NATURE

SATURDAY, JUNE 23, 1923.

CONTENTS.

Editorial and Publishing Offices:
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.

Advertisements and business letters should be addressed to the Publishers.
Editorial communications to the Editor.

Telegraphic Address: PHUSIS, LONDON.
Telephone Number: GERRARD 8830.

NO. 2799, VOL. 111]

University and Secondary Education.

AT the break of gauge between school and university some confusion and loss of time must be expected in a country where both systems are not subject to the control of a state department, and will be excessive unless the responsible authorities on both sides are in general accord as to aims and principles. In England the Board of Education has, during the past twenty years, worked steadily for such an accord and has provided machinery, such as the Secondary School Examinations Council, for making it effective. The report of the Committee on Natural Science in Education helped to focus attention on the subject.

This Committee held that it is desirable on educational and other grounds that boys who intend to pass on to a university should, as a rule, remain at school up to the age of 18; that a general course, which should include science work planned as a self-contained course of physics and chemistry with some study of plant and animal life, should be completed normally about the age of 16, when the First School Examination should be taken. This should be followed by two years of advanced work at school during which those specialising in science should continue some literary study and those specialising in literary study should give some time to science work. Then the universities should adopt such an examination as the First School Examination as the normal test for entrance, with such limitations or amplifications as they may find necessary, *e.g.* "credit" in a certain number of subjects or some measure of success in the Second Examination. It was also considered most important that university degree courses in pure science should be so arranged that students who come well prepared from secondary schools should not be put back to do elementary work.

The dovetailing (without wasteful overlapping) of two years of specialised study in the secondary school with the first year of university work presents certain difficulties. Endeavouring to guard against the mishandling of these difficulties, the Committee points out that it is undesirable that work of pupils between 16 and 18 should be disturbed by having to prepare for an examination (for example, the University Intermediate) not primarily designed to meet school needs; candidates in a Second School Examination who do satisfactory work in any of the subjects required for the Intermediate should, therefore, be exempted from further examination in these subjects. This warning is emphasised in Sir Frederic Kenyon's report of conferences on secondary and university education between the Council for Humanistic Studies and the Conjoint Board of Scientific Societies. The following resolution was passed by the conference:

"A clear distinction *in kind* between the first-year studies of a university in any faculty and the upper-form studies of a school is a fundamental principle of education. A school year should, therefore, in no case be reckoned as the equivalent of a university year, and the practice of allowing pupils to present themselves for a university examination, beyond the matriculation, before or upon entrance to a university is to be deprecated as confusing the educational functions of school and university and leading to an inappropriate type of teaching at both."

In the best secondary schools the science work is really on as high a plane in every respect as that done in the first year at some of the universities, and the staffs are just as well qualified. Pupils from such schools should be able to obtain exemption from the whole of the Intermediate examination: in other cases partial exemption is valuable as minimising the university student's pre-occupation with the business of preparing for examination. But the introduction of advanced courses in secondary schools ought not to be allowed to obscure the principle that work in those schools should be based on the mastery of fundamentals.

As to the results of neglecting this principle, a useful lesson may be learnt from the recent history of education in the United States, as interpreted by the president of the Carnegie Foundation for the Advancement of Teaching in his report for 1921–22. This indicates such confusion of aims and principles and, in consequence, waste, that by correlation and simplification of curricula the normal aggregate duration of studies in the elementary and secondary schools and the college of liberal arts could be reduced with great advantage to all concerned from 16 years to 12.

The typical American secondary school, known as the high school, was formerly called the "People's College," and gave an intellectual training quite comparable with that provided in the authentic college, which was itself little more than a secondary school. The courses were on parallel lines and were such as were deemed suitable respectively for pupils destined for trade and industrial occupations and for those who would enter the learned professions. From being parallel the high school by degrees became anterior to the college course. Hypnotised on one hand by the social prestige of the college for which it came to serve as a vestibule, and driven, on the other, to cater for the needs of pupils who ought to have been in trade schools, the high school became involved in an attempt to teach something of everything from typewriting to psychology. Meanwhile the colleges, although assuming some of the functions of the university, continued to give during the first two years of the college course what was really secondary education. Surveying the situation with special reference to the rate of increase, lately accelerated in the cost of education, the report deplores the results of the so-called enrichment of the secondary school curriculum:

"The high school of to-day has been transformed from a distinctively intellectual agency into one that offers instruction concerning every field of human knowledge, and assumes to provide training for every vocation and profession. . . . In the process the notions of sincerity and thoroughness in education have been displaced. . . . The striking characteristic of our schools under the process of enrichment of the curriculum is superficiality. . . . The total result is to present education and to present technical training as ends to be gained by superficial means. It would be difficult to find a graduate of our undergraduate colleges who knows his native language, who has read the books, or who has done the thinking, of the youth of eighteen who graduates from a German gymnasium, from a French Lycée, or from an English Public School like Eton or Harrow. . . . He knows almost nothing of intellectual discipline, and is neither able nor in the mood to bend himself heartily and effectively to a sharp intellectual task."

It is interesting to compare with this the notes written eighteen years ago by Mr. A. C. Benson, after twenty years' experience of teaching at Eton, on the system then prevalent in English secondary schools and colleges:

"We send out so many boys not only without intellectual life, but not even capable of humble usefulness . . . they have not had time to read any English to speak of . . . I would raise the standards of simple education, and force boys to show that they are working honestly . . . a few subjects thoroughly taught are infinitely better than a large number of subjects flabbily taught. . . . It is difficult to imagine a condition of greater vacuity than that in which a man leaves the university after taking a pass degree. . . . The education is of a contemptible, smattering kind; it is really no education at all. It gives no grip, or vigour or stimulus."

Since then this critic's conception of the principles and aims of secondary education have been widely adopted, and it is owing to the consequent improvement of British secondary school teaching that it can so well bear comparison with the American system, which seems to be now afflicted with some of the former vices of the British. But it would be a mistake to assume that these vices have been eradicated completely and for ever from the British system. They have their roots in human nature, and we must be on the alert to detect their revival. It is certain that attempts to give effect to the recent recommendation of the Consultative Committee of the Board of Education that a more prominent place in the ordinary curriculum should be assigned to æsthetic subjects will entail conditions favourable to precisely that illusive "enrichment" of the curriculum which has had such unfortunate results in America. The

recommendation itself is well founded and, given teachers capable of an adequate conception of the meaning of art, whose æsthetic faculties have been adequately cultivated, nothing but good can result from its adoption, but circumspection is needed; art, like religion, is caught rather than learned.

In the February number of the United States publication *School Life* appears a somewhat detailed description of a type of school organisation adopted by certain "progressive" city school boards, notably in Detroit, Pittsburgh, and Akron, with the object of providing the varied curriculum and instruction by specialist teachers now generally demanded, while keeping expenses within reasonable bounds. The pupils spend half of each day in ordinary class-rooms or "home-rooms," where they are taught formal subjects—reading, writing, arithmetic, formal language, hygiene, and history—and the other half in special rooms or laboratories where they are taught by specialist teachers of science, art, music, literature, manual training or shop work, domestic science, etc. One of these rooms called the auditorium is devoted to co-ordinating all other work by dramatisations and other modes of expression, vocational guidance, and various devices for preparing pupils "for more complete living and the self-control and self-direction needed therefor." These "platoon" or "work-study-play" schools use all their rooms all the time, each of the teachers in the "home-rooms" having the care of two groups of pupils, one in each half of the day. Equipment is minimised and the cost of supplies lessened. Supervision is easier because fewer teachers are responsible for results in any one subject. "Properly directed, the platoon school epitomises socialised education."

Technology of Fuels.

American Fuels. By Dr. Raymond Foss Bacon and William Allen Hamor. (Mellon Institute Technochemical Series.) In 2 vols. Vol. 1. Pp. ix+628. Vol. 2. Pp. vi + 629-1257. (New York and London: McGraw-Hill Book Co., Inc., 1922.) 60*s*.

IN the preface of this work the authors or editors, one of whom is a consulting chemical engineer of New York and formerly a director of the Mellon Institute, and the other the assistant director of that Institute, state that "they have attempted to condense into a series of specially prepared chapters the fruits of the experience of specialists, thereby placing in the hands of manufacturers, engineers, and chemists a composite book representing authoritative accounts of the fuels now regarded as technically important in the United States."

The immediate responsibility of the two authors is therefore limited, since other names are attached to most of the twenty-six chapters into which the work is divided. Most of these names guarantee a first-hand knowledge of the subject treated, and the editors "hope that the treatise will be found to give informative summaries of sound practice and the practical details which are generally not to be found in the literature." This method of treatment has both advantages and disadvantages. The book abounds with detailed information on all sorts of subjects connected with the treatment of fuel, and of apparatus designed for its utilisation, information of a quantity and quality which it would have been exceedingly difficult, if not impossible, for any one or two authors to provide. At the same time the number of subjects and appliances treated is so great, and their detailed consideration covers so much ground, that it has been impossible for the editors to maintain any attitude of appraisement or to reconcile what may be regarded as conflicting claims. To have done so would have been a very awkward task and would have lengthened the book unduly, although it must be remembered that, in consulting it for the purpose of making a selection of a process or apparatus, the reader will be called upon to do this for himself.

The editors say "some of the chapters have been written from the viewpoint of men who are enthusiastic advocates of the particular fuels treated," and reading the book will undoubtedly lead a discriminating reader to the same conclusion. The treatment awarded to some of the processes and appliances is such as one would expect to find in the correspondence of a well-informed agent, or in an intelligently prepared catalogue, and its appearance in a book of this kind is unusual. This is not said in a spirit of condemnation, but is intended to convey a warning, which may be necessary, to a reader who consults it in any expectation of finding the judicial statements on processes and plant to which we have become accustomed in the best of our technical literature.

Approached in the proper spirit, the book is undoubtedly one which can be made of very great service to everybody concerned with its subject-matter. There is, however, an aspect of this work to which some exception may be taken by those who look for well-balanced international treatment in scientific and technological writing. To some extent criticism from this point of view is disarmed by the title, but although fuels may be American, the technology of fuel is international and the scientific basis of that technology even more so. The authors cannot, however, be said to be very deeply imbued with this principle. The reader will reap some advantage from the process of selection which has taken place, inasmuch as this work will

present to his notice much more fully the contributions to the science and practice of fuel technology which have been made by America than would have been possible in anything like the same compass if corresponding notice had been taken of contributions to the subject from other than American sources. Partly perhaps on this account, the scientific treatment of fundamentals is somewhat sketchy and inadequate. Here, again, if the book is approached with the full knowledge that it is primarily concerned with the setting out of American contributions to fuel technology and the treatment of American fuels (the latter according to title), little harm is done, and the many excellences of the book can be utilised to the full.

Reviewing the work more systematically, after a first chapter on "The Coals of the United States" (which includes a six-page table of analyses of representative coals), and a second on "The Principles of Combustion," we find a full and informing chapter on "The Technology of Coke," by F. W. Sperr, the chief chemist of the Koppers Company, Pittsburgh. This occupies 160 pages, and is well done, although it is charitable to suppose that the work of Sir George Beilby and others on the structure of coke during the last two years must have been published a little too late to allow of its consideration. A useful inclusion here is a summary on methods of sampling and testing. Briquetted or compressed fuels are treated next, and various processes are described, but when the author says that "there are no unsolved fundamental problems in briquetting practically any kind of material, especially in the field of fuel," and that "there is nothing that stands in the way of the design and construction of a briquetting plant to briquet any kind of coal," he will find many to question his judgment.

An excellent economic review of coal preparation raises a number of interesting questions, and in discussing power-generation and the possibilities of the turbine we are told that "higher efficiencies may be more readily obtained by using two vapors in series, such as mercury and steam. Mercury vapor has a much greater density than steam and a lower heat of vaporisation; hence the spouting velocity is low and it may be used in a high-temperature turbine of very simple design. A mercury turbine and boiler are being developed by the General Electric Co."

"The Gasification of Fuels," including that of low-grade fuels, is broadly treated by Mr. Coffin of the General Electric Co., and conveys a detailed description of a horizontal rotary gas producer made by the General Reduction Gas and By-Products Co., for which quite high thermal efficiencies are claimed, and the capacity to deal with most unpromising materials, such as anthracite slush containing 20 per cent. moisture and 25 per cent. ash, a mixture of coke breeze and slush containing 45 per cent. of ash, and sawdust. The statement is made that it has been found possible to make methane from blue gas synthetically in the presence of a nickel catalyser, but an expansion of the term "possible" would have been useful in this connexion.

In the chapter on the "Distillation of Coal at Low Temperatures" the excellent and comprehensive review of the history, theory, and practice of the low-temperature carbonisation of coal, which was submitted to the Society of Chemical Industry by Mr. Edgar C. Evans, has been printed in condensed form, and a number of processes are described in some detail. One of the most interesting chapters is on the use of finely divided fuel, the technique of this subject having been much more highly developed in America than in Great Britain. A chapter on "Fuel Oil and its Utilisation" is followed by one on "Colloidal Fuel," for which that well-known authority on the subject—Mr. Lindon W. Bates—has made himself responsible. Natural gas and producer gas technology are treated in turn, and we are informed that "lack of proper operating organisation has been the cause of many failures," and that "another cause is the over-enthusiastic salesman. Most producer projects look good on paper." There is a section on freak producers, and a summary which includes such prohibitions as "Do not employ an engineer who has never made a mistake on producer gas work," and "Do not lose your nerve after the first six months of operation."

