important papers were on the corrosion of metals, anti-fouling compositions, and the spontaneous ignition of coal.

Prof. Lewes's principal technical field, however, was in connection with coal gas. He was always a welcome lecturer at the Institute of Gas Engineers and other similar societies, before the members of which he dealt in a lucid manner with current problems affecting this important industry. He was the author of several books, including "Acetylene," which is a standard work of reference, "Service Chemistry," now in its fourth edition, "Liquid and Gaseous Fuel," and "The Carbonisation of Coal."

Prof. Lewes's genial personality, his kindly and generous nature, endeared him to a very wide circle, both of personal and professional friends. Among the large number of naval officers with whom his duties brought him in contact no one was more popular or more respected.

NOTES.

WE much regret to announce the death, on October 23, from heart failure following influenza, at fifty-one years of age, of Dr. R. Assheton, F.R.S., University lecturer in animal embryology at Cambridge since 1911.

WE regret to announce that Sir Andrew Noble, Bart., K.C.B., F.R.S., to whose scientific work on artillery and explosives the marvellous developments of heavy weapons within the last fifty years are chiefly due, died on October 22, at eighty-four years of age.

MR. W. MARRIOTT has retired from the post of assistant secretary of the Royal Meteorological Society held by him for the last forty years, and has been succeeded by Mr. A. H. Brown, the chief clerk of the society.

MR. W. K. CARR, the owner of one of the best-equipped private laboratories in the United States, died recently at his home in Washington, at the age of fifty-five. On leaving the University of Virginia in 1878, he spent twelve years in the sale and manufacture of cotton at Norfolk, Va. Since then he had devoted most of his time to scientific research.

THE death is announced, in his sixty-fifth year, of Mr. C. F. Holder, of Pasadena, the writer of a large number of books on the natural history of southern California. He was educated at the Friends' School, Providence, R.I., and at the United States Naval Academy. For a few years he was an assistant at the American Museum of Natural History, New York. Mr. Holder's special interests were in marine zoology.

THE first meeting of the new session of the Geological Society will be held on Wednesday next, November 3, at 5.30 p.m., when Dr. C. W. Andrews will exhibit photographs and give an account of the discovery of a fossil elephant at Chatham. Owing to the possibility of air-raids over the metropolis, and the consequent disorganisation of traffic, the council has decided that the time of the evening meetings shall be changed temporarily from 8 p.m. to 5.30 p.m.

WE regret to record the death of Lieut. J. Gordon Hollingsworth, of the 10th Battalion of the Middlesex Regiment, who was killed in the Gallipoli Peninsula on August 12. He was the second and only surviving son of Mr. A. T. Hollingsworth, one of the managing directors of *Engineering*. He was reported "missing" some weeks ago, and it was only on October 15 that official announcement was made that he fell gallantly leading his men in an advance which took place soon after the landing at Sulva Bay. He was educated as an engineer, and joined the staff of our contemporary, being later elected a director of *Engineering*, Ltd.

IN a review of Dr. E. Hindle's book on "Flies in Relation to Disease," published in *Science* for July 16, the remark was made that the author had been killed in Africa. Referring to this statement, Prof. G. H. F. Nuttall writes from Cambridge:—"Dr. Hindle has never been in Africa, and he is alive and well. He is expecting to leave for the front at any moment as a divisional signal officer in the R.E. I shall be much obliged to you if you will help me to make the facts known, as the statement in *Science* has caused unnecessary pain to Dr. Hindle's friends in many parts of the world."

A CORRESPONDENT, writing from Amsterdam in the *Times* of October 22, contributes incidentally some interesting observations on the effects of distant gunfiring. "At more than one point in the southern frontier" of Holland, he says, "one hears the guns from the French front," the distance being about a hundred miles. "It is difficult to say whether one really hears them with one's ears or whether one feels them. It is not, at this distance, a definite sound so much as a jarring and throbbing of the air. But it is audible, or sensible, enough that one can pick out the detonations of pieces of different calibre, the almost continuous low muttering (for heavy work was going on) of the smaller guns being punctuated at intervals with the double shock of something much bigger."

AT the annual statutory meeting of the Royal Society of Edinburgh on October 25 the following were elected as council:—*President*: Dr. J. Horne; *Vice-Presidents*: Prof. F. O. Bower, Sir T. R. Fraser, Dr. B. N. Peach, Sir E. A. Schäfer, the Right Hon. Sir J. H. A. Macdonald, and Prof. R. A. Sampson; *General Secretary*: Dr. Cargill G. Knott; *Secretaries to Ordinary Meetings*: Dr. R. Kidston and Prof. A. Robinson; *Treasurer*: Mr. J. Currie; *Curator of Library and Museum*: Dr. J. S. Black; *Councillors*: Principal A. P. Laurie, Prof. J. Graham Kerr, Dr. L. Dobbin, Dr. E. M. Wedderburn, Dr. W. B. Blaikie, Principal O. C. Bradley, Dr. R. S. MacDougall, Dr. W. A. Tait, Dr. J. H. Ashworth, Prof. C. G. Barkla, Prof. C. R. Marshall, Principal A. Crichton Mitchell. Sir William Turner, former president, is a permanent member of council.

IN addition to the awards announced in April for papers read at the meetings, the council of the Institution of Civil Engineers has made the following awards for papers published in the Proceedings without discussion during the session 1914–15:—A Telford gold medal to Mr. James Forgie (New York); Telford premiums to Messrs. J. R. Mason (Dunedin, N.Z.), Harold Berridge (Aden), C. R. White (London), C. S. Churchill (Roanoke, Va.); and the Trevithick premium to Mr. A. Poulsen (Lemvig, Denmark). The Indian premium for 1915 has been awarded to Mr. C. W. Anderson (Midnapore, India). The ninety-seventh session of the Institution will be opened on Tuesday, November 2, at 8 p.m., when Mr. Alexander Ross, president, will deliver an address, and will present awards made by the council for papers read and discussed or otherwise dealt with during the past session.

A MEETING of the National Illumination Committee of Great Britain was held on October 20, when Mr. W. Duddell was elected chairman of the committee in succession to the late Mr. Edward Allen. Reports on observations carried out at the instance of the committee at a number of technical laboratories, on the height to which the flame of the Hefner amylacetate lamp should be raised to afford a light of one international or English standard candle, were discussed, and their further consideration was postponed until fuller details of some of the observations and other reports which had been promised had been obtained. A report prepared and sent by Dr. E. Ott, of Zürich, on researches which had been carried out in Switzerland on the effect of atmospheric pressure, humidity, and vitiation on the light afforded by the Hefner standard lamp was considered, and it was decided, subject to Dr. Ott's consent being obtained, to prepare a translation of the report for communication to the British technical Press.

THE *Mining Magazine* of October 14 contains an article on weights and measures dealing in a practical manner with the question of the necessity for some reform in our present system. The substitution of the metric system is advocated, but more from the point of view of the technical man than from that of the general trading community. It is pointed out that the modifications which the adoption of the metric system would introduce in mining and metallurgical work are not such as to cause any inconvenience, while on the other hand the confusion which at present exists owing to the various tons, gallons, etc., recognised in the mining profession would be entirely obviated. It is also suggested that if the adoption of the metric system is regarded as too revolutionary for the English-speaking nations, or if the present is not a suitable time for conducting an agitation in its favour, some steps can at least be taken by technical men towards simplifying the British system and agreeing upon a common usage. Various examples are given with the object of illustrating the need for a less complicated and more practical system. The general adoption of the short ton, which is much used in mining circles for recording ore mined or developed, is strongly advocated. Engineers are advised to use the metric system wherever possible, and always to champion it; to use the simplest of English weights and measures and in cases of uncertainty to specify the unit; and further, to avoid, when addressing an English audience, the use of denominations of weights and measures not likely to be understood.

THE civil engineering profession, and especially that section of it connected with river training and coastal defence work, will learn with regret of the death, at the age of eighty-three, of Mr. W. H. Wheeler, formerly of Boston, Lincs, but latterly residing at Bromley, Kent. He practised for many years in the district bordering on the Wash, and became an authority on the drainage of fens and low lands, and the regulation of estuary channels, as also on coastal phenomena generally. His "History of the Fens of South Lincolnshire" is, perhaps, his best known work; it was first published in 1868, and was reissued as a second edition in 1897. Other volumes which followed were "Tidal Rivers: their Hydraulics, Improvement, and Navigation," in Longmans's Civil Engineering Series, 1893; "The Sea Coast: (1) Destruction, (2) Littoral Drift, and (3) Protection," 1902; a "Practical Manual on Tides and Waves," 1906; and "The North Sea: Physical Characteristics, Tides, Currents, and Fishery," 1908. His pen was very prolific, and he contributed a great number of papers to professional societies and articles to technical journals, as well as to our own columns, all bearing on the branch of work which he had made peculiarly his own, and on which, despite inevitable occasional divergences of opinion from professional colleagues on controversial matters, he was ever listened to with attention and respect. He was elected a member of the Institution of Civil Engineers in 1867, and was the recipient of a Telford premium from that body.

A FEW further particulars are available as to the recent long-distance tests in wireless telephony in the United States to which reference was made in NATURE of October 7 (p. 155), but no data have yet been disclosed concerning the type of apparatus employed in the tests. The transmitting apparatus was installed in the U.S. Government wireless station at Arlington, while receiving sets only were used at Mare Island and Pearl Harbour stations. The distance between Arlington and Mare Island is about 2500 miles, and between Arlington and Pearl Harbour 4900 miles. The conversation was overheard at several points, including Darien, Panama, a distance of more than 2000 miles from the transmitting station. The tests are the outcome of many years of painstaking experiments. Early in the spring of this year the system had been developed up to a point where good results were secured over a distance of 250 miles, employing for the aerial an experimental tower erected at Montauk Point, Long Island, and a small tower at Wilmington, Del. This was followed by tests between Montauk Point and St. Simons Island, Ga., a distance of 1000 miles. No novel features are claimed for the system, which is said to be simply the perfection of existing methods. Further and extended trials under varying conditions are necessary, however, before we can state with tolerable certainty whether the problem of long-distance wireless telephony has been satisfactorily solved.

THE Trustees of the National Museum, Melbourne, have issued a second and revised edition of the "Guide to the Ethnological Collections," compiled by Dr. Baldwin Spencer. The older specimens are largely due to Mr. Brough Smith, but they have been largely increased by those made by Dr. Spencer and the late Mr. Gillen in the course of their famous journeys among the Arunta and other tribes. A short introduction gives the latest views on the ethnology of the continent. Specially remarkable are the rare specimens illustrating religious usages, totemism, initiation ceremonies, and the like. The handbook, which is well illustrated, will be indispensable to all students of the Australian aborigines.

MR. MORTEN P. PORSILD, writing from Disco, Greenland, has published a valuable monograph entitled "Studies on the Material Culture of the Eskimo in West Greenland." He adopts the scientific method of discussing in the case of each implement the object aimed at in its construction; the mode of use in order to attain this object; how its form is adapted to its use; how far the nature of the material has influenced its form. He points out that the study of Eskimo culture is specially useful for comparison with that of the European Stone Age people. He concludes that this culture developed in the Arctic area without any borrowing from foreign civilisations, except in the case of the bow and arrow. He finds that the types of the kayak have a regional distribution similar to that of the Greenland dialects. Many implements are for the first time described, and these notes serve to modify certain current theories. He warns museum collectors against the purchase of so-called "models," and he remarks that though faked antiquities are very rare, yet they may be sometimes met with.

OF pelagic Annelids, the Alciopidæ and the Tomopteridæ, not a single species has hitherto been obtained from Japanese waters. Mr. Akira Izuka is therefore to be congratulated on having, in the course of his researches, brought to light no fewer than nine species belonging to these families. Three of the species thereof are new to science. He describes his captures in the Journal of the College of Science of the Imperial University of Tokio (vol. xxxvi., art. 5).

ACCORDING to Dr. J. H. Vernhout, in the July issue of *Zoologische Mededeelingen* (the organ of the Natural History Museum of Leyden), the parasitic *Petricola pholadiformis*, one of the "Venus-shells," recently introduced into British waters with American oysters, has also appeared on the Dutch coast. In addition to cases he has already recorded he now adds to this list Flushing, Isle of Walcheren, eastern Schelde, Zandvoort, and Terschelling. The introduction of American oysters into British waters has not proved an unmixed blessing. For another parasitic mollusc, *Crepidula fornicata*, the "slipper-limpet," one of the Capulidæ, introduced inadvertently into the Whitstable oyster-beds has now become a pest. Furthermore, it is slowly spreading round the coast.