Water-gas does not receive anything like so much attention as might have been expected in an American work of to-day, and although some costs are given there is no satisfactory thermal or chemical analysis of the process.

The chapter on "Blast Furnace Gas" is short, but useful. It is followed by one on the Dayton process, little known in Great Britain, which is essentially an air-oil-gas process in which partial combustion of the oil with air takes place within the retort, thus supplying internally the heat necessary for the thermal decomposition of the hydrocarbons. The need for external heating is thereby minimised. The nitrogen of the air used is, of course, present in the gas made, which may be of various grades. It is stated that approximately 4 gallons of fuel or gas oil is required for the production of 1000 cu. ft. of 450 B.Th.U. gas. A statement which would require very serious examination before acceptance is that "theoretically it has been found, and under practical conditions of industrial operation it has been proved, that Dayton gas of 450 B.Th.U. per cu. ft. is required in no greater *volume* than illuminating gas of 630 B.Th.U. per cu. ft. for the same work." The

metal retorts used seem to undergo rather drastic treatment, and it would be interesting to know their length of life.

The chapter on "Surface Combustion," by Mr. A. E. Blake, reports mainly progress obtained with the impact type of burner, and is followed by one on the "Future of the Artificial Gas Industry," and by others of a general character, such as "Fuel Conservation," and "Some Problems in the Utilisation of Fuel," both these making interesting reading. An appendix deals with methods for the analysis of coal and fuel oils.

The book is well printed and generously illustrated throughout. It is certain to be very useful, not only in America but also in other countries, particularly if read with the discrimination suggested above.

JOHN W. COBB.

The Teaching of the Calculus.

Common Sense of the Calculus. By G. W. Brewster. Pp. 62. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 2*s.* net.

FROM time to time in recent years, small books have appeared which would be more or less correctly describable under the title "How Not to Teach the Calculus." We are sorry to find the present volume to be no exception to this rule, at least in its methods of treatment of infinitesimals.

Its main peculiarity is the way "quantities of the second order" crop up continually, and the way in which readers are led to believe that it does not matter much whether these are put in or left out. The main advantage of this kind of treatment is that students who have neglected their class-work and absorbed such a book for their examination are easily detected by their examiner, as they are certain to do something against which they were warned in class.

If we take $y=x^2$ and define δy as the difference between x^2 and $(x+\delta x)^2$ we undoubtedly get

$$\delta y = 2x\delta x + \delta x^2.$$

But surely it would be more in accordance with most people's ideas of common sense if instead of bringing in the notion of "second order quantities" the author had pointed out that this δy represents the change taking place in the value of the square in an interval which *begins* with the value of x and continues for a distance δx *beyond* that value. It would also surely be easier for a student to see that the *greater* the interval δx the more does this variation fail to give a correct idea of the manner in which the function was varying round about the instant that it passed the value x. Also, as the term δx^2 *increases* in relative importance when δx is made *larger*, it would not be difficult for a reader to infer that this squared difference represents the *error* introduced by measuring the change in a *finite* interval situated all on *one side of* the value x.

In fact, instead of being small quantities which may be included or omitted in this way, these "second order quantities" are really rather of the nature of *errors* which *must* be taken off if we wish to study a continuous process closely at every instant. For example, they represent the correction that would have to be applied to obtain the velocity of a train *at* any instant from the average velocity in an interval of one, two, or more seconds *after* that instant.

Now, it is customary among mathematicians to use δx to denote a finite variation in which second-order quantities may be involved, and dx to denote the limiting form. But Mr. Brewster in his preface says, "The difference between any two values of x is an easy idea to grasp, and the use of δx or dx (it does not matter much which) emphasises the fundamental meaning of a differential." . . . "My advice would be to regard dx and δx as the same thing provided δx is taken very small, and to be satisfied with a common-sense explanation of the omission of terms of the second order." And on p. 23, speaking of dy/dx and $\delta y/\delta x$, he says, "You can get on quite well without bothering to distinguish between the two."

Again, surely it would be more in accordance with common sense if some account were also taken of what happens to a function *before* the variable reaches the given value x, and if this were done with the function x^2 we should get a second value of the variation, say

$$\delta^1 y = 2x\delta x - \delta x^2.$$

The differential equation $dy=2xdx$ has now a precise meaning, as it describes a variation which always lies intermediate between the first and second estimates, however small the interval δx. As a matter of fact, fluctuations in statistics, such as increases of population, rise or fall of stock exchange quotations, *are* always and *must* always be estimated by comparing the value on any day or year with a *previous* value.

The same mistake is made in dealing with integration as applied, for example, to areas. Mr. Brewster's figures replace the actual area of a curve by a series of rectangles the *left-hand* sides of which are ordinates of the curve. Why does he not try taking the right-hand sides as well? If he would only shove his rectangles one space to the left, taking off the first and adding one at the end, he would have spared all his arguments by showing that the true area lies between two limits the difference of which can be made as small as we like by making the slices thin enough.

There is undoubtedly a great demand for a book that will introduce the notions of a differential co-efficient and an integral and illustrate them with applications not involving any other functions than

series of positive integral powers. So far as relates to selection of subject matter in the form of examples and applications, "Common Sense of the Calculus" exactly meets the case. We should be glad if Mr. Brewster would republish this collection based on a different method of dealing with infinitesimals. He would probably find that instead of making his book larger it would be possible even to make it *smaller*. The "terms of second order" which give so much trouble in this treatment can be got rid of completely by adopting the definition of "limiting equality" mentioned in a letter to NATURE of February 10, as the interpretation of such formulæ as $dy=f^1(x)dx$. "Zero" is a dangerous quantity to put in the hands of a beginner, and so are quantities which "may be neglected," and it was only a year ago that we had a student trying to take mathematical honours who said that two quantities *da* and *db* were "of the same order, therefore they are equal"! On the other hand, we have found it possible to condense into five or six pages of stencilled notes all the information required to explain differentiation and integration and to introduce such differentials as dx, dy, ds, dr, $rd\theta$, $\frac{1}{2}r^2d\theta$, and even $dx\,dy$ and $dx\,dy\,dz$ in a form in which finite quotients and sums of products can be built up in perfect safety, second-order quantities being tabooed, but $ds^2=dx^2+dy^2=dr^2+(rd\theta)^2$ being legitimate. A recent paper by Prof. Alfred Lodge in the *Mathematical Gazette* evidently is based on the same principle.

G. H. B.

Christopher Wren and the Tom Tower.

"*Tom Tower,*" *Christ Church, Oxford. Some Letters of S^r Christopher Wren to John Fell, Bishop of Oxford.* Hitherto Unpublished. Now set forth and Annotated by W. Douglas Caröe; with a chapter by Prof. H. H. Turner, and another by Arthur Cochrane. Pp. xii + 127 + 28 plates. (Oxford: Clarendon Press; London: Oxford University Press, 1923.) 25*s.* net.

THIS book was published in honour of the bi-centenary of Wren's death on February 25. The author had been called upon to direct some necessary repairs to the buildings of Christ Church College, particularly to the "Tom Tower," when his attention was directed to some unpublished letters and documents dealing with the original design and building of the tower, and these have now been published in the present volume. In addition to a contemporary copy of the contract between the College treasurer and the contractor for the building of the tower, there are seven autograph letters written by Wren to John Fell, Bishop of Oxford, the first dated May 26, 1681, and the last September 9, 1682, when the work was nearing completion. The last letter is reproduced in facsimile, showing Wren's firm and very distinct handwriting.

An analysis of each letter follows, and Prof. H. H. Turner has supplied a commentary to the sixth and most interesting one. This letter (dated from Whitehall, December 3, 1681) is a reply to a proposal on the part of the bishop, that the tower should be converted into an observatory. Wren is too polite to reject the proposal altogether, but gives good reasons why it should not be hastily adopted. It would involve a change in the whole design; the bell would have to be lowered so as to heighten the loft, and it might then not be well heard. The Gothic roof, agreeing with the rest of the College buildings, would have to be abandoned, and a flat roof with a horizontal balustrade substituted, while instead of windows there would have to be wooden shutters without mullions or bars. In addition to these objections from the point of view of an architect, Wren next produces others from the point of view of an astronomer, and here also he could speak with authority, having held the office of Savilian professor of astronomy for twelve years (1661–73) until pressure of other work obliged him to relinquish it.

"Give me leave to add that such a room as this will be when built, is no way necessary for observations, as now they are managed. Were I to set up the Trade again I was once well acquainted with, and I think the world doth or may justly own some improvements of it to me, I should require nothing else but these things. First a large mural quadrant fixt to a wall truly built in the meridian, and this is best in an open court or garden, 2^dly a pole to raise large telescopes and manage them, and the like place is properest for this also. 3^dly a quadrant to take distances fixt to a foot so as it may turn to all sort of planes . . . must be housed for its better preservation, but the best house will be a little house of boards and no other roof but what may be taken quite off when the instrument is used. . . . We built indeed an Observatory at Greenwich not unlike what your tower will prove, it was for the Observators habitation and a little for pomp; it is the instruments in the court after the manner I have described which are used, the room keeps the clocks and the instruments that are laid by."

This statement as to what an observatory ought to be like is very interesting, as showing that Wren thoroughly agreed with Flamsteed about the requirements of practical astronomy. Therefore Oxford did not get an observatory on this occasion (there were only two University Observatories in existence at that time, at Copenhagen and at Leyden), and nearly a hundred years had to pass, before the Radcliffe Observatory was built, including a very big tower!

Mr. Caröe devotes a chapter to "Wren and Greenwich Observatory," but the contents are nearly all taken from Baily's book on Flamsteed. That Wren designed the Octagon room seems certain, but he had nothing else to do with the building or the equipment of the Observatory. This chapter is illustrated by two plates giving most interesting views of the buildings and of the interior of the Octagon room, copied from some old engravings given by Baily to the Royal Observatory. It seems, however, very doubtful whether the telescope for observing sun-spots by projection and the large quadrant (Plate XXI.) can have been at Greenwich in Wren's time; at least it is not likely that the quadrant is the 10-foot quadrant made by Hooke and declared by Flamsteed to be useless. But if Wren had been able to devote some of his time to astronomy, he would doubtless have made his mark in that science. It should not be forgotten (we have not found it mentioned in the book under review) that Wren (as well as Hooke and Halley) had realised independently of Newton, that attraction if it existed must be according to the law of the inverse square of the distance, and this was expressly acknowledged by Newton (Princ. lib. I. Prop. IV. Scholium). The silly and slanderous accusation of plagiarism made by Hearne the antiquary against Newton, in favour of Hooke and Wren, should not have been quoted by the author (p. 11) without comment.

The book is beautifully and most profusely illustrated and will appeal to many different classes of readers.

J. L. E. D.

The Future of Arctic Lands.

The Northward Course of Empire. By Vilhjalmar Stefansson. Pp. xx+274+8 plates. (London and Sydney: G. G. Harrap and Co. Ltd., 1922.) 7*s.* 6*d.* net.

MR. STEFANSSON shows, with characteristic force of expression and wealth of example, that every effort to colonise the frontiers of the familiar world has been retarded by fear bred of ignorance. He regards the popular repute of the Arctic regions as a survival of the ancient shrinking of the Mediterranean peoples from cold and darkness, intensified by tales of the sufferings of explorers, which he holds to have been partly unnecessary and partly exaggerated. On the other hand, he shows that throughout the whole history of civilisation the centres of political power of the most advanced races have undergone a steady displacement northward from the neighbourhood of the tropic. He holds that this migration of the dominant races is accompanied by an increase in physical and mental vigour, and he would perhaps be inclined to agree with Richard Chenevix's bold generalisation of ninety years ago, that character is expressible as a mathematical function of latitude.

Mr. Stefansson indicates that the natural northward course of civilisation is now being held up by a superstitious tradition maintained by faulty educational works based on misleading narratives of polar travel. He insists on the fact that Montana, Dakota, and Manitoba are far colder in winter than the low-lying coasts and islands of the Arctic Sea or the North Pole itself. Yet in these far severer climates children go to school daily in temperatures that a polar explorer is very rarely called upon to encounter, so that cold need not deter a sturdy people from moving north.

The main object of the book is to combat this specific ignorance of polar conditions, and Mr. Stefansson enters on the struggle with Berserk gusto. He firmly believes that, even after the mineral resources of Arctic lands —*e.g.* the gold, coal, copper, iron, and oil of Alaska and Northern Canada—have been exhausted or have at least lost their sensational attractive power, there remains a vaster and more permanent source of wealth for the outer world to draw upon in the incredible richness of millions of square miles of Arctic meadows. These are grazed over by herds of reindeer and ovibos, capable of forming the basis of the largest meat and wool production the world has ever seen. In fact, the author goes so far as to hold that Arctic meat alone can furnish a safeguard against famine on an unheard-of scale when the population of the world has doubled itself a century hence.