AMONG the factors of elimination in the "struggle for existence," one does not usually reckon hot springs. Yet these, too, play their part. This much is apparent from the Bulletin of the University of Colorado (vol. xv., No. 6), wherein Messrs. Ellis and Henderson give an account of the Amphibia and Reptilia of Colorado. In the hot springs near Buena Vista, at an elevation of 8500 ft., they found larvæ of the Columbian toad (*Bufo boreas*) in an overflow pool at 23° C. Following the stream back, toward the spring, the temperature of the water increased rapidly, but the young toads continued abundant until the water was at 34° C. Above this point few were seen, though one small specimen was taken from water at 45° C. This toad was swimming rapidly, as if endeavouring to reach cooler water. The pools of very hot water, they remark, were death-traps for *Bufo boreas,* and numerous other animals. From one such pool, the water of which was 54° C., three large specimens of this toad and several insects were taken, the flesh of all of them being thoroughly cooked. A list of animals and plants described as new, and a key to the Entomostraca of Colorado, make up the rest of this bulletin.

IN the issue of *Knowledge* for September there is a short paper on the hairs of rock plants by K. E. Styan, with illustrations. The glandular hairs of the Saxifrages are described, and those of *S. granulata* and *S. lingulata* are figured. The three types of hairs dealt with are the silky or woolly hairs of the Edelweiss, *Sedum arachnoideum,* etc.; the stellate hairs which form a felted covering to many leaves, as in Aubretias and Alyssums, and the glandular, which may occur alone or in conjunction with one of the other types. The hairs are mainly protective against atmospheric conditions, but the glandular hairs may in some cases serve to attract insects.

A BOTANICAL survey of some fields near Leicester is a useful contribution to field botany by Miss Measham, published in the Transactions of the Leicester Literary and Philosophical Society, vol. xix. The fields are mapped, and from a study of the grasses in particular it was found possible to group certain fields together according to their types of vegetation. Fields, for instance, characterised by *Lolium perenne* form one group, while those with *Rhinanthus crista-galli* in abundance are taken as the type of another group. As a preparation for a flora of Leicestershire and Rutland, the work should prove of value.

THE Transactions of the Botanical Society of Edinburgh (vol. xxvi., part iv.) are largely occupied by an important paper on *Primula obconica,* Hance, and its microforms by Prof. Bayley Balfour. The paper is illustrated by thirty-six plates reproduced from photographs of herbarium specimens. The familiar plant *P. obconica* was collected near Ichang in 1879, and was raised from seed sent by Charles Maries to Messrs. Veitch, of Chelsea, in 1880. The type-plant grows in meadow land, but many of its forms grow on rocks in the limestone gorges. The species is widely distributed in eastern Asia, and extends into Burmah and Bhutan, *P. listeri,* King, the East Himalayan species, is mainly a sylvestral form with ivy-shaped leaves and short flower-scapes, but is linked up to the typical round-leaved *P. obconica,* with its longer flower-scapes, by a series of intermediate forms. The variants are nearer to the *obconica* type than to *listeri.* Prof. Balfour places in this Obconico-Listeri section fourteen well-marked micro-species, four of which are of his own making. *P. sino-listeri,* a glabiescent form with acute-lobed small leaves and long scapes, was collected recently by Forrest in Yunnan, and may prove to be a plant of horticultural value. It lacks the irritant property of *P. obconica,* Hance.

THE Report of the Agricultural Department of St. Lucia for the year 1914–15 is a record of steady progress, especially in connection with the lime and coconut industries. The Government lime juice factory proves to be in a flourishing condition, and products of a high quality are being prepared, of which details are given. Useful work is being done by the staff of the department in collecting the grasses of the island, both native and naturalised, with a view to their correct determination and also in order to obtain definite particulars of their economic value. The determinations of those unknown locally have been made by Mr. Hitchcock, the agrostologist to the U.S. Department of Agriculture, and useful notes are given on the more important grasses and an analysis to show their comparative feeding value.

A RELIEF model of Wales has been constructed for the National Museum, Cardiff. An account of its construction, with a geographical description of several of the blocks, has been published by the museum ("Descriptive Handbook to the Relief Model of Wales," by W. E. Whitehouse). The whole model measures 12 ft. by 10 ft. 6 in., and is on a scale of 1 in. to a mile. The vertical scale is 1 in. to 2000 ft. The museum hopes shortly to issue copies of the various blocks of the model at as low a price as possible. Despite the care that has undoubtedly been used in its construction, it is questionable whether such a model is not inferior for teaching purposes to a good contoured map on the same scale. In accuracy of detail there can be no comparison.

NEWS from Sir Aurel Stein of his explorations in Central Asia is published in the *Geographical Journal* for October (vol. xlvi., No. 4). A despatch from the Ulughart Valley dated July 10, 1915, gives an account of last winter's work in the Turfan region, which included a detailed survey of the Turfan depression and of the Kuruk-tagh mountains. The Kuruk-tagh and the Tian-shan range were linked to the trigonometrical survey of India. From Turfan Sir Aurel Stein moved to Korla in the spring, and thence to Kashgar. Large and important archæological collections were made. In a further despatch from "Camp Kara-Chem," Pamirs, August 8, 1915, Sir Aurel Stein says he is proceeding westward to the Pamir source of the Oxus. This he proposes to follow through Wakhan to Khorok, and thence to visit Roshan, Darwaz, Karategin, and so to reach the railway at Bokhara. He hopes to reach Meshed in Persia in October, and after spending the winter in Seistan, to return to India in March.

THE number and variety of the fossil reptiles and amphibians discovered in the Karoo formation of South Africa are very remarkable. Several new genera and species are described by Mr. S. H. Haughton in the Annals of the South African Museum, vol. xii., part iii., just received. Besides a well-preserved Labyrinthodont skeleton and various remains of the usual mammal-like reptiles, there is an interesting skull from the Stormberg Beds bearing much resemblance to that of Ornithosuchus from the Triassic sandstones of Elgin, Scotland.

PART of the lower jaw of a hoofed mammal with teeth like those of the peculiar extinct hoofed mammals of South America has been found in the Lower Eocene of Wyoming, U.S.A., and is described under the name of Arctostylops by Dr. W. D. Matthew in the Bulletin of the American Museum of Natural History, vol. xxxiv., art. xiv. This unexpected discovery suggests that at the beginning of the Tertiary epoch there may have been a longer and closer connection between South and North America than has hitherto been supposed. Numerous other jaws from the same formation and locality in Wyoming are referred by Dr. Matthew to primitive lemurs and insectivores. They show that at the beginning of the Eocene period the lemurs, insectivores, and carnivores cannot be clearly distinguished by the teeth alone.

A BOUND volume of "Papers from the Geological Department, Glasgow University," for 1914, has been issued by Messrs. J. Maclehose and Sons, Glasgow, with the sanction of the University Court. It is proposed to continue this publication annually. The present volume consists of reprints, of differing sizes, of papers published in various journals, some of which have been already noticed in NATURE. It remains to be seen whether a paper will be more readily traced by this mode of reproduction than in its original habitat. If the work relating to the Glasgow district were thus brought together, a new serial might be welcome; but it may be doubted if researches on South Georgia or the desiccation of the earth will be looked for under the head of the University of Glasgow. The volume is a further proof of the activity of what has become, under Prof. J. W. Gregory's influence, one of the chief schools of geology in our islands.

THE Proceedings of the American Philosophical Society for July contains an important article by Prof. A. E. Kennelley and Mr. H. O. Taylor, of Harvard University, on the extent to which the various portions of a telephone diaphragm move during vibration. The diaphragms were circular, of about 5 cm. diameter, of steel or glass, and clamped at the outer edge. The motion was observed by means of a triangular mirror of a millimetre side, one corner of which was pressed lightly against the diaphragm by the torsion of a thin phosphor-bronze strip to which the opposite side of the mirror was attached. The diaphragm was set into vibration either by the sound waves from a series of organ pipes or by alternating electric currents sent round an electromagnet behind it. In almost all cases within the telephonic range of intensity and frequency the diaphragms vibrated in their fundamental mode with the maximum displacement at or near the centre; and the law of distribution of displacement over the rest of the surface closely approximating to the theory as given by Lord Rayleigh in his "Theory of Sound."

THE *Scientific American* for October 2 contains an article on "America as her Own Chemist," giving an account of the first National Exposition of Chemical Industries, which was held in the Grand Central Palace of New York City during the week of September 20. It is stated that this exhibition illustrates in a very striking manner the remarkable advance made in the production of chemicals and dyes in the United States since Germany has been commercially isolated and prevented from exporting. The exhibition included three branches: first, chemicals, ores, metals, drugs, paints, and similar manufactured goods; secondly, apparatus and equipment for chemical laboratories; and, thirdly, machinery and equipment for manufacturing chemists, the treatment of ores, etc. Some of the most striking examples of progress were to be found in the exhibits illustrating the utilisation of waste cherry pips, raisin seeds, and apricot kernels; the application of the osage orange wood of Texas and Oklahoma in place of foreign fustic, and the production of useful products of distillation from different hardwoods. The Petrocine colours, now being manufactured from waste products of petroleum, which are being investigated by the Bureau of Foreign and Domestic Commerce, formed a striking example of new adaptations. The exhibit of the Bureau of Standards was a prominent feature of the exhibition, not only in presenting the apparatus used in the laboratories of the bureau, but also examples of chemicals, metals, ores, and materials recently tested.

AN important study of the quality of platinum ware by Messrs. G. K. Burgess and P. D. Sale is found in No. 254 of the Scientific Papers of the United States Bureau of Standards. A simple thermo-electric method has been devised to determine the degree of purity of the platinum used in platinum vessels which does not mar the article tested; it gives data for the classification of platinum in terms of its equivalent iridium (or rhodium) content. Of 164 pieces of platinum ware tested, 26 per cent. contained less than 0·5 per cent. of iridium and 67 per cent. less than 2 per cent. of this metal. A method is described of ascertaining the loss on heating of platinum crucibles by means of a suitable electric furnace containing no heated metal parts. The loss of weight due to heating per 100 sq. cm. of crucible surface at 1200° ranged from 0·71 mgrm. to 2·69 mgrm. per hour, the smaller losses being for crucibles containing rhodium and the greater losses for crucibles containing iridium. Iron appears to diminish the loss on heating, but its presence is objectionable on account of the soluble oxide formed on the crucible surface. It seems to be possible from a thermo-electric and microscopic examination of a crucible to predict its probable loss of weight on heating within fairly close limits. Suggestions are offered concerning specifications of quality for the highest grade of platinum ware, including the substitution of rhodium for iridium as a stiffening

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agent, and the total elimination of iron. The nature of the disintegration of platinum and its alloys is briefly discussed.

THE announcements of Messrs. Crosby Lockwood and Son include:—A translation of Prof. Klingenberg's Large Electric Power Stations, illustrated; Oil-Field Development, by A. Beeby Thompson; Air Screws: an Analytical Study in the Application of the Analogy of an Aerofoil having a Rectilinear Motion, by M. A. S. Riach; and new editions of Naval Architect's and Shipbuilder's Pocket Book of Formulæ, Rules, and Tables (with a section on Aeronautics), by C. Mackrow and L. Woollard; Mechanical Handling of Material, by G. F. Zimmer.

MESSRS. GEORGE ALLEN AND UNWIN, LTD., will publish shortly:—Table of Compound Interest and Antilogarithms, by J. J. Stuckey, and a translation, by Dr. E. L. Schaub, of Prof. W. Wundt's Elements of Folk Psychology: Outlines of a Psychological History of the Development of Mankind.

OUR ASTRONOMICAL COLUMN.

THE GREAT METEOR OF OCTOBER 5.—A large number of descriptions of this object has reached Mr. W. F. Denning as the result of an appeal for observations published in some of the leading journals of the west of England. Mr. Denning sends us the following summary of the observations:—The meteor appears to have been widely seen over the S.W. region of England, and there were many observers in South Wales. Most of the spectators first saw a brilliant illumination of the sky and landscape, and, looking up to ascertain the cause, the end of the meteor or the luminous streak it left was at once perceived. To many of the observers in Cornwall and Devon the position of the object was in the N. by E. sky, and the streak remained visible for periods varying between two and twenty minutes.

The light evolved from the fireball at the instant of its greatest outburst is said to have exceeded that of the full moon, but there are not many really accurate accounts of its path amongst the stars. At first the streak was projected like a glowing bar among the stars between the pointers in Ursa Major and the Pole star, but it quickly became contorted and curled up, either into a ring with appendages or into an irregular ellipse, expanding as time went on, and becoming fainter.

Using many of the best observations of the meteor for comparison, the height seems to have been from 82 to 55 miles from over Lampeter to Neath, South Wales. The length of the visible course was about 42 miles, and velocity about 35 miles per second. Radiant at $248° + 72°$; but this feature is rather doubtful, and it is hoped that further observations of the flight may yet be acquired so that the position may be tested. The eastern side of the streak expanded so quickly and with a motion decidedly eastwards that its velocity must have been equivalent to about 90 miles per hour.

PROPER MOTIONS MEASURED BY THE BLINK-MICROSCOPE.—There can be no doubt that stereoscopic or quasi-stereoscopic methods are destined to become of very great importance in astronomical work. Thus at the Lowell Observatory, Lampland has employed Pulfrich's device, the blink-microscope, for detecting variables and asteroids; at Yerkes, Slocum has shown that it is equally well adapted for finding proper motions, and the instrument has been enthusiastically adopted at the Union Observatory, Johannesburg. The director, Mr. R. T. A. Innes, can even see this instrument with standard transparent charts replacing the unwieldy durchmusterung catalogues. Already many variable stars have been discovered by its use, asteroids have been successfully picked up, and a good beginning has now been made in its application to the question of proper motions. In Circular No. 25, Union Observatory, Mr. Innes and Mr. J. Vôute, an assistant from the Leyden Observatory, who has been working at the Cape, both describe methods by which the proper motions of a number of stars in the great ω Centauri cluster have been measured. The former not only *detects*, but also *measures* the displacements with the "blink," whilst Mr. Vôute only uses it to make the selection, and then proceeds to take differential micrometric measures. The plates employed (astrographic) had been taken separated by an interval of 23·85 years. Of the 2000 stars on the plate, 30 presented measurable displacements (motions exceeding an annual value of $0{\cdot}04''$–$0{\cdot}06''$), whilst for fifty others the indications were doubtful.

THE LIGHT-CURVE OF XX CYGNI.—Several recently published papers concerning stellar variability have possessed somewhat exceptional attraction, not only in the variety of methods exemplified, but chiefly in consequence of the notable astrophysical importance of the stellar bodies investigated. Another such memoir appears in the September number of the *Astrophysical Journal*, Dr. Harlow Shapley and Martha B. Shapley presenting an account of the employment of the latest methods of photographic actinometry in the study of the light curve of XX Cygni. Previous work indicated that this star was to be regarded as an abnormal Cepheid variable, exceptional not only by reason of its short period—the most rapid known—but also because it had been shown by Kron to present a greater amplitude of light-change visually than photographically. Employing the Mount Wilson 60-in. refractor on four nights, upwards of 300 photographs of the star on ordinary plates alternately with isochromatic plates with yellow screen were secured, providing the material for a photographic and photovisual investigation of its fluctuating light. The results obtained show that the shape of the mean light-curve, and also its range, are both variable. The visual range does not exceed the photographic but apparently is somewhat smaller. It is concluded that the maxima, although occurring at regular intervals, are disturbances varying in character, the minimum being the sensibly constant condition of the star. The value of the colour index indicates an average spectrum of the F type rather than A as classified at Harvard.

ATMOSPHERIC EFFECTS OF KATHODE RAYS.—M. J. Maurer, of the Central Meteorological Bureau, Zurich, describes (No. 4813, *Astronomische Nachrichten*) for the first time what is possibly an atmospheric effect due to solar kathode rays. Having formed the opinion that times of exceptional solar activity would be especially favourable for decisive observations of a long-suspected phenomenon, arrangements were accordingly made with Prof. Wolfer, who supplied information regarding the rapid development of solar activity about the middle of last June. The result was that between 2 and 3 p.m. on June 16, with a blue sky, in addition to the water-vapour halo of 70°, there was also observed a distinct brown aureole having a maximum breadth of about 15°. Prof. Wolfer also noted that some optical effect, comparable with the interposition of a slight veil of vapour, had interfered with his solar observations. It is further pointed out that Prof. Barnard recorded an auroral display on the night of June 16.

RECENT EXCAVATIONS ON A PALÆOLITHIC SITE IN JERSEY.

DURING the past summer excavations on the Palæolithic site known as La Cotte at St. Brelade, in Jersey, have been pushed on vigorously. When the work for the year came to an end in 1914 a trench had been driven across the cave from the western to the eastern side-wall, a distance of about 40 ft. This trench was about 8 ft. from the entrance. The excavations undertaken this year had three objects in view: first, to extend the examination of the Palæolithic floor along the western side-wall, of which 25 ft. in an inward direction had been uncovered in 1911, and if possible reach the hitherto undetermined back-wall; secondly, to clear the entrance of the cave along its whole breadth by removing the barrier of talus, about 25 ft. high, on the outer side of the trench; and lastly, on the inner side of the clearing thus made, to push along the eastern side-wall.

The work of excavation is being carried on by the Société Jersiaise, with the assistance of a committee of the British Association of which Dr. R. R. Marett is chairman. So much of the season's work as had been completed by the end of July was embodied in a report presented to the British Association at the Manchester meeting; but at that time not one-half of the season's work was over. Before describing the later results, it will be convenient to give a brief summary of what had already been done for those who may not have seen the report. The opening up of the Palæolithic floor along the western wall was carried forward a further 5 ft., worked flints being found sparsely at about 2 to 4 ft. above bench-mark. The cave was cleared across its entire front. The central part proved sterile, but a richly implementiferous bed, reaching from floor level to a height of 12 ft., was found under a ledge projecting some 12 ft. along the eastern side-wall. The finds, in addition to worked flints, included a large number of cores and hammer stones. There was also a great deal of bone in fair condition, one piece being apparently the knuckle-bone of a mammoth. A specially fine set of "hemi-Solutrian" implements occurred along the top of this bed. The working under the eastern wall was pushed forward for a distance of 27 ft., and revealed a quantity of burnt bone, indicating a former hearth. Flint was plentiful but of coarse pattern.

This was the extent of the work which had been carried out at the end of July. But by that time the roof of the cave, which consisted of masses of detached blocks, weighing anything up to ten or twelve tons, held in place by clay, had become unsafe. By dynamite and other means, however, all loose blocks, amounting to many tons, were removed, and the cave made reasonably safe after a fortnight's hard work. Excavations were then continued along the western side-wall for a further distance of 6 ft., when a projecting shelf of live rock was reached. On investigation it appeared that this was not the end of the cave. The shelf was undercut by a cavity penetrating inward at an angle of 45°. Here among other implements was found one of the most perfect of Mousterian "points" hitherto obtained on the site.

The working across the front of the cave proved rich in implements, but only up to the line corresponding to the line of the roof; beyond that it yielded nothing. The clearing of the *débris* on the inner side of the trench was begun and carried to a depth of about 30 ft. from the entrance right across the breadth of the cave. The breccia in the centre proved as rich in implements as the side-wall workings. The bone was in good condition, and included a magnificent tooth of a prehistoric elephant (? Antiquus) virtually intact. The implements for the most part were of a coarse type, but finer types occurred among them.

So much for the work of the month of August. It was proposed to carry on excavations throughout September in the hope of reaching the back wall of the cave. It was realised, however, that the work of clearing the undercutting on the western side was a danger. It had cleared away the support of a column of loose rock-rubbish, some 30 or 40 ft. thick, which had descended on the cave through a more or less vertical funnel. After two days' work, which proved remarkably rich in finds, the roof of the cave collapsed. Careful watch had been kept and no one was hurt, though warning was short—only a matter of minutes. About 1000 sq. ft. of floor had been opened up, but these workings are now completely buried under *débris*. As further falls are expected, work has been closed for the year.

Inspection of the chimney, the sides of which are now revealed, shows that another 20 ft. would have reached the cliff wall. It is probable, therefore, that the line of least resistance when work begins again will be to attack the cave from the back. In the meantime, the members of the Société Jersiaise and of the committee in charge of the exploration are busily engaged in sorting and classifying the finds. That this is a work of some magnitude will be gathered from the fact that in the past season some 3000 shaped implements, besides much workshop refuse and bone, have been taken from the site. Both in the number and the character of the finds it has proved one of the richest Palæolithic sites in Europe.

E. N. FALLAIZE.

THE LIGHTING OF FACTORIES AND WORKSHOPS.[1]

AT the present time, when so many factories are working at high pressure on Government contracts, the condition of workers well deserves scientific study. This point is emphasised by the recent appointment by the Minister of Munitions of War, with the concurrence of the Home Secretary, of a committee "to inquire and advise on questions of industrial fatigue, hours of labour, and other matters affecting the health and physical efficiency of workers in munition factories and workshops."

One matter of considerable importance in the factory—the matter of lighting—has just been dealt with in the First Report of the Departmental Committee appointed by the Home Secretary in 1913. The inquiry demanded special methods of investigation, and the committee has carried out a considerable amount of work. Evidence has been received from fifty witnesses, including inspectors of factories and representatives of various trade associations and scientific and technical societies. Eighty-five works in the chief industrial centres have been visited, and about 4000 measurements of illumination carried out. A series of experiments bearing on the standards of illumination required for various purposes was carried out at the National Physical Laboratory.

Inquiries were also made, through the Foreign Office, into the legislation relating to lighting in all the chief European countries and the United States, and the results are published in an appendix. In the United Kingdom no general provisions in regard to lighting (analogous to those regarding heating and ventilation) occur in the Factory Acts, although adequate lighting is required, in general terms, in underground bakehouses and in certain dangerous

[1] First Report of the Departmental Committee on Lighting in Factories and Workshops. Vol. i., Report and Appendices (Cd. 8000); Vol. ii., Minutes of Evidence, etc. (Cd. 8001). (London: H.M.S.O. and Wyman and Sons.) Vol. i., 11*d.*; Vol. ii., 1*s.* 7*d.*

trades. On the other hand, the codes of all the chief European countries, the United States, and India contain provisions requiring adequate lighting in factories.

The results of bad lighting have been studied in detail. A statistical inquiry into the number of accidents in various industries in each month of the year points to the conclusion that inadequate lighting is a contributory cause of accidents; it is significant that in mines the number of fatal accidents in surface work is greater in the winter when there is less daylight available, and the "accident rate" in most industries studied is considerably greater by artificial than by natural illumination. The evidence of witnesses and the statements of the Accident Offices Association, which embraces most of the insurance companies interested in the Workman's Compensation Act, supports this view. Specific instances are quoted of the effect of improved lighting in increasing the output and quality of work, and there is a general impression that unsatisfactory lighting is, in various ways, prejudicial to health.

The committee recommends that:—

(1) There should be a statutory provision:—

(*a*) Requiring adequate and suitable lighting in general terms in every part of a factory and workshop, and

(*b*) Giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

It is pointed out that "adequate lighting" should comply with the following requirements:—

(*a*) Adequacy.

(*b*) A reasonable degree of constancy and uniformity of illumination over the necessary area of work.

(*c*) The placing or shading of lamps so that the light from them does not fall directly in the eyes of an operator when engaged on his work, or when looking horizontally across the workroom.

(*d*) The placing of lights so as to avoid the casting of extraneous shadows on the work.

Certain recommendations are also made regarding the amount of illumination necessary in the working areas of factories, in foundries, dangerous parts of ways and open spaces, etc., and there is a special recommendation providing for exemption in special cases. These values, which range from 0·05–0·4 ft.-candle, are prescribed in the interests of safety and convenience, and without prejudice to the special illumination required for the carrying on of work. At present the committee is not prepared to recommend standards of illumination for various classes of work which require further investigation.

In the appendices, the measurements of illumination in various classes of factories are tabulated in such a way as to show the average values existing, and it is shown that the above values, which are suggested as a practical legal minimum, impose no hardship. Many manufacturers would prefer to provide substantially higher values, and these recommendations would be mainly instrumental in improving the illumination in out-of-date factories which have lagged behind the general advance. Besides carrying out tests of the artificial lighting in factories in terms of foot-candles, the committee has also accumulated a considerable amount of information regarding the natural illumination. This is expressed in terms of the "daylight factor" (*i.e.* the relation between the illumination inside a workroom and the total unrestricted illumination out of doors). The experiments at the National Physical Laboratory illustrate the connection existing between the amount of illumination required and the character of the material illuminated, which may be expressed thus:—

$$\text{Coefficient of reflection of material} \times \text{illumination necessary} = \text{constant}.$$

Other experiments bear on the relative merits of direct and indirect lighting for certain classes of work. The visibility of detail consisting of fabrics, embossed papers, engraved metal, etc., demands unidirectional illumination, and the ability to distinguish such detail is, for the same illumination, greater by direct than by indirect light.

An enterprising step in connection with this report is the issue of a short memorandum summarising its aims and conclusions, and pointing out the special interest attaching to the report at the present time, when so many factories are working overtime and preparations are being made for the period of the year when artificial lighting is mainly required.

THE TURQUOISE.[1]

DURING several years, whilst a curator in the United States National Museum, Dr. Pogue collected all the available information respecting this familiar gem-mineral, visiting for this purpose the principal museums and libraries of America and Europe. The result is an elaborate compilation with numerous footnotes giving references to the scattered literature of the subject. Being an exhaustive treatise on turquoise, although containing practically no original matter, it would have been more accessible and convenient for reference if it had been issued as a separate octavo volume, rather than being buried in the large quarto volumes of an academy publication.

The various aspects under which the subject is treated are indicated in the title. The section on geology contains a detailed account of the occurrence of the mineral at all its known localities, particularly those in Persia, the Sinai Peninsula, and the south-western portion of the United States. The States of New Mexico, Arizona, California, Nevada, and Colorado, where many ancient workings are known, have recently become important sources of the mineral, producing stones rivalling the Persian in quality. A useful table is given stating the enclosing rocks (mainly igneous rocks, and especially trachyte), the associated minerals (usually limonite, kaolin, and sericite), etc., for the more important turquoise occurrences. The mode or modes of origin of the mineral are discussed, and the general conclusion drawn that it has been formed by the percolation of surface waters through aluminous rocks containing apatite and disseminated copper minerals. An attempt is made to disentangle the confusion associated with the name "chalchihuitl" of the American aborigines. Although the early Spaniards confused several green stones under this name, it would appear that the Indians of the south-western States referred to turquoise, whilst in Mexico the material so-called was mainly jade. A detailed bibliography and a good index complete the work. The plates are, for the most part, devoted to representations of ancient ornaments set with turquoises. L. J. S.