The facts cited as to the growth of reindeer herds in Alaska, and the popularity of reindeer flesh in large cities, are most impressive, and the prospects of the Hudson Bay Company's experiment in rearing the ovibos (its old name of musk ox is banned) in Baffin Land appear to be extremely favourable. Mr. Stefansson points out that the failure of farmers in northern lands has almost always been due to their attempts to introduce plants and animals natural to southern localities, whereas success as surely attends their efforts when they devote their attention to those native to the climate.

An interesting chapter is devoted to the prospects of Polar travel by aircraft and submarines, and it would almost appear that the adventures of Capt. Nemo under the ice in Jules Verne's old story were coming true. Mr. Stefansson is usually careful to base his calculations and projects on established facts and the opinion of experts; but we fear that in one point he has failed to do so, and we cannot accept his prediction on p. 186, that "ordinary tramp steamers" can ever navigate the ice-encumbered Arctic waters. Mr. Stefansson

wants to provoke controversy and inquiry with regard to the grounds of his faith in the future of the North, and the vigour, resourcefulness, and good humour of his propaganda should make even his critics his friends, for every one likes a strong man in pursuit of a great idea. HUGH ROBERT MILL.

Our Bookshelf.

Occultism and Modern Science. By Prof. T. Konstantin Oesterreich. Translated from the second German edition. Pp. vii+181. (London: Methuen and Co., Ltd., 1923.) 6*s.* net.

PROF. OESTERREICH'S book is intended to be a popular presentation to the German public of the evidences of "occult" phenomena, which are fairly well known to English-speaking people. He points out that this field of knowledge has been little cultivated in Germany, and, with great impartiality, places such facts as have been observed before his readers. He examines the cases of Helene Smith, Mrs. Piper, Palladino, and Eva C. in detail, and arranges his phenomena under the heads of states of impersonation, psychometry, cross-correspondence, telekinesis, and materialisation. His conclusions are adverse to spiritism; but, on the evidence, he seems to have no doubt of the occurrence of the phenomena in question, though there is no indication in the book of any first-hand acquaintance with the subject. Indeed, there is a lack of judicial balance in the admission of the evidence. Crawford—though the facts were clearly not known to Oesterreich when this work was written—is cited as an authority for telekinesis and materialisation. The introduction is remarkably good, as is the general plea for scientific examination without prejudice of the facts; but the chapter on theosophy has little connexion with the rest of the book, and rather marrs it by the personal note with regard to Rudolf Steiner which it introduces.

Department of Scientific and Industrial Research: Food Investigation Board. Special Report No. 15 by the Engineering Committee of the Board. Insulated and Refrigerator Barges for the Carriage of Perishable Foods. Pp. iii+21. (London: H.M. Stationery Office, 1923.) 1*s.* net.

WHILE in normal circumstances the barges thermally insulated with four inches of cork at present used in Great Britain for the conveyance of perishable food such as frozen meat from the importing ship to the quay or cold store are found to be adequate, conditions arise in practice under which they fail. This report will serve as a valuable guide to those who wish to provide something better. It is shown that the ordinary insulated barge is only satisfactory for 48 hours if the frozen cargo is well packed, so that its rise of temperature owing to its having to cool the barge may be as small as possible, and if the temperature of air and water do not exceed 50° F. If the barge can be pre-cooled to 20° F. it is adequate under the same temperature conditions for 96 hours. If the temperature of air and sea water rises above 70° F., the barge, even when pre-cooled to 20° F., will only prove effective for about 40 hours, and if it is to carry its cargo longer it must be provided with refrigerating machinery. In one experiment with a barge so equipped a cargo of frozen meat was carried for seven days without its temperature rising more than 3° F.

Electric Transients. By Prof. C. E. Magnusson, A. Kalin, and J. R. Tolmie. Pp. viii+193. (New York and London: McGraw-Hill Book Co. Inc., 1922.) 12*s.* 6*d.*

THIS book was primarily written for the electrical engineering students of the University of Washington. It discusses in detail many of the transient phenomena which ensue whenever any of the electric "constants" of a circuit suddenly alters in value. Excellent oscillograms are given, the study of some of which will be of value to advanced students. As a rule, the transient quiver induced in the current wave by a sudden disturbance of the circuit dies away rapidly. In some cases, however, it attains excessive values and does damage. In a few cases it is continually in evidence, as, for example, when an electric arc forms part of the circuit. The question of "transients" therefore needs to be studied carefully by electrical engineers. The introduction is rather too condensed. For example, we are told that the Ohm's law of the dielectric circuit is that the dielectric flux equals the voltage divided by the elastance of the circuit. The elastance is the reciprocal of the condensance. The former is measured in "darafs" and the latter in farads. It is not easy to picture what the authors mean, as apparently the cross-section of the dielectric circuit is constant.

Surface Tension and Surface Energy and their Influence on Chemical Phenomena. By Dr. R. S. Willows and E. Hatschek. (Text-books of Chemical Research and Engineering.) Third edition. Pp. viii+136. (London: J. and A. Churchill, 1923.) 6*s.* 6*d.* net.

THE study of "Surface Tension" has been modified profoundly by the conception of oriented molecules which was introduced by Langmuir in 1917, and has since been developed on a rigid quantitative basis by the researches of N. K. Adam. These new developments are described and discussed in the new edition of this work. The fact that the subject is treated from the physical rather than the chemical point of view increases the value of the book as a contribution to physical chemistry, since it leads to the introduction of information which is not usually available in books written by chemists.

Intelligence Tests and School Reorganization. By Lewis M. Terman and others. Prepared as a Subcommittee Report to the Commission on Revision of Elementary Education, National Education Association. Pp. viii+111. (London, Calcutta, and Sydney: G. G. Harrap and Co., Ltd., n.d.) 4*s.* 6*d.* net.

A USEFUL little set of monographs on the use of intelligence tests. Chapter 3—"Methods of Individual Instruction in the Adjustment Rooms of Los Angeles"—by A. H. Sutherland, is perhaps the most valuable, as indicating a means of securing the incentive of personal interest in acquiring information in the case of backward children.

Letters to the Editor.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, nor to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

Dr. Kammerer's Experiments.

As I had the privilege of entertaining Dr. Kammerer in my house when he was passing through London, and of discussing his experiments with him, and as I acted as his interpreter when he replied to his critics at the meeting of the Linnean Society, space may be permitted me in which to reply to the criticisms of Mr. Cunningham which appeared in NATURE of May 26, and to those of Dr. Bateson in the issue of June 2.

I will deal with Dr. Bateson's remarks first. From his speech at the Linnean Society I gathered that Dr. Bateson completely withdrew his charges of bad faith on the part of Dr. Kammerer, and accepted his published results as genuine, claiming, however—as he had the full right to do—to differ from the deductions which Dr. Kammerer drew from them. But Dr. Bateson's letter reads like a prolonged imputation of fraud to Kammerer; he refers to Dr. Kammerer's illustrations as like "spirit photographs," and demands further evidence before he will base any conclusions on Dr. Kammerer's work. Now, Dr. Kammerer explained at the meeting that the specimens shown by him constituted the salvage of the utter wreck of the experimental laboratories at Vienna owing to the War. His work has been going on since 1900—the year in which, unless I am mistaken, Dr. Bateson began his Mendelian work—and, in my opinion, the work has yielded results which are of as much importance in the study of heredity, from the evolutionary point of view, as all the Mendelian experiments together.

The main point in Dr. Bateson's letter is, however, that the specimen of Alytes shown by Dr. Kammerer to the Linnean Society did not show a typical "nuptial pad" (*Brunstschwiele*), and that the alleged pad was in the wrong place, because it was only the back of the hand which came in contact with the body of the female, so that the rugosities should be there and not on the palm; further, that a typical nuptial pad showed papillæ, and that he could not see them in the specimen. In proof of his assertion that the normal contact between male and female takes place with the dorsal surface of the male hand, Dr. Bateson publishes a print from a photograph of a pair of *Rana agilis* killed in the nuptial embrace. I ought to add that he was kind enough to send me privately a positive of this photograph, which shows his point more clearly than the print in NATURE.

Let us deal first with the structure of the horny patch. Dr. Bateson omits to say that at the meeting a section through one of these patches was shown under the microscope, and that, when the point of structure was raised in the discussion, Dr. Kammerer thought it too frivolous to reply to; he merely referred to the section which he had exhibited as answer. Dr. Kammerer, who has cut sections of the nuptial pads of all our common Anura, and can detect the species by the appearances shown by the microscopic preparation, assumed a similar knowledge on the part of his audience—but, to judge from Dr. Bateson's letter, he was rash in doing so. I have, however, taken the trouble to refer to Lataste's original figures of the callosities ("Mémoire sur les brosses copulatrices des batrachiens anoures," *Annales des Sciences naturelles*, 6me series, vol. 3, 1876), and I have no hesitation in saying that the section shown in the Linnean Society displays almost exactly the same appearances as those figured by Lataste in the figure of a section through the nuptial pad of the closely allied genus Pelodytes. Further, I have had sections through the nuptial pad of *Rana temporaria* prepared in my laboratory, and I can see in them the same structures as were shown in Dr. Kammerer's slide; of course, in Rana, as Lataste's figures show, the papillæ are very strongly developed—much more so than in Pelodytes or Alytes—but the essential structure is the same. The pad in Rana, to the naked eye, looks like a simple patch of pigment, and passing my finger over it I could not detect the papillæ by feeling.

As to the position of the pad, Dr. Bateson seems to think that he has settled this question *for all Anura* by his photograph. Now Alytes belongs to the small family of the Discoglossidæ, probably the most primitive family of the Anura. This family includes, besides Alytes, the genera Discoglossus, Bombinator, Pelodytes, and Pelobates. Boulenger, in his monograph, "The Tail-less Batrachians of Europe" (Ray Society, 1897), gives details of the position of the pads:

(1) Pelodytes, on the *inner side* of the two inner fingers—the antibrachium, the brachium.

(2) Discoglossus, on the *inner* and upper side of the three inner fingers.

(3) Bombinator, on the *inner* side of the three inner fingers and the antibrachium.

(4) Pelobates, copulatory excrescences absent.

The fact is that the primary contact between male and female takes place neither with the dorsal nor the ventral surface of the hand, but with the *radial edge*, and this is in accordance with Dr. Kammerer's experience; for in Alytes the pad first appears here, as shown in Dr. Kammerer's figures[1] (those criticised by Dr. Bateson in NATURE of July 3, 1919), and only later extends to the other fingers. In tight embrace, as indeed Dr. Bateson's photograph shows, the hand of the male becomes embedded in a fold of the female's body, and it is then a question of the direction in which pressure is exerted whether the additional callosities will appear on the inner or on the upper sides of the fingers. Perhaps I may add that the specimen shown in the Linnean Society had been previously exhibited at Cambridge, where it was inspected by Dr. Gadow, probably the best herpetologist at present living in Britain.

Dr. Gadow raised none of Dr. Bateson's objections, but he added the extremely interesting information that in the Portuguese species, *Alytes cisternasii*, old males occasionally develop callosities on the tips of the two inner fingers.

Dr. Bateson refers to Dr. Kammerer's reply "as disquieting to his disciples," since Dr. Kammerer stated that he did not regard the nuptial pad as an adaptation. I fear that my translation of the reply must have been singularly defective if Dr. Bateson drew any such conclusion. Dr. Kammerer's reply was that while, of course, the pad in Alytes was the revival of an ancestral nuptial pad, he had not made up his mind with certainty as to the *stimulus* which had revived it (*i.e.* whether it was pairing in water or the contact with the female). He did not allude to the stimulus in his lecture, and only with caution and reserve in his paper. The tight embrace necessary to hold a slippery partner seems to me,

[1] After consulting with Dr. Kammerer, it is obvious to me that Dr. Bateson mistook a patch of dirt adhering to the fourth finger of the specimen shown in these figures for the pad.

however, as it does to Dr. Kammerer, the most likely explanation; and as the male is frequently smaller than the female, this may lead to a deeper embedding of his hand in her flank and a larger area of contact, and thus to an extension of the callosities.

Since the pad only appears on males in the third generation after they have begun to pair in water, and then in the same place as it appears in Pelodytes and Bombinator, to suggest that it is not a functional adaptation but a chance mutation throws a singular light on what I may term the constitution of the Mendelian mind.

Turning now to Mr. Cunningham's letter in NATURE of May 26, I find that he criticises Dr. Kammerer's experiments on Salamander and Ciona. Taking his remarks on Salamander first, he has misunderstood Dr. Kammerer's reference to the ovary of the Salamander as being enclosed in a membrane, while that of the bird is not. It really does not assist in the controversy for Mr. Cunningham to accuse Dr. Kammerer of childish mistakes which would disgrace a first-year student in biology. Translating Dr. Kammerer's statement into modern technical language, it reads thus: "The ovary of the Salamander is completely invested by peritoneum and suspended to the back by a mesentery" (a fact which I have verified), "whereas the ovary of a bird is covered only on its ventral surface by peritoneum and is largely retroperitoneal, and therefore more difficult to remove in its entirety."

Next, Mr. Cunningham refers to Dr. Kammerer's Mendelian experiments with naturally and artificially striped Salamanders and the "forma typica." It is indeed disquieting to find so sound a Lamarckian as Mr. Cunningham so much under the influence of what I may term Mendelian dogmatism as to suggest that because the artificially-striped Salamander does not "Mendelise" when crossed with "typica," therefore the character is not gametic or hereditary! Truly a vicious circle of thought: the test as to whether a character is hereditary or not is surely whether or not it can be transmitted to the offspring.