PURPOSEFUL FORAMINIFERS.

MR. EDWARD HERON-ALLEN is to be congratulated on the interesting results which are rewarding his assiduous study of the Foraminifera. His latest contribution (*Phil. Trans.*, June, 1915) deals with the processes of reproduction and of shell-making. In addition to the production of zoospores observed

[1] "The Turquoise. A Study of its History, Mineralogy, Geology, Ethnology, Archæology, Mythology, Folklore, and Technology." By J. E. Pogue. Memoirs of the National Academy of Sciences, Washington, D.C., 1915, vol. xii., part ii., 3rd Memoir, pp. 162, 22 plates.

by Lister and others, some species exhibit viviparous reproduction and the budding-off of young individuals. The viviparous young are formed inside the parent shell and emerge by the dissolution of the base. The process demands a sacrifice of the whole of the protoplasm and of the internal septa, whereas in zoospore-production the shells of the young are formed outside the parent, from material derived from the surrounding medium, and not from the internal septa. Another method of multiplication is to bud-off a young individual from the shell-aperture of the parent. To this process and to the occasional (possibly fortuitous) mingling of the extruded protoplasm of two or more shells, is generally attributable what has been described as "plastogamy" in the Foraminifera.

In regard to shell-making, Mr. Heron-Allen has some remarkable evidence to submit of a quality which he calls "intelligence," or "an apparent development of purpose." The Foraminifer may select out of a large supply of possibilities one particular kind of material, such as sponge-spicules, minute flakes of mica, Echinoderm plates, and it may use this material in a purposive way. Thus in *Technitella legumen* "the whole shell wall consists of two distinct layers of spicules, an outer layer in which the spicules are all laid down with their long axes parallel to the long axis of the test, and an inner layer of spicules laid with their long axes at right angles to the outer layer, giving as close an approximation to the woof and warp of a textile fabric as is possible with a rigid non-flexible material such as sponge-spicules. It is obvious that by the crossing of these two layers the strength and resistance of the test to strain is enormously increased."

Or again, while *Marsipella cylindrica* forms a long and very friable tube of broken sponge-spicules, "it was left for *M. spiralis* to make the same great discovery as did the prehistoric genius who invented string—it has clearly realised that a twisted yarn is stronger than an untwisted wisp of fibre." The author maintains that "the Foraminifera exhibit the highest functions and the most 'intelligent behaviour' of which undifferentiated protoplasm has been observed to be capable."

MATHEMATICAL AND PHYSICAL SCIENCE AT THE BRITISH ASSOCIATION.

THE Section of Mathematical and Physical Science met under the presidency of Sir F. W. Dyson, whose address on the construction of the heavens appeared in NATURE of September 9.

Radio-active Elements and the Periodic Law.

Following the address, a discussion on radio-active elements and the periodic law took place. The opener, Prof. F. Soddy, explained that the discovery of a large number of radio-active disintegration products seemed at first difficult to reconcile with the periodic table of the elements; for it was clear that the existing gaps would not provide for more than a few of them. But it had been found that among them there were only three new separable elements —radium, polonium, and actinium; the others were isotopes of known elements, *i.e.*, they had identical chemical properties, although differing somewhat in atomic weight. The fundamental discovery, which brought order amongst these diverse products, was that when an α particle was expelled a shift of two places to the left in the table took place, whilst the expulsion of a β particle caused a shift of one place to the right. Since an α particle carries two positive charges, and a β particle one negative charge, this suggests that position in the periodic table is a function of the charge. Moseley's work has extended this by showing that it is true from end to end of the periodic table. Another fundamental fact is Rutherford's discovery of the nucleus of the atom, which was detected by experiments in scattering. We arrive at the conclusion that isotopes have the same *net* nuclear charge, though the gross number of positive and negative charges differs. Isotopes cannot be separated by chemical means, and hitherto diffusion methods have been unsuccessful. In view of the numerous isotopes of lead the question of the variability of the atomic weight of lead derived from different minerals becomes important; variations from 206·05 (uranium lead) to 207·67 (thorite lead) have been found. The new view of the periodic table is that it is a relation between chemical character and nuclear charge, not between character and mass; and it is possible now to state that there are exactly 92 elements up to uranium (counting isotopes as one element), of which 86 are known. We seem to be returning to the view of the Greeks and alchemists that elements are qualities, in contrast to the later view that elements are constituents.

Dr. N. Bohr pointed out that the dimensions of the nucleus are so small compared with the outer rings of electrons, that the nuclear constitution would have negligible effect on the electric field in these outer parts, only the net charge being important. Consequently, properties depending on the outer rings of electrons would be the same for all isotopes. In the case of spectral vibrations, there occurs a small term depending on the mass of the central nucleus, and accordingly we ought to look out for a small but perceptible difference between the spectra of two isotopes. Dr. F. A. Lindemann gave a theoretical argument to show that you could not have identical chemical *and* physical properties when the atomic weight differed. If the chemical properties were the same, certain physical properties must differ, and *vice versâ*. Mr. A. Fleck compared the effects of taking away charges from uranium, (*a*) by reduction (uranous salts), and (*b*) by disintegration (UrX salts). Dr. Whytlaw Gray described experiments on minute quantities of RaD, showing that it answered the chemical tests for lead. He thought it would not be difficult to observe its melting point directly. Sir E. Rutherford said that it was surprising how simply the whole system of thirty-four new products had been absorbed in the periodic table. In one case we have seven isotopes, all radio-active except one (Pb). Those which show radio-activity are distinguishable from one another by that property. Several references were made to the loss of Mr. H. G.-J. Moseley, killed at the Dardanelles, to whose researches this subject has owed so much.

The Order of Stellar Evolution.

On Thursday morning, Prof. A. Fowler opened a discussion on spectral classification of stars and the order of stellar evolution. He described the order of the types of stellar spectrum, which, according to the Draper notation, form the sequence O, B, A, F, G, K, M, and pointed out that this sequence has come to be regarded not merely as a convenient mode of description, but as actually representing successive stages of evolution. The spectra present striking evidence of a continuity extending from one end to the other of the sequence, and there are links connecting the earliest type, O, to the gaseous nebulæ. The temperatures of the stars decrease in the order of the sequence from upwards of 10,000° C. for the B stars to 3000° C. for the M stars, and at the same time the colour changes continuously from white to red. Additional evidence in support of the sequence is obtained from laboratory researches; from types G to M, the stars show spectral lines characteristic of the "arc"; from B2 to F the "spark" lines are shown; and in the earliest divisions O to B1 the lines are for the most part unattainable in the laboratory, except by the most powerful electric discharge. These last may be described as "super-spark" stars. The evidence fully establishes a physical continuity corresponding to the Draper sequence. Prof. Fowler concluded by referring to the theory of Sir Norman Lockyer, and to Prof. Russell's hypothesis, which is closely akin to it. According to these, the stars fall into parallel series of ascending and descending temperature respectively, so that the hottest stars (types B and O) come midway in the order of evolution.

Sir Frank Dyson set forth the evidence, based on the observed luminosities and densities of the stars, which led Russell to the view that the red stars represent both the earliest and latest stages of evolution. It seems necessary to believe that some of the M stars are extremely diffused bodies, and others very dense. The Draper sequence gives the order of temperature; but the order of evolution is that of increasing density, not necessarily that of decreasing temperature. Prof. Eddington pointed out that the actual calculations of stellar density in particular cases compel us to admit that two stars having the densities respectively of water and of air can yet show the same type of spectrum; this seems to remove one of the chief objections brought against Russell's theory. The adoption of this theory would, however, play havoc with the regularity of many statistical results which have hitherto seemed orderly and intelligible. Father Cortie referred to the changes of a spectrum in a Nova, which seem to show that in these cases the nebular and type O spectra come, not before, but after the B and A stages. Prof. Nicholson and Mr. Merton discussed the nature of the Wolf-Rayet spectrum (type O). In his reply, Prof. Fowler pointed out a serious difficulty of Russell's hypothesis, that we have no celestial spectra which can be regarded as bridging the gap between primordial nebulous matter and the intensely bright giant stars of type M.

Thermionic Emission.

On Friday Prof. O. W. Richardson opened a discussion on thermionic emission. He said that he would confine his remarks to the emission of negative ions from hot bodies, which seemed to be an intrinsic property, whereas the emission of positive ions was not permanent and could be traced to impurities. The emission of negative ions increases rapidly with temperature according to the formula $C=AT^{\frac{1}{2}}e^{-b/T}$, where T is the absolute temperature. It was found, however, by H. A. Wilson and by Langmuir that the constants depend greatly on the experimental conditions. The temperature-law would follow theoretically from purely physical considerations. On the other hand, a similar law may be deduced if the effect is due to chemical action. In the experiments of Haber and Just the emission of electrons from alkali metals was observed under the action of water vapour and other agents. This is the only known case of the kind, and the distribution of energy among the emitted electrons suggests that it is something different from thermionic emission. On the question of the distribution of energy among the electrons during chemical action, Prof. Richardson had gained the impression from his experiments that it did not conform to Maxwell's law, but was more analogous to the laws governing the photoelectric effect; the facts of thermionic emission require Maxwell's law. As the best possible test between the physical and chemical theories, he had recently conducted experiments on a tungsten wire with special precautions against impurities; the emission was found to be much too great and persistent to be accounted for by residual gaseous impurities. He concluded that the action was not chemical, nor could it be a photoelectric action of the temperature radiation; and the physical theory seemed the most satisfactory.

Dr. F. A. Lindemann discussed the bearing of the experiments on the chain theory of electric conduction. Mr. E. Newbery criticised the use of tungsten in the crucial experiment on account of its great chemical activity at high temperature. Dr. J. A. Harker discussed the bearing of experiments on the electric arc under high pressure.

Miscellaneous Papers.

There was no subdivision of the Section this year, and the papers selected for reading were taken in full Section. Technical subjects were therefore avoided, and even the mathematical papers were such as would appeal to the members generally. Mr. G. H. Hardy greatly interested his audience with a paper on prime numbers. He gave an historical survey of the investigation of the distribution of primes, with particular reference to the theorem that the number of primes less than x approaches asymptotically to $x/\log x$ for large numbers. This theorem was first conjectured by Legendre, but was not proved until 1896. An explanation of the importance of the Riemann-ζ function in this connection was given. The paper is to be printed *in extenso* in the report. Prof. A. N. Whitehead, in a paper on space, time, and relativity, gave an account of the philosophical difficulties connected with space and time so far as they concern mathematicians. His remarkably simple method of arriving at the fundamental equations of the principle of relativity was especially valuable. Mr. A. A. Robb and Mr. H. R. Hassé took part in the discussion, the former explaining his method of logical development of the subject based on the idea of points arranged in "conical order."

Prof. W. H. Bragg's account of X-rays and crystal structure showed the power of the new methods of determining the arrangement of the atoms in a crystal. Instead of attempting to summarise this remarkable paper, we may refer the reader to Prof. Bragg's Bakerian lecture in the *Phil. Trans.* (vol. ccxv., p. 253), which covers similar ground. Prof. J. C. McClennan gave an account of his production of single-line spectra of cadmium and zinc, showing that the wave-lengths of the lines are connected with the ionisation potential by a relation depending on the quantum theory. Sir J. Larmor discussed the decomposition of the irregular vibrations constituting white light into regular trains of waves, when a grating or prism is used; for the prism, he gave an explanation based on the difference between wave-velocity and group-velocity in a dispersive medium.

Meteorology was represented by a paper by Mr. F. J. W. Whipple on the mechanism of cyclones, in which an account was given of the observed distribution and pressure at different heights, and the dynamical connection between the pressure-gradient and the inflow and outflow of air was discussed. In presenting the report of the committee on seismology, Prof. H. H. Turner stated that the work of plotting on a map the earthquake epicentres observed by Milne had now been completed. The epicentres were found especially on two great circles cutting at right angles. He referred also to improvements made in the Milne seismograph by Messrs. J. J. Shaw and J. H. Burgess.

The meeting concluded on Friday afternoon with a very interesting address by Prof. Pierre Weiss on new views of magnetism, in which he described his researches on the part played by the magneton, or definite unit of magnetism, in the phenomena of iron, nickel, cobalt, and their alloys.

THE BRITISH ASSOCIATION.

SECTION K

BOTANY.

OPENING ADDRESS [1] BY PROF. W. H. LANG, F.R.S., PRESIDENT OF THE SECTION.

Phyletic and Causal Morphology.