I agree with Mr. Cunningham that Dr. Kammerer's results in Mendelising and in ovarian transplantation are extremely unexpected, and I may add that Dr. Kammerer himself did not expect them, and frankly admits that he has been unable to frame an explanation for them which is satisfactory to himself. I will not waste space by attempting to suggest an explanation, but I will refer Mr. Cunningham to Dr. Kammerer's long paper, where full details are given. I think he will find that the results are such that it would be difficult for mistakes to be made, and therefore, unless Dr. Kammerer is to be charged with deliberate bad faith, they must be accepted.

Dr. Kammerer regarded his experiments on Ciona as affording the clearest proofs of the inheritance of acquired characters. He showed photographs of his results. Mr. Cunningham objects that no photographs of the controls, *i.e.* of ordinary adult specimens of Ciona, were shown, in spite of the fact that Dr. Kammerer stated at the meeting that the experiment had been conducted on 100 specimens, and that, of course, controls had been made—that, indeed, the establishment of controls was the A B C of experimental science. I think that Mr. Cunningham, on reflection, will see that by this attitude he is joining the ranks of those who seek to escape from the inevitable deductions to be drawn from Dr. Kammerer's results by accusing him of deception, and this is an attitude with which none of us who had the pleasure of meeting Dr. Kammerer and seeing his specimens and discussing matters with him would have any sympathy.

E. W. MACBRIDE.

Law governing the Connexion between the Number of Particles and their Diameters in grinding Crushed Sand.

THE discovery of a simple law relating to continuity of particle size in fine grinding (or the breaking up larger into smaller particles) has long been a matter of scientific and technical importance. By means of experiments extending over some years, the British Portland Cement Research Association has definitely ascertained that, so far as a crystalline substance such as "standard sand" is concerned, a definite law does undoubtedly exist, which may be defined mathematically as follows:

In a given weight of W of finely crushed sand, if N be the number of particles of diameter x and if N and x be considered as variables, then in every case so far tested

$$N = ae^{-bx}, \quad . \quad . \quad . \quad . \quad (1)$$

where a and b are two constants characteristic of the particular sample tested.

Differentiating (1) we obtain:

$$\frac{dN}{dx} = -b \, . \, ae^{-bx} = -b \, . \, N. \quad . \quad . \quad (2)$$

In other words, *the rate of increase with decrease of diameter, of the number of particles present of any given size is proportional to the number of particles of that size.*

It is therefore possible to calculate the number of particles of any given diameter without going through the laborious process of sieving.

Another result of this law is that it now becomes possible to calculate exactly the theoretical amount of work required to produce powders of different degrees of fineness, and in that way do for the art of grinding what has long since been done for steam and electricity, namely, reduce grinding to an exact mechanical science. In other words, just as the engineer knows the amount of electrical energy or steam necessary to perform a given amount of work under definite conditions, so also he will in future be able to estimate the amount of work required to reduce a given material to a given degree of fineness under given conditions. It will thus be possible to deduce the efficiency of any grinding machine. These and other matters will be gone into in a paper now in preparation, in which the experimental details will be fully described.

The physical significance of this law is simple.

Consider a set of sand particles A (Fig. 1). By *grinding, each* of the particles A gives rise to the same number k (in our illustration $k = 2$) of smaller particles B, each of which in its turn gives rise to the same number k of still smaller particles C, and so on *all down the scale so far as we can pursue the matter by means of the microscope, with the ultimate production of colloidal particles.*

The law is probably the expression of the fact that crystals have a definite and fixed structure, and consequently break up when subjected to percussion or pressure in a regular and definite manner, which follows a definite mathematical law when the number of particles considered are sufficiently numerous to allow of the application of the law of probability.

The subject is of great scientific interest. For example, there is an obvious thermodynamical connexion between the work done in grinding (*i.e.* producing small particles from large ones) and the amount of heat required theoretically to *gasify* the material. For—considering the simplest possible case—in gasifying a homogeneous solid material (without passing through the intermediate liquid

state) we are merely reducing the material to particles of molecular dimensions and separated by distances beyond each other's sphere of molecular attraction. Whereas in ordinary grinding the same action is performed but the particles remain of considerable size. It follows from this that a homogeneous crystalline substance such as the diamond—which requires a large amount of heat and a high temperature to gasify—would be expected to require the expenditure of more work in reducing it to a certain fine state of division than a substance like ice (supposed kept at a temperature below freezing-point of water), which can be comparatively easily gasified.

This aspect obviously opens out a large field of research until now quite untouched; for example,

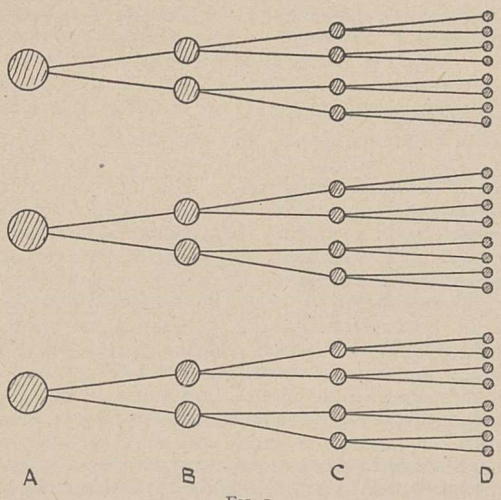

FIG. 1.

there exists a large number of organic crystalline compounds of which the heats of volatilisation are known, and the action of which under percussion or pressure could be investigated from this point of view.

The research work carried out has already proceeded sufficiently far to allow one to hope that in the near future the art of "grinding" will be transferred from its present chaotic state of empiricism into that of an exact science. The importance of this development in the gold-mining, pigment, and other industries—which depend so largely upon the production of materials in a state of fine division—will be apparent when we reflect on the great advances which occurred in the electrical and steam engineering sciences when the underlying laws were worked out.

CHARLES E. BLYTH.
GEOFFREY MARTIN.
HAROLD TONGUE.
The British Portland Cement Research Association,
Rosherville Court, Burch Road, Gravesend,
May 30.

Adsorption and Hæmoglobin.

ONE fundamental difficulty in the hypothesis that oxygen and carbon monoxide are "adsorbed" by hæmoglobin lies in the highly specific nature of the absorption spectrum of the compounds so formed. The change in colour of reduced blood, or of a dilute solution of reduced hæmoglobin, when shaken with air or oxygen, is very obvious to the naked eye, as also is the change when the oxygen is replaced by carbon monoxide. These colour changes can be used, either as in Haldane's method with direct vision, or as in Hartridge's by the spectroscope, for the exact quantitative measurement of the amount of gas taken up. Such remarkable, definite, and highly specific changes in the absorption spectra have no parallel, so far as I am aware, in any well-authenticated case of adsorption (unless the phenomena of electrolytic dissociation be classed as such), and must be explained by any theory, as of course they are by that of a specific chemical change in the nature of hæmoglobin by its combination with gas.

Sir William Bayliss, in his letter to NATURE of May 19, p. 666, and elsewhere, argues that the "widely divergent results obtained by different investigators of the heat of combination between oxygen and hæmoglobin" have not been adequately explained. The explanation really is simple, experimental error. If the solutions, or the blood, be reasonably aseptic, if due attention be paid to the carbon dioxide driven off when oxygen passes in, and if the observations be made with sufficient care and criticism, divergent results are *not* obtained. Any theory can be confused by imperfect experiments.

Again, Sir William Bayliss states that "in connexion with the relations between hæmoglobin and carbon dioxide, no proof has yet been given that the union is of a different nature from that with oxygen." Several such proofs exist: (*a*) it can be shown that nearly all, if not all, of the CO_2 taken up by blood at small CO_2 pressures (*i.e.* within the "physiological" range) exists there as actual bicarbonate (HCO'_3) ions; no other reasonable explanation is possible of the manner in which the hydrogen ion concentration of blood varies with CO_2 pressure; (*b*) the reaction of blood with CO_2, over the same range of CO_2 pressures, produces no change whatever in its absorption spectrum; (*c*) as the CO_2 pressure is increased the amount of CO_2 taken up does not approach a maximum in the same definite manner as does the amount of oxygen when the pressure of the latter is increased; neither is there any such precise relation between the Fe and the CO_2 as between the Fe and the O_2 or CO; (*d*) the effect of CO_2 on the hæmoglobin-CO reaction is precisely equal to that of a change of hydrogen ion concentration, exactly equal to that produced by the CO_2 but set up by another acid, such as HCl; in other words, the total effect of CO_2 on the hæmoglobin-CO reaction is exactly equal to that due to its acid character, which leaves no margin at all for any specific effect of CO_2 in turning out CO; in contrast to this, the considerable effect of oxygen on the same reaction is certainly not due to any change of hydrogen ion concentration produced by the oxygen, for (provided the hæmoglobin be kept saturated with CO and O_2) this change is *nil*; (*e*) the effects (i.) of oxygen and (ii.) of CO_2 on the combination of hæmoglobin with carbon monoxide are quantitatively quite different; (*f*) the effects of carbon monoxide on the reactions of hæmoglobin (i.) with oxygen and (ii.) with CO_2 are also different.

Sir William Bayliss affirms that "sometimes . . . workers are so convinced that the mass action view is all that is necessary, that they are not interested in testing the truth of the assumption." I can assure him that at least ten active workers of my personal acquaintance are "sometimes" very much interested, and indeed have recently applied the most stringent and searching tests to the view that the combinations of hæmoglobin with oxygen and carbon monoxide are, in the ordinary sense of the word, chemical, and obey the usual laws of chemistry. The accepted manner of "testing the truth of an assumption" is to make theoretical (and preferably quantitative) deductions from it, and then to see if,

and how far, these deductions are verified experimentally. This is being done repeatedly with the chemical theory of the dynamics and statics of the hæmoglobin reactions. If only those who believe in the adsorption theory would make some precise deductions from their theory, it would be easy to test that also. At present it evades any quantitative trial.

Attempts have been made to apply the Phase Rule, and to attribute the properties of large-scale matter to the single ultimate unit of hæmoglobin as it exists in solution. Presumably this ultimate unit has a diameter about 10 times that of the oxygen molecule; it is presumably in violent, oscillatory (thermal) movement; there is no good evidence that it has ever been observed with the ultramicroscope. To regard it therefore as a separate phase is to disregard the statistical basis of the Second Law from which the Phase Rule is deduced. *If* the hæmoglobin unit be indeed a separate phase, then admittedly the known number of degrees of freedom of the hæmoglobin-oxygen system prohibits the possibility of regarding oxy- and reduced hæmoglobin as separate chemical compounds. No evidence, however, can be given for the existence of hæmoglobin, in solution in water, as a phase separate from the water, except that it can be precipitated by various violent means—which surely is not evidence; the separate phase is a pure hypothesis and must be judged by its fruits, which at present are difficult to discern.

Sir William Bayliss's attitude of continual and friendly scepticism, on this particular subject, has had one important and valuable effect, the effect which he set out to achieve, which, however, his modesty prevents him acknowledging, or possibly even from appreciating. It has urged a number of workers to produce, what was badly needed, a body of sound quantitative experimental evidence on one of the most fascinating problems in the borderland between biology and chemistry. The evidence is not complete and we cannot convince him yet; but if he will only maintain his scepticism, in an equally friendly way, for a few years more, he will really force us to produce all the testimony which he requires.

A. V. HILL.

The University, Manchester,
May 31.

IN the recent correspondence touching the nature of the combination of hæmoglobin with oxygen, references have been made to Wo. Ostwald's adsorption theory. It may clarify the issue if I remind readers of NATURE what that theory was. Wo. Ostwald argued that the equilibrium between oxygen and hæmoglobin could be expressed by a curve based on the following equation, $X = KC^m$, where X is the amount of oxygen combined with the hæmoglobin, C the concentration of oxygen in solution, K a quantity proportional to the total mass of hæmoglobin present, and m a constant. The graphic expression of this equation must necessarily be a simple curve which is at all points concave to the abscissa. No published curve representing the equilibrium between hæmoglobin and oxygen, which has been determined experimentally, is of this character, all being more or less S-shaped, though in some cases the convex inflection is very slight.

It may seem strange that a theory should have been put forward which is at variance with the facts in so fundamental a respect. In justice to Wo. Ostwald it must be pointed out that he wrote before the experimental technique now in use had been elaborated. The most recent curves at his disposal were those of Bohr, Hasselbalch, and Krogh (for the oxygen hæmoglobin equilibrium at various CO_2 pressures). These are S-shaped in character, but at the time commanded less confidence than they deserved; I think because they were determined not as individual curves but as a surface in three dimensions, the published curves being contours. All modern work has confirmed the essential character of the curves of Bohr, Hasselbalch, and Krogh.

Finally, may I pay a tribute to the helpful nature of Sir William Bayliss's criticism (NATURE, May 19, p. 666), and suggest an extension of that help in the direction of his modifying Ostwald's theory, expanding it into an equation which would fit the facts sufficiently exactly to stimulate further research on the subject.

J. BARCROFT.

Physiological Laboratory, Cambridge,
June 6.