I PROPOSE to deal with some aspects of the study of plant-morphology. In doing so I shall not accept any definition of morphology that would separate it artificially from other departments of botany. I regard the aim of plant-morphology as the study and scientific explanation of the form, structure, and development of plants. This abandons any sharp separation of morphology and physiology, and claims for morphology a wider scope than has been customary for the past fifty years. During this period the problem of morphology has been recognised as being "a purely historical one," "perfectly distinct from any of the questions with which physiology has to do," its aim being "to reconstruct the evolutionary tree." The limitation of the purpose of morphological study, expressed in these phrases from the admirable addresses delivered to this section by Dr. Scott and Prof. Bower some twenty years ago, was due to the influence of the theory of descent. I fully recognise the interest of the phyletic ideal, but am unable to regard it as the exclusive, or perhaps as the most important, object of morphological investigation. To accept the limitation of morphology to genealogical problems is inconsistent with the progress of this branch of study before the acceptance of the theory of descent, and leaves out many of the most important problems that were raised and studied by the earlier morphologists.

In the history of morphology, after it had ceased to be the handmaid of the systematic botany of the higher plants, we may broadly distinguish an idealistic period, a developmental period, and a phyletic period. The period of developmental morphology, the most fruitful and the most purely inductive in our science, was characterised by an intimate connection between morphological and physiological work. Among its contributions were studies of development or "growth histories" of whole plants and their members. These were carried out, in part at least, in order to investigate the nature of development, and such general problems found their expression at the close of the period in the "Allgemeine Morphologie" of Hofmeister. The "Origin of Species" took some years before it affected the methods and aims of botanical work. Then its effect on morphology was revolutionary, and, as in all revolutions, some of the best elements of the previous *régime* were temporarily obscured. This excessive influence of the theory of descent upon morphology did not come from Darwin himself, but from his apostle Haeckel, who gave a very precise expression to the idea of a genealogical grouping of animals and plants, illustrated by elaborate hypothetical phylogenetic trees. Such ideas rapidly dominated morphological work, and we find a special "phylogenetic method" advocated by Strasburger. The persistence of the phyletic period to the present time is shown, not only in the devotion of morphology to questions of relationship, but in the attempts made to base homologies upon descent only. Lankester's idea of homogeny can be traced to the influence of Haeckel, and nothing shows the consistency of phyletic morphology to its clear but somewhat narrow ideal so plainly as the repeated attempts to introduce into practice a sharp distinction between homogeny and homoplasy.

Prof. Bower, in his address last year and in other papers, has dealt illuminatingly with the aims and methods of phyletic morphology. I need only direct attention to some aspects of the present position of this, which bear on causal morphology. The goal of phyletic morphology has throughout been to construct the genealogical tree of the vegetable kingdom. In some ways this seems farther off than ever. Phyletic work has been its own critic, and the phylogeny of the genealogical tree, since that first very complete monophyletic one by Haeckel, affords a clear example of a reduction series. The most recent and trustworthy graphic representations of the inter-relationships of plants look more like a bundle of sticks than a tree. Consider for a moment our complete ignorance of the inter-relationships of the Algæ, Bryophyta, and Pteridophyta. Regarding the Algæ we have no direct evidence, but the comparative study of existing forms has suggested parallel developments along four or more main lines from different starting-points in a very simple unicellular ancestry. We have no clue, direct or indirect, to the ancestral forms of the Bryophyta, and it is an open question whether there may not be as many parallel series in this group as in the Algæ. The Pteridophyta seem a better case, for we have direct evidence from fossil plants as well as the comparison of living forms to assist us. Though palæobotany has added the Sphenophyllales to the existing groups of vascular cryptogams and has greatly enlarged our conceptions of the others, there is no proof of how the great groups are related to one another. As in the Bryophyta, they may represent several completely independent parallel lines. There is no evidence as to what sort of plants the Pteridophyta were derived from, and in particular none that relates them to any group of Bryophyta or Algæ. I do not want to labour the argument, but much the same can be said of the seed-plants, though there is considerable evidence and fairly general agreement as to some Gymnosperms having come from ancient Filicales. The progress of phyletic work has thus brought into relief the limitations of the possible results and the inherent difficulties. As pointed out by Prof. Bower, we can hope for detailed and definite results only in particularly favourable cases, like that of the Filicales.

The change of attitude shown in recent phyletic work towards "parallel developments in phyla which are believed to have been of distinct origin" is even more significant. Prof. Bower spoke of the prevalence of this as an "obstacle to success," and so it is if our aim is purely phyletic. In another way the demonstration of parallel developments constitutes a positive result of great value. Thus Prof. Bower's own work has led to the recognition of a number of series leading from the lower to the higher Filicales. By independent but parallel evolutionary paths, from diverse starting-points in the more ancient ferns, such similarity has been reached that systematists have placed the plants of distinct origin in the same genus. In these progressions a number of characters run more or less clearly parallel, so that the final result appears to be due "to a phyletic drift that may have affected similarly a plurality of lines of descent." This conclusion, based on detailed investigation,

[1] Abridged by the author.

appears to me to be of far-reaching importance. If a "phyletic drift" in the ferns has resulted in the independent and parallel origin of such characters as dictyostely, the mixed sorus, and the very definite type of sporangium with a vertical annulus and transverse dehiscence, the case for parallel developments in other groups is greatly strengthened. The interest shifts to the causes underlying such progressive changes as appear in parallel developments, and the problem becomes one of causal morphology rather than purely historical.

The study of parallel developments would, indeed, seem likely to throw more light on the morphology of plants than the changes traced in a pure phyletic line, for it leads us to seek for common causes, whether internal or external. We cease to be limited in our comparisons by actual relationship, or forbidden to elucidate the organisation in one group by that which has arisen independently in another. Similarly the prohibition against comparing the one generation in the life-cycle with the other falls to the ground, quite apart from any question of whether the alternation is homologous or antithetic. The methods of advance and the causal factors concerned become the important things, and if, for example, light is thrown on the organisation of the fern-plant by comparison with the gametophyte of the moss, so much the better. This, however, is frankly to abandon phylogeny as "the only real basis of morphological study," and with this any attempt to base homology on homogeny. Many of the homologies that exist between series of parallel development are what have been happily termed homologies of organisation; these are sometimes so close as to result in practical identity, at other times so distinct as to be evident homoplasies. The critical study of homologies of organisation over as wide an area as possible becomes of primary interest and importance.

Since about the beginning of the present century a change of attitude towards morphological problems has become more and more evident in several ways. It seems to be a phyletic drift affecting simultaneously a plurality of lines of thought. The increasing tendency to look upon problems of development and construction from a causal point of view is seen in the prominence given to what may be termed developmental physiology, and also in what Goebel has called organography. These deal with the same problems from different sides and neither formulates them as they appear to the morphologist. Together with genetics, they indicate the need of recognising what I prefer to call general or causal morphology.

The problems of causal morphology are not new, though most of them are still unsolved and are difficult to formulate, let alone to answer. As we have seen, they were recognised in the time of developmental morphology, though they have since been almost wholly neglected by morphologists. So far as they have been studied during the phyletic period, it has been from the physiological rather than the morphological side. Still, such problems force themselves upon the ordinary morphologist, and it is from his position that I venture to approach them. I willingly recognise, however, that causal morphology may also be regarded as a department of plant-physiology. In development, which is the essential of the problem, the distinction between morphology and physiology really disappears, even if this distinction can be usefully maintained in the study of the fully developed organism. We are brought up against a fact which is readily overlooked in these days of specialisation, that botany is the scientific study of plants.

General morphology agrees with physiology in its aim, being a causal explanation of the plant and not historical. Its problems would remain if the phyletic history were before us in full. In the present state of our ignorance, however, we need not be limited to a physico-chemical explanation of the plant. Modern physiology rightly aims at this so far as possible, but, while successful in some departments, has to adopt other methods of explanation and analysis in dealing with irritability. It is even more obvious that no physico-chemical explanation extends far enough to reach the problems of development and morphological construction. The morphologist must therefore take the complicated form and its genesis in development and strive for a morphological analysis of the developing plant. This is to attack the problem from the other side, and to work back from the phenomena of organisation toward concepts of the nature of the underlying substance.

It is to these questions of general morphology with a causal aim (for causal morphology, though convenient, is really too ambitious a name for anything we yet possess) that I wish to ask your attention. All we can do at first is to take up a new attitude towards our problems, and to gather here and there hints upon which new lines of attack may be based. This new attitude is, however, as I have pointed out, a very old one, and in adopting it we re-connect with the period of developmental morphology. Since the limited time at my disposal forbids adequate reference to historical details, and to the work and thought of many botanists in this field, let me in a word disclaim any originality in trying to express in relation to some morphological problems what seems to me the significant trend, in part deliberate and in part unconscious, of morphology at present. The methods available in causal morphology are the detailed study in selected plants of the normal development and its results, comparison over as wide an area as possible, with special attention to the essential correspondences (homologies of organisation) arrived at independently, the study of variations, mutations, and abnormalities in the light of their development, and ultimately critical experimental work. This will be evident in the following attempt to look at some old questions from the causal point of view. I shall take them as suggested by the fern, without confining my remarks to this. The fern presents all the main problems in the morphology of the vegetative organs of the higher plants, and what little I have to say regarding the further step to the seed-habit will come as a natural appendix to its consideration.

Individual Development.

Twice in its normal life-history the fern exhibits a process of development starting from the single cell and resulting in the one case in the prothallus and in the other in the fern-plant. For the present we may treat these two stages in the life-history as individuals, their development presenting the same general problems as a plant of, say, Fucus or Enteromorpha, where there is no alternation of generations. How is the morphologist to regard this process of individual development?

In the first place, we seem forced to regard the specific distinctness as holding for the germ as well as the resulting mature plant, however the relation between the germ-cell and the characters of the developed organism is to be explained. We start thus with a conception of specific substance, leaving it quite an open question on what the specific nature depends. This enables us to state the problem of development freed from all considerations of the ultimate uses of the developed structure. The course of development to the adult condition can be looked upon as the manifestation of the properties of the specific substance under certain conditions. This decides our attitude as morphologists to the functions of the plant and to teleology. Function does not concern us except in so far as it is found to enter as a causal factor into the process of development. Similarly, until purpose can be shown to be effective as a causal factor it is merely an unfortunate expression for the result attained.

Let me remind you, also, that the individual plant, whether it be unicellular, cœnocytic, or multicellular, may behave as a whole at all stages of its development. We see this, for instance, in the germination of Œdogonium, in the germination and subsequent strengthening of the basal region in Fucus or Laminaria, in the moss-plant or fern-plant, or in a dicotyledonous tree. A system of relations is evident in the plant, expressed in the polarity and the mutual influences of the main axis and lateral branches, as well as in the influences exerted on the basal region by the distant growing parts. We thus recognise, in its most general form, the correlation of parts, a concept of proved value in botany.

To some the expression of the observed facts in this way may appear perilously mystical. I do not think so myself. It is true that the nature of the specific substance and of the system of relations is unknown to us, but it is regarded as a subject for scientific inquiry and further explanation. To recognise fully the complexity of the substance of the plant is not, however, a step towards neo-vitalism, but is perhaps our best safeguard against the dangers of this.

The wholeness of the individual, together with important phenomena of regeneration, has suggested the conclusion that something other than physico-chemical or mechanical laws are concerned in the development of the organism. To this something Driesch applies the name entelechy. Without discussing the vitalistic philosophy of the organism, or other modern phases of philosophic thought that treat life as an entity, it seems worth while to point out that they are based mainly on the consideration of animal development. It would be interesting to inquire into the difficulties that are met with in applying such views to plants, where regeneration in one form or another is the rule rather than the exception, and often does not lead to restitution of the individual. Causal morphology can recognise phenomena of development and of the individual, which are at present beyond physico-chemical explanation, and try to attack them by any methods of investigation that seem practicable, without begging the main question at the outset and then proceeding deductively. To assume any special inner director of development, be it entelechy or vital force, is to cut the knot that may ultimately be untied.

The previous experience of botany in the time of nature-philosophy may well make us cautious of solving our difficulties by the help of any new biological philosophy. On the other hand, co-operation between biology and philosophic thought is highly desirable. In this connection I should like to refer to an idea contained in Prof. Alexander's paper on the basis of realism. He suggests that there is only one matrix from which all qualities arise, and that (without introducing any fresh stuff of existence) the secondary qualities, life, and at a still higher level, mind, emerge by some grouping of the elements within the matrix. The development of this idea as it applies to life would appear to offer a real point of contact between inductive biological work and philosophy.

To return to our plant, its development, with increase in size and progressive complexity of external form and internal structure, must be considered. The power of continued development possessed by most plants and wanting in most animals makes comparison between the two kingdoms difficult. That there is no fundamental difference between the continued and the definitely limited types of embryogeny is, however, shown by plants themselves. The bryophyte sporogonium is a clear example of the latter, while the fern sporophyte is one of many examples of the former. A difference less commonly emphasised is that in the sporogonium (as in the higher animals) the later stages of development proceed by transformation of the whole of the embryo into the mature or adult condition; in the fern-plant the apical development results in successive additions of regions which then attain their mature structure by transformation of the meristematic tissue.

These distinctions are of some importance in considering the generalisation originally founded on animal development and known as the biogenetic law. That "the ontogeny is a concise and compressed recapitulation of the phylogeny" is essentially a phyletic conception. It has been more or less criticised and challenged by some distinguished zoologists, and has always been difficult to apply to plants. If we avoid being prejudiced by zoological theory and results, we do not find that the characters of the embryos of plants have given the key to doubtful questions of phylogeny. What help do they give us, for instance, in the algæ or the vascular cryptogams? The extension of the idea of recapitulation to the successively formed regions of the seedling plant requires critical examination; if admitted, it is at any rate something different from what the zoologist usually means by this. The facts—as shown, for instance, in a young fern-plant—are most interesting, but can perhaps be better looked at in another way. Development is accompanied by an increase in size of the successively formed leaves and portions of stem, and the process is often cumulative, going on more and more rapidly as the means increase until the adult proportions are attained. The same specific system of relations may thus find different expression in the developing plant as constructive materials accumulate. I do not want to imply that the question is merely a quantitative one; quality of material may be involved, or the explanation may lie still deeper. The point is that the progression is not a necessary one due to some recapitulative memory.

There are some other classes of facts, clearly cognate to normal individual development, that seem to require the causal explanation. I may mention three:—(1) Vegetatively produced plants (from bulbils, gemmæ, etc.) tend in their development to pass through stages in elaboration similar to young plants developing from a spore or zygote. The similarities are more striking the smaller the portion of material from which a start is made. (2) Branches may repeat the stages in ontogeny more or less completely also in relation to differences in the nutritive conditions. (3) In the course of continued development there may be a return to the simpler form and structure passed through on the way to the more complex. These cases of parallels to, or reversals of, the normal ontogenetic sequence suggest explanation on causal lines, but are difficulties in the way of phyletic recapitulation; the first two cases can be included under this, while the third seems definitely antagonistic. On the whole, it may be said that recapitulation cannot be accepted for plants without further evidence, and that preliminary inquiry disposes us to seek a deeper and more fruitful method of explaining the facts of development.

The development of most plant-individuals starts from a single cell, and when we compare mature forms of various grades of complexity the unicellular condition is also our usual starting-point. What is not so generally recognised or emphasised is the importance of the filament as the primitive construction-form of most plants. I do not use the word primitive in a phyletic sense, nor in the sense of an ideal form, but to indicate a real stage in independent progressions underlying many homologies of organisation. I cannot develop this fully here, but wide comparison of independent lines of advance suggests that the main types of progress in complexity of the plant-body have involved the elaboration of the single filament with apical growth and with subordinated "branches." It is generally recognised that various groups of algæ show how a solid multicellular axis may come about, not only by the further partition of the segments of the apical cell, but by the congenital cortication of a central filament or the congenital condensation of the subordinated "branches" on to the central axis. The algæ further show the change from the dome-shaped apical cell of a filament to the sunken initial cell with two, three, or four sides. The central filament then only appears, if at all, as a subsequent differentiation in the tissue, and the segments serially cut off from the apical cell may or may not bear projecting hair-shoots or "leaves." The algæ thus attain in independent lines a construction corresponding to that of the plant in liverworts and mosses. In the various parallel series of Bryophyta the filament is not only more or less evident in the ontogeny, but may be regarded as the form underlying both thallus and shoot, between which on this view there is no fundamental distinction. The sporogonium also can be readily regarded as an elaborated filament. While the same interpretation of the fern-prothallus will readily be granted, to think of the fern-plant as the equivalent of an elaborated filament may appear far-fetched. So far from this being the case, I believe that it will be found helpful in understanding the essential morphology of the shoot. In a number of vascular cryptogams and seed-plants, there is actually a filamentous juvenile stage, the suspensor, while the growth by a single apical cell is essentially the same in the fern as in the moss and some algæ.

There follows from this a natural explanation of the growth by a single initial cell so commonly found in plants. The apical cell appears to be the one part of the massive plant-body (for instance, of Laurencia, a moss, or a fern) that persists as a filament; it is a filament one cell long. It may be replaced by a group of initial cells, as we see in some algæ, liverworts, and Pteridophyta, and this leads naturally to the small-celled meristems found in most Gymnosperms and Angiosperms. The filamentous condition is then wholly lost, though the system of relations and especially the polarity is maintained throughout all the changes in the apical meristem.

I feel confirmed in regarding the construction of the sporophyte in this fashion by the fact that it fits naturally with the conclusions resulting from the masterly comparative treatment of the embryology of the vascular cryptogams by Prof. Bower. These are (1) the primary importance of the longitudinal axis of the shoot, the position of the first root and the foot being variable; (2) the constancy of the position of the stem-apex near the centre of the epibasal half of the embryo; (3) the probability that embryos without suspensors have been derived from forms with suspensors, without any example of the converse change. These and other related facts seem to find their morphological explanation in the shoot of the sporophyte being the result of the elaboration of a filament.

The Construction of the Shoot.

The view to which we are thus led is that the uniaxial shoot is a complex whole, equivalent to the axial filament together with its congenitally associated subordinated "branches." This applies to the multicellular plant-bodies found in various independent lines of algæ and Bryophyta, whether they have definite projecting appendages of the nature of leaves or not. The discarding of the distinction between thallus and shoot, which in practice has proved an unsatisfactory one, is no great loss. Even taking the word in the narrower sense of a stem with distinct leaves, the shoots in algæ, liverworts, and mosses, though admittedly independent developments, exhibit an essential correspondence amounting to a homology of organisation. The resemblances are not analogies, for it is doubtful whether the "leaves" in the different cases correspond in function. The comparison of the shoot of the sporophyte of a vascular cryptogam with, for example, the shoot of the moss seems equally justifiable. It is only forbidden by strict phyletic morphology, which for our purpose has no jurisdiction. The general agreement as regards the leaf-arrangement between the ferns and the Bryophyta suggests that similar laws will be found to hold in the shoot of both gametophyte and sporophyte. Apart from plagiotropic shoots, there is a constructionally dorsiventral type of fern-rhizome. The leaves of this alternate as in the leafy liverworts, while the radial type of fern corresponds to the moss-shoot. It is significant that the early leaves of radially constructed ferns usually exhibit a divergence of $\frac{1}{3}$ in the seedling, passing higher up the stem into more complicated arrangements, and the same is the case in mosses. I must not enter into questions of phyllotaxy, but may remark on the hopefulness of attacking it from the study of the simpler shoots of algæ and Bryophyta rather than, as has usually been done, beginning with the flowering plants.

In some ferns (the striking example being Ceratopteris) the relation between the segmentation of the apical cell and leaf-production is as definite as in the moss, each segment giving rise to a leaf. This may hold more widely for ferns than is at present demonstrated, and the question deserves thorough re-investigation to ascertain the facts independently of any theoretical views. That the coincidence of the segmentation of the shoot expressed by the leaf-arrangement and the segmentation of an apical cell is not a necessary one is, however, clearly shown in other ferns, and is obvious in the case of shoots with a small-celled meristem. The two segmentations appear to be determined by some deeper system of relations, which may also be manifested in a cœnocytic plant-body.

In the complication of the uniaxial shoot introduced by branching also there seems to be an advantage in a wide area of comparison. The question most often discussed concerns dichotomous and monopodial branching. If the details of development are to be taken into consideration, the term "dichotomy" has usually been very loosely applied. Apparent dichotomy, the continuation of one shoot by two equally strong ones, is fairly common. But in most cases investigated in detail the branching seems to be really monopodial and the forking due to the equally strong development of a lateral branch close to the main apex, not to the division of the latter. In plants growing by a single initial cell almost the only case of strict dichotomy known is the classic one of Dictyota. The branching of the ferns has been the subject of numerous investigations, but there is a great lack of developmental data. Usually the branches stand in some definite relation to the leaves of the shoot, behind, to one side, or on the leaf-base, itself, the most interesting but least common case being when the branch is in an axillary position. When the mature shoot only is considered, it is possible to argue for the derivation of monopodial branching from dichotomy or the converse. Even the facts obtainable from the mature plant, however, point to the dichotomous branching being a modification of the monopodial, the opposite view appearing to land us in difficulties regarding the morphology of the main shoot. It is unlikely that a dichotomy involving the division of the apical cell occurs in the fern-shoot, and comparison with the Bryophyta confirms the suspicion that the cases of dichotomy are only apparent.

In considering the construction of the shoot we are at present limited to comparison of the normal structure and development. The system of relations in the shoot of the fern, affecting in the first place the distribution of the leaves and secondly that of the branches, appears, however, to be of the same nature as in the independently evolved shoots of Bryophyta and algæ. A morphological analysis based on the simpler examples may lead on to the experimental investigation of the common construction. The relation that exists between the general construction and the vascular anatomy offers a special and more immediately hopeful problem. Here also, in considering the fern, we are assisted by homologies of organisation in other vascular cryptogams and in the more complex Bryophyta, though the algæ are of little help.

In few departments of botany has our knowledge increased so greatly and become so accurate as in that of vascular anatomy. The definiteness of the structures concerned and the fact that they have been almost as readily studied in fossil as in living plants has led to this. Not less important have been the clear concepts first of the bundle system and later of the stele under which the wealth of fact has been brought. Great progress has been made under the influence of phyletic morphology, and anatomy has adopted further conventions of its own and tended to treat the vascular system as if it had an almost independent existence in the plant. The chief method employed has been the comparative study of the mature regions, of necessity in the fossils and by choice in the case of existing plants. I do not, of course, mean to say that we are ignorant of the development of the vascular system, but the variety in it has not been adequately studied in the light of apical development. A gap in our knowledge usually comes between the apical meristem itself and the region with a developed vascular system. It is in this intermediate region that the real differentiation takes place, and the arrangement of the first vascular tracts is then modified by unequal extension of the various parts. The apical differentiation requires separate study for each grade of complexity of the vascular system, even in the same plant.

If we look at the vascular system, not as if it had an independent existence or from the phyletic point of view, but as a differentiation taking place within the body of the individual plant, we can inquire as to the causal factors in the process. A deeper insight into the nature of the stele may be obtained by regarding it as the resultant of a number of factors, as part of the manifestation of the system of relations in development. The first step towards this is the critical consideration of normal developing plants, but so long as the causal influences in the developing substance of a plant remain unchanged the resulting vascular structure will remain constant. Our hope of advance lies in the study of cases where these influences are modified. Herein lies the value of abnormalities, of natural experiments, and the results of experimental interference. Possible influences that have at various times been suggested are functional stimuli, the inductive influence of the older pre-formed parts on the developing region, and formative stimuli of unknown nature proceeding from the developing region. The functional stimuli do not come into play at the time of laying down the vascular tracts, though they may have importance in their maintenance later; the inductive influence of the anatomy of older regions is excluded in the first differentiation of the vascular system in an embryo; we are thus led to attach special importance to the detection of the action of formative stimuli proceeding from the young developing primordia. We have further to take external stimuli into account, though these must act by influencing the internal system of relations.

Time will not permit of reference to the scattered literature bearing on this subject, but it may make the reality of such formative stimuli a little clearer if I refer to some examples that have turned up in the course of my morphological work. In the case of the shoot, formative influences must act in the small apical region where we have the meristematic growing point with the primordia of the leaves. There is a presumption in favour of some sort of segmental construction of the meristem in relation to the leaves, whether this coincides with the cell-segmentation or not, and such a segmental construction is reflected in the vascular system. Can we in the first place distinguish any parts played by influences from the stem-apex and the developing leaves respectively? Unfortunately we know little or nothing of the anatomical relations in the rare cases of adventitious leaf-formation. We get a little insight into the respective influences of leaf and axis, however, when we compare shoots with well-developed leaves and those without leaves or with greatly reduced leaves; this may be done between distinct plants or between different regions of the same plant. It seems to emerge from such comparisons that, as regards the xylem at least, a central strand may be independent of influences from the leaves, while the latter may not only determine the leaf-traces connecting with the central strand, but may influence the periphery of this; the result is a cylinder of outer xylem continuous with the leaf-traces. This general conception is borne out by widely different plants, the correspondences between which are homologies of organisation. I may instance the stele of the Polytrichaceæ as analysed by Mr. and Mrs. Tansley, the stele of the rhizome and aerial shoots of the Psilotaceæ, of the Lycopods with larger or smaller leaves, and the stele of the ferns at various ages of the plant. The shoot of Isoetes, which is of the Lycopod type, but has relatively large leaves, shows the composite nature of the stelar xylem particularly clearly, and also suggests how the component influences are at work in the meristematic region of the stem bringing about the resultant structure.