IN his letter published in NATURE of May 19, Sir William Bayliss suggests that two cases of adsorption do not come within the definition of adsorption to which I directed attention in NATURE of April 14. These are the cases when two or more substances are adsorbed upon a surface, and when a substance is adsorbed to a thickness of several molecules. Both these cases were intended by me to be included, and I think reasonably so, with the definition that it is a case of adsorption, if the substance is taken up uniformly over the whole surface; uniformly, that is, when the scale of measurement is large compared with individual molecules. This sense of uniformity is well understood in the theory of gases, where a mixture of gases or a single gas may be said to fill space uniformly, with equal correctness. I had no intention of limiting the definition to layers only one molecule thick; indeed perhaps I may be permitted, as it is suggested that I accept Langmuir's views, to point out that the theory employed by Langmuir does not seem to me necessarily to postulate that adsorbed layers are always one molecule thick. Such a proposition could only be established by estimating the amount adsorbed on unit area and calculating the thickness of the layer in terms of known data as to the size of the molecules in every case of adsorption; it does seem to be established by the beautiful experimental work of Langmuir in many cases, but is not, I think, claimed by him to be an invariable law governing adsorption.

Sir William Bayliss says in his first paragraph that no serious attempt has been made to consider surface phenomena in the combination of oxygen and hæmoglobin, since Wo. Ostwald showed that the data of the taking up of oxygen by hæmoglobin could be expressed by the adsorption formula; but he seems to have overlooked that the *sole* argument put forward in my letter of April 14, to prove that the attraction of hæmoglobin for oxygen is a highly localised property of the hæmoglobin particle, was that the hæmoglobin is so much larger than the oxygen with which it combines that the oxygen must be attached to only a very small portion of the surface. If there were general attraction of the surface of the hæmoglobin particle for oxygen, then combination would not stop when only a small fraction was covered, but hæmoglobin would take up much more oxygen than it actually does. Surely this is a very definite attempt to consider the surfaces of the particles. It is a mistake to confuse the argument used in my letter with those based on the well-known mass-action formulæ of Barcroft and Hill; it is entirely independent of them, and essentially treats the hæmoglobin in solution as a hetero-

geneous system, possessing an interface; it shows that this interface is, in fact, very much too large to be satisfied by the amount of oxygen which is actually taken up at saturation, and that therefore the oxygen *must* be held by some other means than adsorption. N. K. ADAM.

The University, Sheffield,
May 24.

Relation between Hæmoglobin-Content and Surface of Red Blood-Cells.

BÜRKER (*Archiv für die gesammte Physiologie*, CXCV., 1922, p. 516) has demonstrated that the relation between the hæmoglobin-content and the surface of a single red blood-cell is constant, whatever may be the divergencies in size and hæmoglobin-content of the blood-cells of different animals.

Taking as examples the rabbit, the chromocytes of which are of medium size, and the goat, which has very small red blood-cells, he gives the following numbers:

	Hæmoglobin-content per 100 c.c. Blood in Grams.	Number of Red Blood-cells per mm. in Millions.	Average of a Single Cell.	Surface of one Blood-cell in μ^2.[1]	Average Hæmoglobin-content per μ^2 Surface in 10^{-14} gm.
Rabbit .	11·9	5·86	20×10^{-12} gm.	68·4	27
Goat . .	10·9	13·94	8×10^{-12} gm.	25·1	29

[1] These numbers are to be multiplied by 1·09; *vide* NATURE, January 6, 1923.

Now, as is already evident from the numbers given by Abderhalden ("Lehrbuch der physiologischen Chemie"), the relation between the hæmoglobin-content of a blood-cell and its volume is also constant. In the following experiment the volume of the red blood-cells was determined by centrifugation of blood after addition of a trace of sodium fluorate.

	Hæmoglobin-content per 100 c.c. Blood in Grams.	Number of Red Blood-cells per mm. in Millions.	Average of a Single Cell.	Volume of all the Blood-cells from 5 c.c. Blood.	Hence Volume of one Blood-cell in μ^3.	Relation.
Rabbit .	10·6	5·7	19×10^{-12} gm.	1·7 c.c.	60	32
Goat . .	9·6	16·3	6×10^{-12} gm.	1·5 c.c.	18·4	31

The constant is the same in both cases. How are these two results to be reconciled?

One hypothesis is that the chromocytes of the goat have not the same shape as those of the rabbit. This hypothesis, however, does not seem to be satisfactory, because microscopic examination of the red blood-cells from the rabbit and the goat does not show an important difference in form.

A second hypothesis is that the method of determining the volume of the red blood-cells by centrifugation of the blood is not trustworthy.

The difficulty may be solved if, for example, the larger cells lost more water by the centrifugal force than the smaller ones; but this does not seem very probable either.

I am specially interested in the solution of this problem, because I am studying the question as to whether the hæmoglobin is distributed about the surface of the red blood-cell in such a way that all the iron is in the position that enables it to act as a catalyser. If we calculate how much iron can be placed at the surface of one human red blood-cell, it appears that this iron can form exactly one monomolecular layer, provided that one atom of iron occupies a surface of 8×10^{-16} cm^2. If, however, all the hæmoglobin should be placed at the surface in one monomolecular layer, this surface would have to be a hundred times greater. It seems probable that the surface that governs the law of Bürker must be the surface of all the "micelles" of the hæmoglobin-solution.

First of all, however, it ought to be definitely settled whether Bürker is right, when speaking of a "Hämoglobinverteilungsgesetz."

E. GORTER.

Leyden, May 7.

A Lost Collection of Indian Sketches.

IN the *Geographical Journal* for March 1922, it is stated (p. 219) that the Indian sketches made by me could not be found. As these are numerous, quite 160, made between 1852 and 1858, some details regarding them, their value as sketches, where and how they were made, may be of interest, and may possibly assist the authorities at Scotland Yard to trace them; even the discovery of one sketch might do so. It will also show fellows of the Royal Geographical Society and others why I have so persistently directed attention to the loss.

The sketches are not a traveller's collection of the ordinary kind; they were made to illustrate the country I was in, and the work on which I was employed. I cannot take a better example than the very first, made after landing in Burma. It was a water-colour sketch of the Lake at Rangoon, from the stockade which then surrounded the Pagoda hill, in its pristine state, now known as the Royal Lakes in Dalhousie Park, its artificial state. This sketch also showed the Rangoon River and hill on which stands the Syriam Pagoda, and how greatly the delta of the Irravady differs from that of the Ganges.

The first sketches go back to 1852, the year I obtained my commission and sailed for India, round the Cape, in a small troopship of 590 tons. Landing at Calcutta after a five months' voyage, and finally going on to Burma, where I passed my nineteenth birthday, all my spare time in that country was given up to making a geological map. Burma was then practically unknown, and on being appointed A.D.C. to General T. Godwin, on tours of inspection I saw much of the country.

This work compared well with the Geological map of Pegu as surveyed some years after by Messrs. W. Theobald, W. T. Blanford, and Feddon, only they were able to put an age to the formations seen; beyond knowing that the limestone of Akouk-thoung was very much the oldest, I could not. It was good practice, and many years after when I was surveying Manipur the knowledge gained was of immense value.

I must explain why when so young an officer I was able to do this. From an early age I had had most unusual opportunities to learn: my father was a geologist, always at work, always collecting, geological friends such as Edward Forbes always in the house. After learning surveying at Sandhurst I was able to help him to make plans near home to illustrate a paper he was writing—"On the Gravel Beds of the Valley of the Wey," Q.J. Geolog. Soc., vol. vii., 1857.

I helped to make the plan "On the Valley of the English Channel" (Q.J. Geolog. Soc., February 1850, vol. vi.), and learnt a great deal from seeing so much of the plans which finally illustrated the paper

"On the possible Extension of the Coal-measures beneath the South-Eastern part of England (Q.J. Geolog. Soc., February 1856). Among the geologists I met at home were Dr. Falconer and Thomas Oldham; they were the first friends to meet again in Calcutta in September 1852. I had read the work of the first with Lt. Cautley, R.E., and knew something of the Sivalik Formation when I crossed it at Kasauli in 1853. The 160 drawings cover a very large extent of country, which I roughly spread over thus:

1. Burma	29
2. Calcutta to Simla, via the Ganges Valley and on to Sealkote	26
3. Peshawar to Kashmir, through Hazara	73
4. On appointment to the Trigonometrical Survey of India and joining Capt. Montgomerie	10
5. When at Sealkote with 24th Regt. of Foot. In Sivaliks near Jammu	10
6. Various at Cape of Good Hope. Historical of the time	20
Total	168

H. H. GODWIN-AUSTEN.

Nore, Godalming, Surrey,
April 27.

Science and Economics.

THE function of NATURE is not to expound economics or finance, but when a famous man of science uses its widely-read pages to challenge the fundamentals of the almost ubiquitous system under which humanity lives—or perishes, the humble individual who has undertaken to defend the philosophy of the system must be pardoned if a little extra space is required to try to elucidate an aspect of the subject overlooked both by would-be reformers and unreflecting conservatives.

(1) Prof. Soddy tells us now quite plainly (NATURE, May 19, p. 669) that economics should be classified as natural physical phenomena, and, in effect, that all would be well with humanity were we to reorganise our economic system according to the laws formulated by men of science from their investigations in inorganic chemistry and physics. This is, if I may say so, a purely theoretical conception that is not substantiated by experiment or experience. Prof. Soddy lays stress on the physical aspect of phenomena. I had thought that scientific investigators had ceased to view any natural phenomenon as purely physical. However, that is perhaps only a matter of definition; but granting his terminology, I cannot agree that it is, or ever could be, possible to apply the laws of physical nature to the activities of mankind. Inorganic nature appears to be a finished product, since the laws of its atomic systems are unalterable by human means. Humanity, on the other hand, is obviously "in the making," and the doctrines and social systems adopted in different periods are temporary expedients that assist its evolution and correspond to the stage reached at any given time. As an Eastern proverb says, "The gods of one age become the devils of a succeeding age." Now, this makes life interesting and gives us all something to do. If mankind were to be reconstituted as is inorganic nature, instead of being organised as it is, those of us who now form theories and opinions and exercise our minds would be without occupation, if we had not shaken the dust of this dull world from our arrogant heads and departed to conquer other worlds.

Seriously, "economics" describes a human method; it is not a natural science and, hence, cannot be exact. There is an element in man not governed by the laws of physical nature, and this principle seeks to govern and direct them. This may imply "distorting physical nature to suit human nature," but the father of experimental science started it on the way by commanding us to "torture Nature," and thoroughly well have we obeyed him! The object of science is surely to understand Nature in order to use it for human ends. Prof. Soddy would reverse this, and advocates modelling our economic system on the laws of physical nature, a proposal tantamount to an attempt to baulk human evolution and to impose on man the rules of an inferior order of existence. Theoretically it would be easy to formulate a *fool*-proof economic system according to the laws of an atomic system; practically, any such system could not be *genius*-proof, and, certainly, if we value the evidence of history, we should be most unscientific to discount the geniuses who, ever so often, appear and alter existing conditions and methods. The "Robots" of the drama could never become a permanent feature of the human world.

(2) With regard to the age of our present system, it is necessary to make clear the essential difference between *the financial system* and *economic methods*. The principles of the former accord with fundamental characteristics of the human race; the methods of the latter are adjusted to changing environmental conditions and advancing knowledge of the resources of our planet. The essence of the financial system is, and always has been, *credit*, without which no civilisation would ever have been initiated by the trusted geniuses and leaders of the mass of mankind. I fear there is confusion in the minds of economists, both orthodox and heterodox, as to the origin and basis of credit as distinct from money and currency. Economics is a study of methods and theories. When orthodox, its laws are deduced from observations of a system at work *which it did not originate*; when heterodox, it consists of speculations, most of which are useless anachronisms, as their formulæ, like those of Karl Marx, do not take account of the fact that science is transmuting the economic basis of man's existence, which depends less and less on human physical "work," more and more on the application, direct and indirect, of "mental energy."

The financial system, on the other hand, is a principle in actual operation, and at present its methods are simply a modification of a tradition of credit-control handed down through many civilisations. Rome, Egypt, Babylon, India, China, etc., had their financiers who controlled credit according to the accepted code of laws. Archæological investigations, for example, have produced huge vaults of Babylonian cylinders containing the records of the accounts of banking concerns, their debts and credits. It would be naïve to imagine that the personal and commercial intercourse between the peoples of earlier civilised nations, such as Greece and Rome, was conducted on a cash basis without the assistance of credit. When a boy could be sent from Greece to school in Rome with a note to his father's banker in that city to pay his school expenses it is apparent that the credit-system was in operation. The kind of currency is quite subsidiary to the principle of credit—for if the Emperor of Rome had had bone or other discs of different sizes etched with the Royal insignia and issued in amount to meet the exchange needs of his Empire, the Greek boy would have got on as well with these as with the silver, gold and copper coins he used while in the Imperial city. His father, a merchant, had a credit account in Rome, for use as and when required.