Owing to the small size of the shoot-apex, it is difficult to induce deviations from the normal to show the respective parts played by the central axis and by the influences from the leaf-primordia. The reality of influences proceeding backwards from developing structures is better brought out when they may be present or absent, and for this lateral buds are of special interest. As a rule, the primary development of buds has proceeded far enough to determine the connecting vascular tracts, but in the case of the dormant axillary apices of Botrychium no influence has been exercised on the vascular structure of the main shoot. When, however, such a lateral apex is called into activity, it not only forms its own vascular system as it develops, but exerts an influence backwards through permanent tissue leading to the production of a "branch-trace" connecting with the adaxial face of the subtending leaf-trace. In Helminthostachys a similar connection is established with the stele of the main stem, and the influence may extend to the whole periphery of the main stele, inducing a continued or secondary production of xylem both behind and before the place of insertion of the branch.

These constructions were, in a sense, called forth by experimental interference, since they occurred in plants the normal apical growth of which had been arrested. Plants of Osmunda are normally unbranched, and no indication of dormant lateral apices has ever been detected. I tried on young plants of *Osmunda regalis* the experiment of injuring or destroying the apex of the shoot, with the result that in a number of them branching was induced. The vascular relations exhibited considerable variety, but in some clear cases the branch was developed in an axillary position with regard to a leaf-primordium, and its vascular connection was with the adaxial face of the subtending trace in the same fashion as in Botrychium and in some species of Zygopteris. The disturbance of the normal growth had apparently brought out (in more or less irregular form) the system of relations governing the position of development of lateral branches. The result showed the correspondence with what is the normal condition in some Zygopterideæ. It has been said from the phyletic side, and on the whole rightly, that experiment cannot reconstruct history. In the light of Dr. Kidston and Professor Gwynne-Vaughan's conclusions as to the derivation of the Osmundaceæ from a Zygopterid ancestry, this induced branching of Osmunda might almost be cited as a partial exception to the statement.

These examples will suffice to indicate the justification for a change of attitude in the study of the vascular system. Looked at in this light, the stele appears not as a characteristic thing inherited as such, but as a complex resultant. The problem gains in interest, new questions (which are different from, though not antagonistic to, phyletic problems) can be put as to stelar structure, leaf-trace structure, the venation of leaves, etc. We see this if we glance at the progression in stelar structure that accompanies the development of the young fern. The phyletic explanation has been recapitulation. We have found reason to criticise the adequacy of this as applied to external form, and the same line of criticism applies to the stelar progression. In this also the early stages may be hurried over or absent, and, still more significant, the early type of stelar structure may recur, when the shoot has fallen upon evil days and approximated in size of stem and leaf-form to the seedling condition. From such points of view the vascular system offers problems in general or causal morphology not merely of great interest, but with some possibility of solution. Thus the parallel progressions from protostely to a medullated monostele, and from protostely to solenostely and dictyostely may be treated as problems in the expansion and condensation of a stelar structure, which is itself the resultant of a system of influences. Such parallel progressions are before us within the ferns and also in other groups of vascular cryptogams.

(Alternation of generations, the morphology of the seed, and the morphology of the embryo of seed-plants were then considered from the viewpoint of causal morphology.)

Conclusion.

I have touched on a number of large questions, any one of which demanded separate treatment. My concern has not, however, been with them individually, but as cognate problems justifying the deliberate adoption of a causal explanation as the aim of morphological work. I have confined myself to problems bearing on the development and self-construction of the individual, and tried to treat them so as to illustrate the causal attitude and possible lines of attack. Preliminary speculations on the questions considered can at best contain a germ of truth, and must be subsequently adjusted in the light of further facts. I have discussed these questions rather than the smaller modifications in individual development shown in metamorphosis, partly because the latter have of late years been treated from a causal point of view, and partly because I wished to consider questions that immediately affect us as working morphologists.

Did time allow, we should naturally be led to recognise the same change of attitude in biological science toward the problems of the origin of new forms. Questions of bud-variation and mutation are clearly akin to some of those considered, and the whole subject of genetics is a special attempt at a causal explanation of form and structure and the resulting functions. Close co-operation between the morphological analysis of the plant and the genetic analysis attained by the study of hybridisation is most desirable. It is especially desirable that both should deal with structure as well as with form, and in the light of individual development.

The causal factors which have determined and guided evolution can be naturally regarded as an extension of the same line of inquiry. The Darwinian theory, and especially the exposition of the principle of natural selection, was the greatest contribution ever made to the causal explanation of the organic world. Strangely enough, it led to a period of morphological work in which the causal aim was almost lost sight of. Why evolution has taken place in certain directions and not in others is a problem to the solution of which causal morphology will contribute. The probability of orthogenesis, both in the animal and vegetable kingdoms, is again coming into prominence, however it is to be explained. When we consider the renewed activity in this field it is well to remember that, just as is the case with causal morphological work, we are picking up a broken thread in the botanical web. Lastly, as if summing up all our difficulties in one, we have the problem of adaptation. In attacking it we must realise that use and purpose have often been assumed rather than proved. We may look to scientific ecological work to help us to estimate the usefulness or the selection value of various characters of the plant. On the other hand, causal morphology may throw light on whether the "adaptation" has not, in some cases at least, arisen before there was a "use" for it. The hopeful sign in the recent study of these greater morphological problems is that the difficulties are being more intensely realised, and that rapid solutions are justly suspect. The more the causal attitude is adopted in ordinary morphological work, the more hope there is of these larger questions being inductively studied rather than argued about.

The causal aim is essentially different from the historical one, but there is no opposition between causal and phyletic morphology. They are rather mutually helpful, for there has been an evolution, not of mature plants, but of specific substances exhibiting development. A deeper insight into the nature of ontogeny is thus bound to be of assistance to phyletic morphology, while the tested results of phyletic work afford most valuable guidance in general causal morphology, though this cannot accept any limitation to single lines of descent in its comparisons.

I have tried to bring before you the possibilities of causal morphology partly because the same attention has never been given to it in this country as to other branches of botany, and partly because if morphology be conceived in this broader spirit it need not be said that it has no practical bearing. I should not regard it as a serious disability were the study of purely scientific interest only, but this is not the case. When, if ever, we penetrate into the secrets of organisation so far as to be able to modify the organism at will (and genetics has advanced in this direction), the practical possibilities become incalculable.

Probably all of us have reflected on what changes the war may bring to botanical work. It is impossible to forecast this, but I should like to emphasise what my predecessor said in his address last year as to pure science being the root from which applied science must spring. Though results may seem far off, we must not slacken, but redouble our efforts towards the solution of the fundamental problems of the organism. This can be done without any antagonism between pure and applied botany; indeed, there is every advantage in conducting investigations on plants of economic importance. It would be well if every botanist made himself really familiar with some limited portion of applied botany, so as to be able to give useful assistance and advice at need. The stimulus to investigation would amply repay the time required. Even in continuing to devote ourselves to pure botany we cannot afford to waste time and energy in purposeless work. It is written in "Alice in Wonderland" that "no wise fish goes anywhere without a porpoise," and this might hang as a text in every research laboratory.

A plant is a very mysterious and wonderful thing, and our business as botanists is to try to understand and explain it as a whole and to avoid being bound by any conventional views of the moment. We have to think of the plant as at once a physico-chemical mechanism and as a living being; to avoid either treating it as something essentially different from non-living matter or forcibly explaining it by the physics and chemistry of to-day. It is an advantage of the study of causal morphology that it requires us to keep the line between these two crudities, a line that may some day lead us to a causal explanation of the developing plant and the beginnings of a single science of botany.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LONDON.—The course of six advanced lectures on "Stelar Anatomy in Angiosperms," by Miss E. N. Thomas, University reader in botany, announced to begin at Bedford College on November 1, has been postponed until January next.

OXFORD.—On October 26 the honorary degree of D.Sc. was conferred on Mr. Guy A. K. Marshall, director of the Imperial Bureau of Entomology. The Public Orator, in presenting Mr. Marshall, spoke of the great services rendered by him to scientific entomology during his residence in South Africa, mentioning in especial his work on Coleoptera and Lepidoptera. He also referred in appreciative terms to the valuable researches being carried on under Mr. Marshall's direction in the recently established Imperial Bureau of Entomology.

In moving Congregation for the grant of a pension to Mr. Henry Walters, assistant for forty-five years in the Clarendon Laboratory, Prof. E. B. Elliott made a sympathetic reference to the retirement of Prof. R. B. Clifton, after fifty years of devoted service to the department of physics in the University.

PROF. A. H. WHITE has resigned the chair of pathology in the school of the Royal College of Surgeons in Ireland, after a tenure of seventeen years.

DR. MICHELL CLARKE will deliver the Bradshaw lecture at the Royal College of Physicians of London on November 2, taking as his subject "Nervous Affections of the Sixth and Seventh Decades of Life"; the FitzPatrick lectures will be given on November 4 and 9, by Dr. W. H. R. Rivers, on "Medicine, Magic, and Religion"; and the Goulstonian lectures by Dr. Gordon Holmes, on November 16, 18, and 23, on "Acute Spinal Lesions, with Special Reference to those of Warfare."

THE arrangements announced in the calendar of the University of Leeds for the current session follow the same general lines of previous years. They are subject to modification in the event of rearrangements being necessitated by circumstances arising in connection with the war. As has become usual in our more modern universities, great prominence is given to the work in applied science and technology. Students may graduate in science and take for their principal subject one of the following branches:—Mechanical, civil, electrical, mining, or gas engineering; fuel and metallurgy; agriculture; colour chemistry and dyeing; and the chemistry of leather manufacture. Similarly the needs of commerce have been recognised. Students in the department of economics and commerce may take a three years' course for the degree of Bachelor of Commerce, a two years' course for the diploma in commerce, or a one year's course for the diploma in social organisation and public service. Side by side with these courses, designed to meet the special needs of the area served by the University, are others covering completely the requirements of students in arts, science, law, medicine, and so on. Evening classes in many subjects have been arranged and university extension lectures are provided in a miscellany of subjects.

SOCIETIES AND ACADEMIES.

MANCHESTER.

Literary and Philosophical Society, October 5.—Prof. S. J. Hickson, president, in the chair.—W. J. **Perry**: The relationship between the geographical distributions of megalithic monuments and ancient mines. The fact that the distribution of megalithic monuments coincides with the centres of ancient mining and coast-lines adjoining pearl-shell fisheries suggests a genetic relationship between the two kinds of activities. The megalithic monuments that have been found in various places beyond the limits of the ancient East are the tombs and temples of the mining camps of the settlements engaged in exploiting gold, silver, copper, tin, and precious stones. The search for pearl-shell led the Phœnicians, and their pupils, from the Red Sea and the Persian Gulf to India and Ceylon, to Indonesia and Japan, to the islands of the Pacific, and eventually to America; and in every spot where they settled to work the mines or collect pearl-shell they planted the germs of the Old World civilisation.

PARIS.

Academy of Sciences, October 18.—M. Ed. Perrier in the chair.—The President announced the deaths of Gaston Vasseur and Henri Fabre.—Louis **Fabry** and Henri **Blondel**: The identity of the new Comas Sola planet with 193 Ambrosie. This planet proves to be identical with that discovered in 1879 by M. Coggia.—J. **Dejust**: The use of a Venturi tube for the direct measurement of the flow in a pipe. The main pipe is by-passed at a point on the tube and at the contracted portion of the Venturi, and an ordinary small water meter is placed in the by-pass. It is shown both by calculation and experiment that the ratio of the volumes of water flowing by the two paths is constant to within 1 per cent. for varying rates of flow, and hence that the small meter can be graduated to give the total volume of water flowing through the main pipe.—Albert **Colson**: The heats of saturation of some alkaline salts.—Maurice **Drapier**: The application of cryoscopy to chemical analysis.—Em. **Bourquelot** and A. **Aubry**: The activity, in the course of the biochemical synthesis of the β-glucosides by β-glucosidase, of the other ferments which accompany it in the emulsin.

WASHINGTON, D.C.