The fact that many of us are only just realising the

erroneous theories the economists had formulated and taught about the intrinsic value of gold as the basis of currency, is no proof that the initiators of the financial system, whoever they may have been, laboured under the same absurd delusion. The reasons why a particular kind of currency came into use are fairly obvious to any one who has thought about it in relation to different stages of civilisation and human development. The problem of counterfeit money has also to be considered in this connexion. Our present system is an evolution of the Italian banking system bequeathed to that nation from a former civilisation. Since the founding of the Bank of England in 1694, industry and the financial system have expanded together on the basis of personal integrity and national credit. The fundamental principle of the system has never changed as far back as we can trace it into the remote past. It is founded on the permanent principle in human nature described as *a sense of responsibility* (individuality) and *a desire for action* (progress and evolution), and it is this which has guided the granting of credit and the use of a nation's currency. Individuals who obtain the use of the community's credit at any time are those who are able to produce what mankind desires, or is taught to desire, whether goods, ideas or adventures. It is a fact that gold alone did not finance the first factories erected and operated mechanically in this country, and credit has been issued ever since in increasing amounts on the basis of the ability of industrial concerns to produce what men desire to consume.

(3) Prof. Soddy says of the financial system that "Such a system as the present has never even been attempted before." This is not correct, as I have tried to indicate briefly above. He says, further, that "It is an absolute innovation." An *absolute* innovation is impossible under the laws of evolution and is not known in all the annals of human history, with the single exception of revolution, which is always followed by a restoration of tradition in a modified form. But the innovation here referred to is evidently the alteration in the class of persons to whom credit was granted after the introduction of mechanical power. It appears to have been a fundamental innovation because mankind then entered upon a new stage of evolution under new economic methods and new incentives and desires; and, therefore, the ostensible basis of credit was gradually transferred from land to the more productive industrial plant. The use of mechanical energy made it possible to satisfy growing desires, and the financial adaptation took place naturally as an "inflation" of currency necessary for the distribution of the increased products. This was not a fundamental change in the financial system as such; it was a change in economic methods: a new form or symbol of credit came into use.

The century or more since then has afforded ample time for the evolutionary process to complete the cycle of existence of this form so that the signs of age are apparent, as I suggested in a previous communication. The reasons are obviously that—

1. Machines are becoming more and more perfect and human labour less and less necessary for the production of the means of existence.
2. Most countries, even into the East, are becoming industrialised and their products cannot be marketed abroad as readily as in the nineteenth century.
3. Credit facilities have become too concentrated in the extension of industrial production, and the desires of those devoted to learning and the fine arts have been comparatively neglected under a democratic regime.

The results of 1 and 2 will gradually operate to inaugurate a new modification in the use of credit, because a wider base, another symbol or form of credit, must be found by which the means of human evolution and of existence under new conditions can be more adequately distributed. As machines now perform so much of the world's work, an extensive "unearned" distribution of currency would be possible and would benefit the skilled staffs of industries because of the increased expenditure of the people. The "out-of-work" allowance, however, is admitted to be an undesirable method, as the recognition of the mere "right to live" is not sufficient for those who realise the responsibilities of human government. The ethical effects cannot be disregarded, and the problem in this age of transition is to find suitable occupations for certain types. The latent powers in human beings are developed by individual effort, and it is evident that the financial system and social laws were originally formed with the view of inspiring and rewarding such effort. It is in this respect that our present methods require modification, and doubtless many new, and extensions of old, occupations would suggest themselves were the standards of character and attainment different. The scholarship method of encouraging self-development and distributing currency could be extended in other directions and to other occupations, and incentives devised for human endeavour toward worthier ends than now attract the majority. But it would be unsafe to attempt a change on a wide scale until the principles which should guide the innovation are clearer.

(4) Finally, Prof. Soddy describes the present system as "counterfeit." I presume (under correction) that he has in mind the "interest" on credit-loans. The philosophy of "usury" is very interesting, as it involves the polar principle which science has demonstrated, and also the principle of growth or development which evolution implies. Interest is roughly the measure of the increased productive capacity from year to year, and this increase is returned immediately to industry as new "loans" and distributed as currency in wages, salaries and dividends, according to the ability of industry to absorb and use it. Interest or "usury" acts as an automatic regulator and indicator; it shows where the energy and desires of man are expended. It also acts as a check and restraining influence on impetuous individuals, although to economists who may not realise the polar principle of "debt" and "credit" it is rather of the nature of the red flag.

Greed and selfishness (concomitants of the evolutionary process) would be even more in evidence were human beings not automatically controlled and regulated by the laws of its own credit system, which at the same time fulfils the human function of providing for changing conditions, growing desires and the development of individuality—otherwise we might, indeed, perish. Even as things are, honest intention to meet "promises to pay" and ability to perform what this industrial age and its ideals demand (Mr. Lane Fox Pitt's "practical instruction," May 19, p. 670) underlie our credit system, and any one who has the "credulity" to evade these conditions comes sooner or later to the end of his rope and his character.

In conclusion, my object is elucidation and is not to prove any person wrong, least of all Prof. Soddy, whose courageous tilting at economic conditions has stimulated thought and will help to hasten a most urgent readjustment of methods and conditions which, in my opinion, can be brought about only by a change of ideals.

W. WILSON LEISENRING.

May 22.

Separation of Isotopic Ions.

IN the issue of NATURE for June 2, p. 763, there is a reference to a paper by Kendall and Crittenden (Washington: National Academy of Sciences, vol. 9, No. 3) which describes a method for separating isotopic ions. This method was first described by Prof. F. A. Lindemann at the Royal Society conference on isotopes (March 1921). A considerable number of experiments on this subject have been carried out here during the past year, but it seemed desirable to postpone publication until a definite result had been achieved. JOHN G. PILLEY.

Clarendon Laboratory,
University Museum, Oxford,
June 5.

Haze on Derby Day—June 6.

THERE was a dense haze overlying Southern England on June 6, becoming worse towards evening and greatly interfering with visibility. It was very marked in Surrey in the neighbourhood of Epsom, where the race-goers found it difficult to see clearly. Records of this haze taken with my dust-counter at Cheam, between 7 and 7.30 P.M., gave a greyish deposit of dust particles upon the cover-glass. These particles varied in diameter from 1½ microns down to ultra-microscopic size; the average diameter was about ½ micron. Most of them were irregular in shape and insoluble in water, but scattered among the irregular dust particles were a number of small spheres. The proportion of these spheres present was about 3 per cent. of the total number of dust particles. They were transparent and usually colourless, but some were distinctly brown or reddish. The maximum diameter of the spheres found was 1½ microns, but most of them were less than this. They were insoluble in water. The haze was unusually dense for a country district, and the number of dust particles per cubic centimetre was between 9000 and 10,000.

It will be remembered that on Derby Day there was very little wind, but what there was was from the north. It is difficult to avoid the conclusion that a large proportion of this dust travelled south from the manufacturing districts of the Midlands. The presence of coloured and colourless transparent spheres points towards ash particles ejected from chimneys, while the grey colour is not what one would expect if domestic smoke were the origin. The records obtained during London fogs are black, and a dense fog gives 40,000 to 50,000 particles per cubic centimetre.

For comparison with June 6, a dust record taken at 7 P.M. on the evening of June 10 at Cheam gave less than 100 dust particles per c.c. The wind was strong and blowing from the west, and visibility very good. J. S. OWENS.

Perseid Meteors in July 1592.

WITH reference to Dr. Fotheringham's interesting comments in NATURE, June 9, p. 774, on the probable shower of Perseids in 1592, I thought it best to accept the date kindly sent to me by Mr. Beveridge, as it fell near the time when a shower might be expected to occur. However, the shower of 1592 appears to have been 19 days earlier than the correct time, and this (with another reason stated later) at once throws doubts on the identity of the display with the true Perseids.

The near correspondence in epoch may still, however, occasion some suspicion that the Perseid shower formed the incident recorded in history, though the exact date and direction of the meteor flights are incorrectly given. This idea is encouraged by the fact that in two other cases (A.D. 784 and 865) the shower dates differed 10 days from the normal.

It is perhaps important to remark in this connexion that several rich showers of non-Perseids have been frequently observed in modern times which do not differ materially from the date of the Perseids. Three of these may be mentioned as possibly the same as the ancient showers recorded which failed to conform with the exact Perseid dates.

(1) There is a strong shower at 303° − 9° near α Capricorni on July 25-August 6.

(2) A rich display from 339° − 11° in Aquarius on July 26-August 2.

(3) A fine shower seen in 1879 from Draco 291° + 60° on August 21-25.

If the meteors of 1592, to which Mr. Beveridge has directed attention, "traversed the heavens from west to east," as stated in the ancient chronicle, they could scarcely have been Perseids, for the latter are moving nearly from east to west, and this seems an important detail.

The direction of the meteors of 1592 from west to east means that their apparent motions must have been slow and that they were overtaking the earth in its orbit. The Perseids belong to another class; they are swift objects meeting the earth at a velocity of 38 miles per second. I was not aware until I saw Dr. Fotheringham's letter that the direction of the meteors had been described as from west to east.

I adopted a period of 11·75 years (*Observatory*, May 1923) as agreeing with a large number of abundant returns of the Perseids and as it seemed the best to be derived. I directed attention to it in the hope that future observers would bear it in mind and test it in the light of additional observations.

W. F. DENNING.

44 Egerton Road, Bishopston,
Bristol, May 30.

Tactile Vision of Insects and Arachnida.

WITH regard to Father O'Hea's letter in NATURE of May 26, p. 705, I wish to point out—

(1) That I originally questioned the statement that the house-fly and certain spiders avoided the approach of one's hand by detecting "convection currents."

(2) That experiments in this direction can only be made with *totally blind* insects.

(3) That I have not stated that vision is universal or even general among insects and arachnida possessed of eyes, and I offer no explanation (at present) of the use or purpose of "sightless eyes." Neither can I enter a discussion on "vision and light-sensitiveness."

I do maintain, however, that many species form comparatively clear images and can judge distances. The fact that a male Attid (and some Lycosids) will perform for the benefit of a female in an adjacent glass tube is at present only explicable on the assumption of vision. Father O'Hea has not, he says, worked on this point, and I persist in offering it as a preliminary objection to his hypothesis. This discussion cannot, however, proceed to any satisfactory conclusion until we have his further evidence for a large number of species; and until this is forthcoming I should suggest that a generalisation on the question of vision among arthropods cannot be made.

G. H. LOCKET.

Salmon's Cross, Reigate, Surrey.

The Eötvös Torsion Balance and its Use in the Field.

By Capt. H. SHAW and E. LANCASTER JONES.

THE problem of locating from the surface mineral deposits in the interior of the earth presents numerous difficulties, and has been considered by many investigators who have employed methods based on the physical properties of these bodies, utilising electrical, magnetic, seismic, and density effects. Speaking generally the useful minerals are of either very high or very low density, so that a method dependent upon the difference in density between the mineral and its surroundings would appear to be suitable for the location of such deposits, especially as these effects are noticeable at a considerable distance.

The attraction due to a heavy body is superimposed upon the normal force of gravity at any point in its vicinity, and it is by observations on this local field by means of a torsion balance that the disturbing mass may be located most readily.

The torsion balance of Michell and Cavendish was redesigned and employed for this purpose in 1888 by Baron Roland von Eötvös, professor of physics at Budapest, who gave to the balance a new construction which is retained essentially in the modern instrument, although numerous improvements have since been introduced.

The essential features of the balance can be seen on reference to Fig. 1. A light aluminium beam loaded with platinum weights is suspended by a fine platinum iridium torsion wire. One of the weights is attached directly to one end of the beam, but at the other end the weight is suspended about 60 cm. below the beam by means of a fine wire.

The forces of gravity acting on the two masses are not wholly vertical, but have small horizontal components which give rise to a minute horizontal torque tending to rotate the balance arm. The displacement of the beam relative to its case is observed by means of a telescope and scale fixed to the case, with the aid of a mirror carried by the beam.

When the position of equilibrium of the system has been read, the entire beam and case are rotated through 72° and the observation repeated. Five observations are thus obtained in one revolution of the balance, and the readings in these positions are sufficient to furnish the information required for the station at which the balance is situated.

The modern type of balance consists of two similar beam systems placed side by side, with the suspended weights at opposite ends, and as with this type only three observations at angles of 120° are required for a complete determination, a considerable saving of time results. These improved instruments are in some cases fitted with photographic recording arrangements, the balance case being rotated automatically into its new azimuth after the beam has come to rest and the exposure made.

The suspended system requires most careful protection against convection currents and other disturbing influences, and consequently is enclosed in a double or treble-walled brass case of uniform thickness. Temperature and radiation effects are thus reduced considerably, while the additional precaution is taken of working at night, thereby eliminating solar radiation effects and securing a greater constancy of temperature. Under these conditions the instrument is found to give uniform and satisfactory results in the field when protected only by a tent.

In order to secure the necessary degree of sensitivity it is essential that the period of oscillation should be large, and Eötvös has succeeded in obtaining a period of swing of 1500 to 1800 seconds by employing weights of 30 grams and a beam of 40 cm. length, the lower

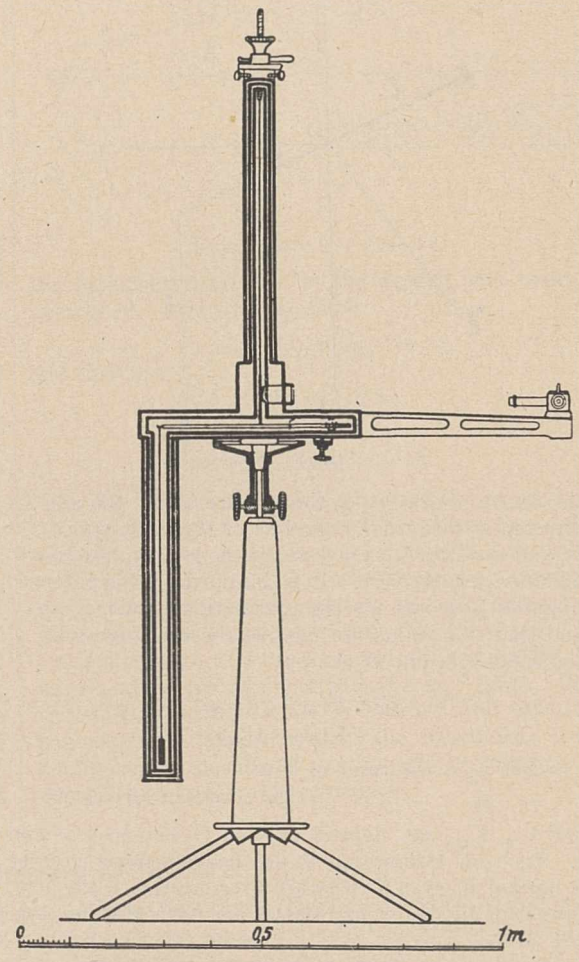

FIG. 1.—Section of balance.

weight being suspended at a depth of about 60 cm. below the beam. The sensitivity of the instrument is partly controlled by the coefficient of torsion of the suspension wire, and by using a platinum wire 0·04 mm. in diameter, alloyed with 20 per cent. iridium, it is possible to measure variations of gravity to within one 10^{-9} C.G.S. unit per centimetre. These wires, which have hitherto proved the most suitable for the purpose, are previously subjected to a special "baking" treatment with the view of eliminating remanent torsion. Similar instruments of smaller dimensions have been constructed and tried by Eötvös, but were subsequently abandoned as being unsatisfactory. Quartz fibres have also been employed in place of the torsion

wire, but it was found by Eötvös that a quartz fibre which is sufficiently strong to carry the loaded beam is more rigid than the platinum iridium wire and in consequence a smaller deflexion of the beam results. It was partly owing to this fact and partly owing to the exceptional fragility of the quartz fibre that it was not adopted by Eötvös in his field instrument.

The action of the balance and the nature of the quantities measured may be appreciated from the following consideration. Let a system of rectangular co-ordinates Ox, Oy, Oz, Fig. 2, have its origin O at

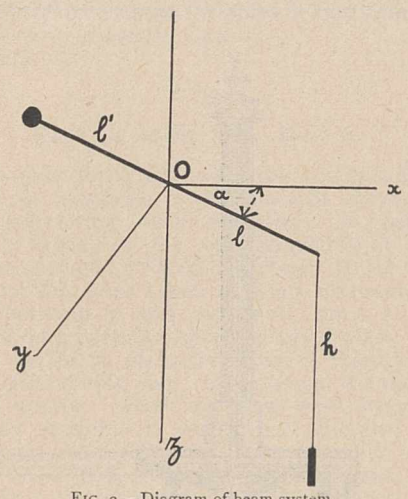

FIG. 2.—Diagram of beam system.

the centre of gravity of the balance beam, the axis Oz directed downwards in the line of resultant gravity at O, and the axes Ox, Oy towards the geographical north and east respectively. It is assumed that a potential function U exists for the gravitational field about O and that, for points not outside the range of swing of the balance beam, we can put

$$U = U_0 + g_0 z + \tfrac{1}{2}U_{11}x^2 + \tfrac{1}{2}U_{22}y^2 + \tfrac{1}{2}U_{33}z^2 + U_{12}xy + U_{13}xz + U_{23}yz,$$

where U_0 is the value of U at O,

g_0 „ „ „ the resultant force at O,

and U_{11}, U_{12}, etc. depend only on O, not on x, y, and z. Such an assumption is justified whenever gravity is normal, or even if there are irregularities in the field, provided the disturbing masses are fairly distant from the balance.

If the balance beam lies in any position in the plane Oxy, making an angle α with the axis Ox, its main mass is concentrated at two points of which the co-ordinates are $(l' \cos(\alpha+\pi), l' \sin(\alpha+\pi), 0)$ for the upper weight and $(l \cos\alpha, l \sin\alpha, h)$ for the lower. The potential of the whole system will therefore depend on α, and will only be a minimum or maximum for a limited number of values of α. For all other azimuths the beam will tend to rotate so as to set itself in a position of minimum potential, and will actually rotate until this tendency is balanced by the torsion of the suspension wire. The latter, measured by means of the telescope and scale, affords a means of determining the twisting moment due to the gravitational field at any value α, and thus enables us to evaluate the quantities which specify the field and the torque due to it. It is shown in the mathematical theory that these quantities are none other than the magnitudes

$$(U_{22} - U_{11}),\ U_{12},\ U_{13}, \text{ and } U_{23},$$

which are thus determined for every station O.

APPLICATION OF THE BALANCE.

The magnitudes $(U_{22} - U_{11})$, U_{12}, U_{23}, U_{13} determined by the balance are not sufficient to enable us to reproduce the complete gravitational field about O—in other words, to describe its equipotential surfaces—since we require to know both U_{11} and U_{22} separately, and also U_{33} and g_0. Eötvös, however, has shown that, by means of the four magnitudes determined by his balance, and one or two pendulum measurements, the magnitude of g, the force of gravity, can be determined throughout a region where the earth's surface deviates only slightly from the equipotential surface through the base point. The balance is thus of great service to geodesy.

In recent years, however, the balance has been extensively employed for work having a wider appeal than the problems of geodesy. By its capacity to explore the regions below the earth's surface, not by penetrating it but by remaining always on the surface, it has proved itself a valuable ally to the geologist, and its use is superseding much of the costly boring and drilling hitherto necessary in locating mineral deposits. Wherever such deposits differ sufficiently in density from their surroundings, and are sufficiently extensive to cause appreciable irregularities in the gravitational field at the surface above them, the balance not only registers their existence, but also helps to determine their density, shape, extent, and depth below the surface, so that, in favourable circumstances, a single boring may suffice to settle any remaining doubts regarding the nature and size of the deposit. In this work of exploring subterranean disturbing masses, the same four quantities $(U_{22}—U_{11})$, U_{12}, U_{23}, and U_{13} are employed, but the influence of all known disturbing masses, and the normal field due to the size and shape of the earth, must be calculated and eliminated before accurate conclusions regarding the unknown masses can be drawn. This may be a very laborious and complicated process, and may even be impossible in unfavourable regions, *e.g.*, where there are mountain ranges of an irregular character in the vicinity.

In such regions, however, the variations of strata as regards character and shape are frequently sufficiently apparent from surface indications to render the use of the instrument unnecessary, so that the balance is of most use where it is most accurate, namely, in regions presenting a regular and comparatively unbroken surface, but having important irregularities below the surface.

In this work, certain simple combinations of $(U_{22} - U_{11})$, U_{12}, U_{23}, U_{13}, are more useful than the magnitudes themselves. Those mainly used are S, R, λ, μ, where

$$S = \sqrt{U_{13}^2 + U_{23}^2}, \qquad R = -\frac{1}{g}(U_{22} - U_{11}) \sec 2\lambda,$$

$$\tan\mu = \frac{U_{23}}{U_{13}}, \qquad \tan 2\lambda = -\frac{2U_{12}}{U_{22} - U_{11}}.$$

The magnitude S represents the "maximum gradient of gravity in the horizontal surface," *i.e.*, the maximum amount by which the vertical force of gravity is increased as we proceed from the origin through unit distance in any direction in the horizontal surface, and is obviously the resultant of U_{13} and U_{23}, the gradients in the direction Ox, Oy respectively. Also the direction of this maximum gradient is given by μ, the angle which it makes with Ox.

The magnitude R is equal to the difference between the reciprocals of the principal radii of curvature of the level surface at O, and is always positive. Thus, if ρ_1 is the least radius of curvature at O, and ρ_2 the greatest,

$$R = \frac{1}{\rho_1} - \frac{1}{\rho_2},$$

while λ is the angle which the plane of greatest radius of curvature, or least curvature, makes with the plane Oxz.

The work of survey consists in finding these values S, R, λ, μ at as many stations as possible, correcting them for normal gravity effects and known irregularities, and plotting the final values, representing the maximum gradient S by an arrow drawn through the station in the direction μ, and proportional in length to the magnitude of S, and indicating R by another arrow in the direction λ. The positions, directions, and lengths of these arrows are then compared with the corresponding arrows given by certain simple mass distributions of which the effects can be calculated, and the probable distribution corresponding to the observed results is deduced.

To illustrate the gravitational effect of a subterranean mass and the variation of the magnitudes measured by the balance from point to point on the earth's surface above such a deposit, we may consider the simple case represented in Fig. 3. Here a horizontal layer of matter, having a density greater by unity than its surroundings, is bounded on the top and bottom by horizontal surfaces at depths 200 and 300 metres below the earth's surface. The layer extends to infinity in the north, east, and west directions, but terminates at the south end in a vertical plane through the east-west line. Let O be a point on the earth's surface on the line where this vertical boundary meets the latter, $x'Ox$ the meridian through O, and Oz the downwards vertical meeting the faces of the deposit in A and B. Consider the force of gravity due to the deposit alone—which is thus to be regarded as having a density unity—at any point X on $x'Ox$. The force at X will be wholly in the plane xOz, and the corresponding potential surface through X will be a cylinder having its axis perpendicular to this plane. In these circumstances the magnitudes U_{11}, U_{12}, etc., specifying

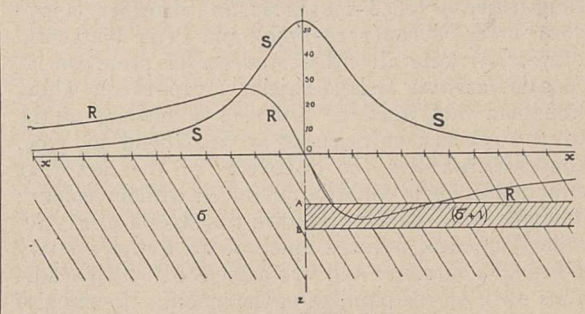

FIG. 3.—Results for a simple case.

the disturbing field due to the deposit, can easily be calculated. Moreover we have

$$U_{12} = U_{22} = U_{23} = 0,$$

and therefore

$$\lambda = \mu = 0 \text{ or } \pi,$$
$$R = U_{11},$$
$$S = U_{13}.$$

In Fig. 3 the values of U_{11} are plotted as ordinates corresponding to the abscissæ OX in the curve RRR, and the values of U_{13} in the curve SSS. It will be noticed that the point O, vertically above the edge of the deposit, is strongly marked in each curve by a maximum on one and a zero value on the other. The maximum value of S has a magnitude 53×10^{-9} C.G.S. units, and the maximum of R is 26×10^{-9} units. Since values of R and S as low as 1×10^{-9} unit affect the balance, it is apparent that the instrument would readily show the effects due to such a subterranean deposit, and indicate its extremity.

Science and Industry in Sweden.

THE exhibition recently opened at Gothenburg to celebrate the tercentenary of the founding of that city by Gustavus Adolphus, with its display of Swedish manufactures, is an eloquent reminder of the part taken by Sweden in the development of certain industries and also of the debt of the world to Swedish men of science. Though she cannot lay claim to mathematicians of the rank of Leibnitz, Newton, or Euler, or to astronomers equal to Galileo or Herschel, in chemistry and mineralogy Sweden has often led the way, and few countries can boast of names more widely known than those of Bergmann, Scheele, Gadolin, Berzelius, Nilson, Cleve, and Arrhenius.

The rise of science in Sweden is generally traced to Linnæus, but it really had its foundation in the middle of the seventeenth century. Like all the western nations Sweden felt the influence of the discoveries of Copernicus, Kepler, and Galileo, and one of the objects the young and eccentric Queen Christina had in view when she invited Descartes to her capital, was to place him at the head of the academy she proposed to establish. The plans of Christina, however, came to nothing, for Descartes died in 1650 and four years later she herself abdicated.

Sweden has a comparatively large territory but a very limited population. Until recent times there were but two seats of learning, Uppsala and Lund. Both are still small cities, the former having about 20,000 inhabitants, the latter some 4000 less. Uppsala is about 40 miles north of Stockholm, while Lund is not far from Malmö in the extreme south. Lund University was founded in 1666, Uppsala in 1476. It was in Uppsala that Swedish science had its birth, and there it has found its principal home. Johann Gestrin and Magnus Celsius (1621–1679) were among

the mathematicians of Uppsala during the seventeenth century, the former being the author of a commentary on Euclid and works on astronomy and mechanics. The grandson of the latter, Magnus Celsius, was Anders Celsius (1701–1744) who accompanied Clairaut and Maupertuis on their degree-measuring expedition to Lapland. To him we are indebted for the Centigrade thermometer. For some years he was professor of astronomy at Uppsala.