National Academy of Sciences (Proceedings, No. 10, vol. i.).—G. G. **MacCurdy**: The octopus motive in ancient Chiriquian art. After discussing general features of animal motives in Chiriquian art, the octopus motive, which appears hitherto not to have been identified, is traced through a number of varying forms in vases, of which six are figured in cuts.—Rh. **Erdmann**: The life-cycle of *Trypanosoma brucei* in the rat and in rat plasma. The method employed affords the means of following, outside the body of the host, the sequence of changes in the life of trypanosomes, and its use has shown dimorphic forms, latent or round, and crithidia-like forms in *Trypanosoma brucei* outside of the host.—P. W. **Bridgman**: The effect of pressure on polymorphic transitions. This note presents, in a compact form by means of diagrams, many of the essential facts concerning the effect of high hydrostatic pressure on the polymorphic transitions of thirty substances.—G. M. **Green**: Isothermally conjugate nets of space curves. A necessary and sufficient condition that a conjugate net of curves on a surface be isothermally conjugate is that at each point of the surface the pair of axis tangents, the pair of associate conjugate tangents, and the pair of anti-ray tangents be pairs of the same involution.—P. D. **Lamson**: The rôle of the liver in acute polycythæmia. There is in the body a mechanism for regulating the red corpuscle content of the blood; this mechanism is under nervous control, responding to nervous, chemical, and emotional stimuli; the adrenal glands play a part in this mechanism, and the liver is the seat of the changes which increase the number of red cells, partly by a reduction in plasma volume, and partly by bringing cells into the circulation which are not normally present.—D. A. **MacInnes**: The potentials at the junctions of salt solutions. The author directs attention to the fact that the liquid junction potential E_L of a concentration-cell of the type

$$Ag+AgCl,KCl(\mathbf{C}_2),KCl(\mathbf{C}_2),AgCl+Ag$$

can be derived from measurements of its electromotive force, E, and of the cation-transference number, n_c, with the aid of the equation $E_L/E=(2n_c-1)/2n_c$. This equation involves only the assumption that the work attending the transfer from one concentration to the other of one equivalent of ion is the same for the cation as for the anion. The author substantiates this assumption by showing that this equation, when applied to the electromotive force data of Jahn, leads to nearly the same values of $E-E_L$ (which should equal the difference in the two electrode-potentials) whether the electrolyte be KCl, NaCl, or HCl.—R. G. **Aitken**: A statistical study of the visual double stars in the northern sky. At least one in every eighteen, on the average, of the stars as bright as 9·0 magnitude in the northern half of the sky is a double star visible with the 36-in. telescope. Close visual double stars are relatively more numerous in the Milky Way than elsewhere in the sky, and visual double stars as a rule revolve in relatively small orbits. Close visual double stars are rare among stars of either very early or very late spectral class.—E. B. **Babcock**: Walnut mutant investigations. The mutation takes place in female flowers only, and appears in the first generation after the mutation occurs, but on crossing with the species type it is completely recessive in the F_2 generation, and the nature of the mutation is such that only certain genetic factors are affected without having the chromosome number disturbed.—C. B. **Davenport** and H. S. **Conard**: Hereditary fragility of bone. Of a parent who early in life was affected with brittle bones at least half the children will be similarly affected, but if neither parent, though of affected stock, has shown the tendency then expectation is that none of the children will have brittle bones.

CAPE TOWN.

Royal Society of South Africa, September 15.—Dr. L. Péringuey, president, in the chair.—Ethel M. **Doidge**: South African Perisporiales: (1) Perisporiaceæ. The Perisporiaceæ and allied fungi are very plentiful in South Africa, especially in forest regions and in warm districts with a fairly plentiful rainfall. The specimens in the Union Mycological Herbarium are mostly from the Woodbush forests in the Zoutpansberg, from the Knysna, and from the coast regions of Natal; there is also a fair sprinkling from other parts of the coast and from Natal as far inland as Pietermaritzburg. The Middle and High Veld of the Transvaal are only represented by a single specimen, a species of Dimeriella collected at Bandolier Kop. All that is known of the South African Perisporiales up to the present is comprised in diagnoses and descriptions of fungi collected by Prof. MacOwan and Dr. J. Medley Wood, and in a few descriptions of fungi more recently collected and published in the *Annales Mycologici* and elsewhere. All the earlier work was done in the Grahamstown district and the coast region of Natal, so that a large part of the Union was left totally unexplored so far as this group was concerned.—Alex. **Brown**: The arrangement of successive convergents in order of accuracy. One of the most important uses of simple continued fractions is for the solution of the problem to find the fraction the denominator of which does not exceed a given integer, which shall most closely approximate to a given number commensurable or incommensurable. A practically complete solution was provided by Lagrange in 1769 in his paper, "Sur la Resolution des Equations Numériques" in the *Mémoires de l'Académie royale des Sciences et Belles-Lettres de Berlin.* His results give the fraction nearest in defect and the fraction nearest in excess satisfying the conditions. He does not, however, consider the question of deciding which of these two fractions is nearest in absolute value to the given number. The author gives a proof of the rule and a method of arranging the convergents in one set so as to show the nearest in defect, the nearest in excess, and the nearest in absolute value, satisfying the stated condition.—Alex. **Brown**: The use of a standard parabola for drawing diagrams of bending moment and of shear in a beam uniformly loaded. The important stresses in a uniform continuous beam are the shear and the bending moment; they are best shown in the form of graphs where length along the beam is taken as abscissa and the required function as ordinate.

BOOKS RECEIVED.

Smithsonian Institution. U.S. National Museum. Bulletin 82: A Monograph of the Existing Crinoids. By A. H. Clark. Vol. i., The Comatulids. Part i. Pp. vi+387. (Washington: Government Printing Office.)

Smithsonian Institution. U.S. National Museum. Contributions from the U.S. National Herbarium. Vol. xix.: Flora of New Mexico. By E. O. Wooton and P. C. Standley. Pp. 794. (Washington: Government Printing Office.)

U.S. Geological Survey. The Pleistocene of Indiana and Michigan, and the History of the Great Lakes. By F. Leverett and F. B. Taylor. Pp. 529. (Washington: Government Printing Office.)

Elementary Lessons in Electricity and Magnetism. By Prof. S. P. Thompson. New edition. Pp. xvi+744. (London: Macmillan and Co., Ltd.) 4*s.* 6*d.*

The Cambridge Pocket Diary, 1915–16. Pp. xv+255. (Cambridge: At the University Press.) 1*s.* net.

My Garden in Autumn and Winter. By E. A. Bowles. Pp. viii+272. (London: T. C. and E. C. Jack.) 5*s.* net.

An Introduction to Ethics for Training Colleges. By G. A. Johnston. Pp. x+254. (London: Macmillan and Co., Ltd.) 3*s.* net.

A Treatise on Light. By Dr. R. A. Houstoun. Pp. xi+478. (London: Longmans and Co.) 7*s.* 6*d.* net.

Is Venus Inhabited? By C. E. Housden. Pp. 39. (London: Longmans and Co.) 1*s.* 6*d.* net.

First Aid in the Laboratory and Workshop. By A. A. Eldridge and H. V. A. Briscoe. Pp. 32. (London: E. Arnold.) 1*s.* net.

Stanford's Compendium of Geography and Travel (New Issue). North America. Vol. i., Canada and Newfoundland. Second edition, revised. By Dr. H. M. Ami. Pp. xxviii+1069. (London: E. Stanford, Ltd.) 15*s.* net.

Soils: Their Properties and Management. By Profs. T. L. Lyon, E. O. Fippin, and H. O. Buckman. Pp. xxi+764. (New York: The Macmillan Company; London: Macmillan and Co., Ltd.) 8*s.* net.

Canada. Department of Mines. Geological Survey Memoir 68: A Geological Reconnaissance between Golden and Kamloops, B.C., along the Canadian Pacific Railway. By R. A. Daly. Pp. viii+260. (Ottawa: Government Printing Bureau.)

Savage Man in Central Africa. By A. L. Cureau. Translated by E. Andrews. Pp. 351. (London: T. Fisher Unwin, Ltd.) 12*s.* 6*d.* net.

Survey of India. General Report, 1913–14, from 1st October 1913 to 30th September 1914. Prepared under the direction of Col Sir S. G. Burrard. (Calcutta: Survey of India.)

Maternity and Child Welfare. By E. J. Smith. Pp. 88. (London: P. S. King and Son, Ltd.) 1*s.* net.

Transactions and Proceedings of the New Zealand Institute for the Year 1914. Vol. xlvii. Pp. vii+704. (Wellington, N.Z.: J. Mackay; London: W. Wesley and Son.)

DIARY OF SOCIETIES.

FRIDAY, OCTOBER 29.

INSTITUTION OF MECHANICAL ENGINEERS, at 8.—Thomas Hawksley Lecture: The World's Sources of Fuel and Motive Power: Dr. Dugald Clerk.

SATURDAY, OCTOBER 30.

ESSEX FIELD CLUB (at the Essex Museum, Stratford), at 6.—Some Remarks on the Ease with which the guns in Flanders may be heard in Essex: Miller Christy.—The Structure and Growth of Lichens: Miss A. Lorrain Smith.—Field Notes on Essex Ornithology: F. J. Stubbs.

TUESDAY, NOVEMBER 2.

RÖNTGEN SOCIETY, at 8.15.—Presidential Address: J. H. Gardiner.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 5.—The First Siege of Troy: H. J. E. Peake.

WEDNESDAY, NOVEMBER 3.

GEOLOGICAL SOCIETY, at 5.30.—Discovery of a Fossil Elephant at Chatham: Dr. C. W. Andrews.

SOCIETY OF PUBLIC ANALYSTS, at 8.—Formic Acid as a Reagent in Essential Oil Analysis: W. H. Simmons.—Note on the Melting-point of Salicylic Acid, and a Test for the Presence of Para-hydroxybenzoic Acid: H. L. Smith.—The Persistence of Hydrogen Peroxide in Milk: E. Hinks.

ENTOMOLOGICAL SOCIETY, at 8.

THURSDAY, NOVEMBER 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers:* A Diagram to Facilitate the Study of External Ballistics: Prof. W. E. Dalby.—An Application of the Principle of Dynamical Similitude to Molecular Physics: W. B. Hardy.—The Motion of a Stream of Finite Depth past a Body: R. Jones.—Deep-sea Water Waves caused by a Local Disturbance on or beneath the Surface: K. Terazawa.—The Consumption of Carbon in the Electric Arc: W. G. Duffield.

SOCIETY OF ENGINEERS, at 7.30.

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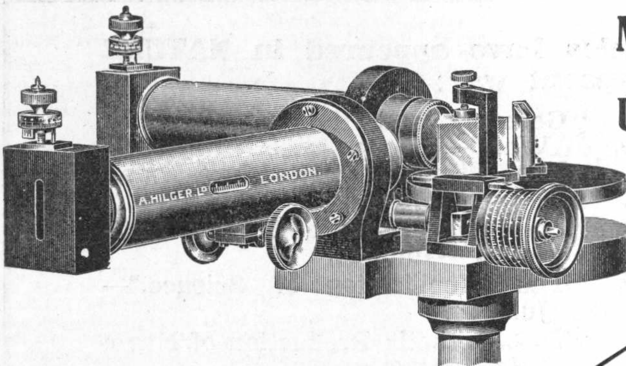

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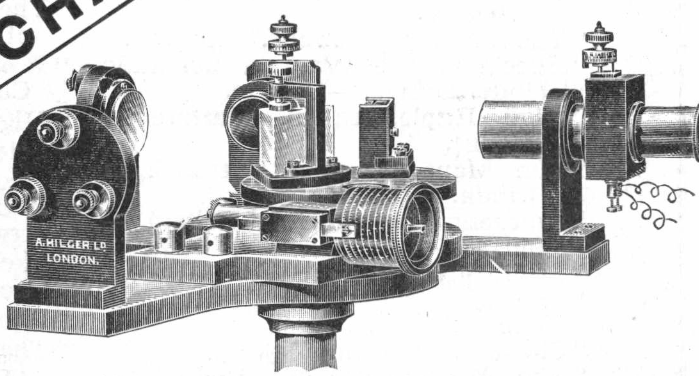

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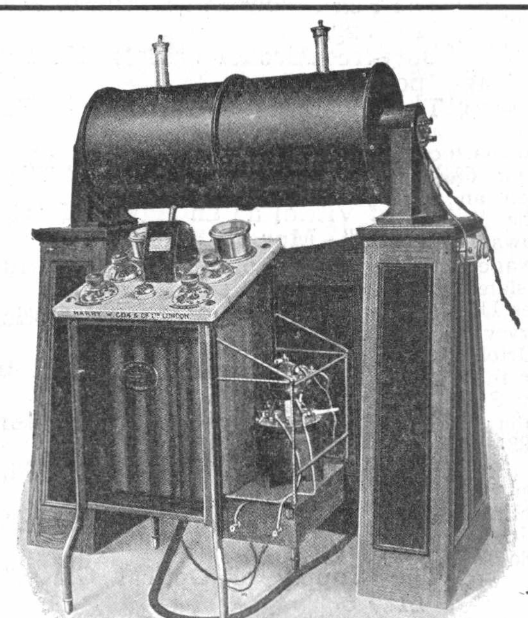

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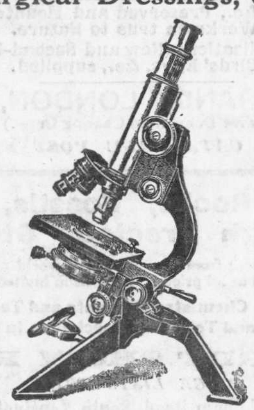

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5	18 10 0	17 0 0	19 10 0	20 10 0	4 0 0
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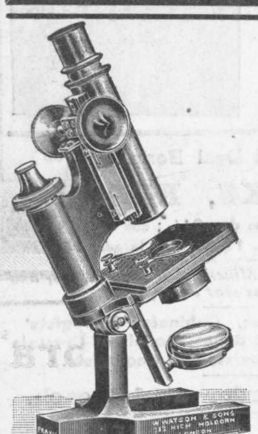

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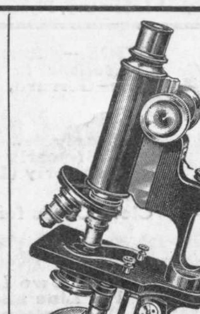

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