The great Swedenborg (1688–1772), the learned Klingenstierna (1698–1785), Martin Stroemer (1707–1770), Peter Elvius (1710–1749), and Peter Wargentin (1717–1783) were all either students or professors at Uppsala, as was Melanderhjelm (1726–1810), whom Brougham met when he attended a meeting of the Royal Academy of Sciences at Stockholm in 1799. Klingenstierna was the discoverer of the fact that refraction of light could be produced without colour; Stroemer made the first Swedish translation of Euclid, while Wargentin devoted much of his life to a study of Jupiter's satellites and was associated with Lacaille in his work on the parallax of the moon. He was also the first director of the observatory at Stockholm founded in 1759 largely through the instrumentality of the capable and public-spirited administrator, Claude Grill (1704–1767).

Of all the men of science connected with Uppsala the place of honour must be given to Linnæus, whose tomb is in the Cathedral there. Whether we think of him as a boy watching the bees and flowers in his father's beautiful garden at Rashult, as the budding botanist at the school at Wexio, or as the struggling student first at Lund and then at Uppsala, or again as the intrepid explorer in the wilds of Lapland, we are impressed with his untiring energy and his singleness of purpose. Born in 1707, at the age of twenty-three Linnæus became an assistant professor at Uppsala, but the years 1735 to 1738 he spent in travel. In Holland he became the friend of Boerhaave and worked in the garden of the wealthy Cliffort, near Haarlem. He also visited England, France, and Germany, and it was during this time he brought out the first edition of his "Systema Natura." Returning to Sweden he was made the president of the newly founded Academy of Sciences at Stockholm, and in 1741 became professor of anatomy at Uppsala, where he died on January 10, 1778. With his never-ceasing industry he combined a passionate love of order, and it has been said that thus "he was able to serve his own generation with great effect, to methodise the labour of naturalists, to devise useful expedients for lightening their toil, and to apply scientific knowledge to the practical purposes of life."

Contemporary with Linnæus, but occupied with a different branch of science, was Johann Wallerius (1709–1785), the writer of many scientific books and for a long time professor of chemistry, metallurgy, and pharmacy. It was to his chair that Bergmann succeeded in 1767. A native of West Gothland, where he was born in 1735, Bergmann as a student came under the influence of Linnæus and passed nearly the whole of his life at Uppsala. He was one of the earliest chemists to deal with chemical problems in a strictly scientific manner, and he was the pioneer of systematic chemical analysis. Holding his chair until his death in 1784, he counted among his pupils Johann Gahn (1745–1818), who added manganese to the list of elements and instructed Berzelius in the use of the blowpipe, and Johann Gadolin (1760–1852). Gadolin became a professor at the university of Abo, then belonging to Sweden, and to him Finland was indebted for the introduction of a knowledge of the discoveries of Lavoisier and the other French chemists. The town and university of Abo were destroyed by fire in 1827, but when visited by Bishop Heber, the writer of the hymn "From Greenland's icy mountains," in 1805, he described it as "a place possessing an archbishop, fifteen professors, three hundred students, a ruined castle, a whitewashed cathedral, and certainly the most northerly university in Europe."

Gadolin had been a candidate for the chair left vacant by the death of Bergmann, but this was given to Afzelius (1755–1837). Bergmann's greatest contemporary was undoubtedly Scheele. Seven years younger than Bergmann, Scheele began life as an apprentice in Gothenburg. From Gothenburg he removed to Malmö, then to Stockholm and to Uppsala, and finally settled at Koping where he purchased a business. It was here he made his great discovery of oxygen. Endowed with a genius for resolving the most obscure chemical reactions, Scheele stands almost unrivalled for the number and value of his discoveries. He died two years after Bergmann, and his statue now adorns the Swedish capital.

Though, with the death of Bergmann and of Scheele, the progress of chemical discovery slackened somewhat, the greatest of Swedish chemists had yet to appear. Berzelius, who stands beside Linnæus in the roll of Swedish science, was born in 1779, a year after Davy. In 1798—the year Davy went as assistant to Beddoes at Clifton—Berzelius became an assistant to the medical superintendent at Medvi. While Davy was establishing his reputation at the Royal Institution, Berzelius as a professor of medicine was gaining the admiration of Stockholm, and on Davy's death in 1829 he was recognised as the leading chemist in the world. Sir William Ramsay once remarked that he believed that since the time of Boyle none had done more for the advancement of chemistry than had Berzelius. His kitchen laboratory at Stockholm was as famous as that of Lord Kelvin in the cellar beneath the old College of Glasgow. Dulong, Mitscherlich, Gmelin, Gustav and Heinrich Rose were all taught there by the great master, and Wöhler has fortunately left a description of it. "The laboratory," he said, "consisted of two ordinary rooms furnished in the simplest possible manner; there were no furnaces or draught places, neither gas nor water supply. In one of these rooms were two common deal tables; at one of these Berzelius worked, the other was intended for me. On the walls were a few cupboards for reagents; in the middle was a mercury trough, while the glass blower's lamp stood on the hearth. In addition was a sink, where the despotic Anna, the cook, had daily to clean the apparatus." When in 1833 Berzelius married, the King of Sweden wrote of him, "Sweden and the whole world were debtors to the man whose entire life had been devoted to pursuits as useful to all as they were glorious to his native country."

Berzelius died in 1848, and the torch of chemistry has been handed on by worthy successors such as Lars Fredrik Nilson (1840–1899) and Per Theodor Cleve (1840–1905), while to-day science in Sweden has no more illustrious name than that of Svante Arrhenius, the originator of the theory of electrolytic dissociation and the director of the Nobel Institute of Physics, who began his career in the old university where Bergmann had taught.

While chemistry in particular has flourished in Sweden, other sciences have by no means been neglected. In all that appertains to the sea and fisheries, to agriculture and forestry, and to exploration, much valuable work has been done. One of the meetings to be held at Gothenburg this summer is the Congress of Scandinavian Naturalists. In astronomy, in physics, and in geology, Sweden has also played her part. Uppsala has possessed an observatory since about 1730, and during the nineteenth century this was directed by Gustav Svanberg (1801–1882), Herman Schultz (1823–1890), known for his micrometrical measurements of nebulæ, and by Nils Christophr Duner (1839–1914), who devoted himself to a study of stellar spectra and in 1892 received the Rumford Medal of the Royal Society. Another well-known astronomer was Hugo Gylden (1841–1896), for more than twenty years head of the Stockholm observatory, where Backlund was his pupil. Anders Jonas Ångström (1814–1874) began his career in the Swedish observatories, but his great work on the solar spectrum was done while he held the chair of physics at Uppsala to which he was appointed after the death of Adolph Svanberg (1806–1857). Ångström's successors, Tobias Thalen (1827–1905) and Knut Johan Ångström (1857–1910), were also distinguished workers in spectroscopy, while it was said that Thalen's magnetometer was in use in every iron mine of importance in Sweden.

Geological studies in Sweden may be said to have been begun with the writings of Urban Hiarne (1641–1724), physician to the king, who in 1694 published his views on the history of the earth. Some of the earliest geological maps of Sweden were prepared by Gustav Hermelin (1744–1820) a student of Uppsala and an officer in the Swedish mining service. Geological surveys of Norway and Sweden were inaugurated in 1858. Among the directors have been Otto Torell (1828–1900) and Alfred Törnebohm (1838–1911). In a country possessing rich mineral deposits, the work of these geologists has been of the greatest value.

Apart from agriculture, which still employs about half the population of 6,000,000, the main industries of Sweden depend on the iron mines, the magnificent forests, and the ample water power. The manufacture of wood pulp and the timber trade have grown enormously. At one time Sweden was the principal iron-producing country in the world. Though to-day her position in this respect is much more modest, the quality of her iron is still unrivalled. The steam engine was introduced into Sweden by the Swedish man of letters, Abraham Edelcrantz (1754–1821), while the first marine engine was made by Samuel Owen, whose bust has been placed in the Gothenburg Exhibition together with a model of the engine he built. In the field of shipbuilding Sweden has done much pioneering work, and at one time no writings on naval architecture were more highly esteemed in England than those of Chapman (1721–1808), who was a native of Gothenburg. The famous engineer and naval architect, John Ericsson, was a Swede, and began work on the Göta Canal, which had been first surveyed by Swedenborg, but was built to the plans of the British engineer Telford. Ericsson was in England from 1826 to 1839; he then emigrated to the United States and it was there that he produced the *Monitor* which during the civil war saved the North. After his death in 1889, Ericsson's body was sent to Sweden in an American warship, and it now lies at Filipstad in the beautiful Wermland district.

Many Swedish civil and mechanical engineers have gained a world wide-reputation. Nordenfelt, who died in 1920, was one of the pioneers of the submarine, Goransson, who died in 1900, assisted in perfecting Bessemer's great invention, while Fredrik Kjellin (1872–1910) was a pioneer of the electric steel industry. Of the three brothers Nobel, it was Alfred Bernhard Nobel (1833–1896) who first produced dynamite and afterwards left more than a million sterling to found the Nobel prizes. The list could be lengthened considerably, but few names have stood higher than that of Gustav de Laval (1845–1913), whose cream separators are to be found in use all over the world; he is also widely known as the inventor of the de Laval steam turbine, the first patent for which was taken out in 1884, the same year that the Parsons turbine was patented. De Laval, it may be added, was a student and graduate of Uppsala University, and was thus one of the makers of modern Sweden who laid the foundation of their knowledge in the ancient university where Swedish science had its birth.

Current Topics and Events.

AN important paper by Prof. Georges Dreyer, of Oxford, in the last number of the *British Journal of Experimental Pathology* has been the subject of widespread comment, as, apparently, it is likely to inaugurate a new era in the specific treatment of infective disease, and particularly of tuberculosis. It is a matter of common knowledge that the "tuberculins" hitherto employed have not been completely successful against the highly resistant bacillus of tuberculosis. Dreyer's main thesis—and it is supported by a mass of accurate experimental evidence—is that the relative failure of certain vaccine preparations is due to the presence in some bacteria of various lipoidal substances which, covering or incorporated with the protoplasm of the microbe, offer a considerable protection to the latter, so that it is able to escape the destructive bactericidal and other antibodies which are evoked by the host in response to the infection. By a process consisting essentially of the extraction of the lipoids, the "defatted" bacteria have been found not only to preserve their antigenic properties, but also the latter are actually enhanced when compared side by side with antigens which still preserve their

lipoids. The bulk of Dreyer's work refers to tubercle bacillus, and there can be no doubt that, so far as this microbe is concerned, he has proved his point experimentally. From his protocols he appears to have done what has not been done before, namely, the arrest, clinical and histological, of tubercle in guinea-pigs. It has always been felt that any method which could bring this about offered great hopes in the treatment of tuberculosis. It is necessary, however, at this stage to adopt an attitude of caution as regards the treatment of human pulmonary tuberculosis, for it will be a long time, probably years, before the full value of the method can be assessed.

IN the issue of *Science* for May 18 prominence is given to a communication entitled "Problems in the Field of Animal Nutrition," issued by the sub-committee on Animal Nutrition of the United States National Research Council. The paper is an endeavour to indicate problems and fields of research worthy of study in relation to animal nutrition. It is noteworthy that under this heading are included such diverse subjects as human dietetics, animal and forage husbandry, judging and food requirements of farm animals, and diet in relation to reproduction. There are undoubtedly great advantages in describing and defining the objects of scientific research, but it is, perhaps, permissible to stress the fact that, in the last resort, the organisation of research depends upon the supply, and, what in this connexion may be termed, the "nutrition," of qualified scientific workers! So far as Great Britain is concerned, it would appear that the majority of the problems indicated (with the exception, perhaps, of the scientific judging of farm animals) are the subject of study in one quarter or another. For example, at Cambridge great additions to the knowledge of nutrition continue to be made at the School of Bio-chemistry under Prof. Gowland Hopkins, and at the School of Agriculture, under Prof. T. B. Wood, workers on nutritional calorimetry and the physiology of reproduction continue to make progress. The most prominent consideration, however, before workers on the scientific aspects of nutrition in Great Britain is the need for the careful study of what may be termed the balance of essential food substances, as distinct from the absolute amounts of each of such, and it would appear that a great deal has still to be learned as to the interplay in nutrition between the relative quantity of proteins, carbohydrates, minerals, and even vitamins, which may be contained in diets, both in health and disease. On the applied side of the subject, the ultimate (and most difficult) problem is, undoubtedly, how effectively to introduce science into a subject so much at the mercy of fashion and prejudice as the feeding of animals.

A PAPER by G. McCready Price on "The Fossils as Age-markers in Geology" (*Princeton Theological Review*, vol. 20, p. 585, 1922) affords interesting evidence, even in its place of origin, of the campaign that is being carried on in the United States against the recognition of organic evolution. The author states that he is a geologist, who has convinced himself that no true sequence of faunas is traceable in the rocks, and that zoological provinces may have existed in which trilobites, nummulites, and ammonites lived simultaneously in various portions of the globe. The apparent absence of eroded surfaces between stratified series that are judged, by their fossil contents, to differ widely in their age is regarded as a proof that no gap in the sequence has occurred. On this matter the author should study L. F. Noble's paper on the succession in the Grand Cañon of Arizona, which was recently noticed in NATURE (April 7, p. 480). It is alleged that thrust-planes and reversals by folding have been called in as explanations by those who still cling to the views put forward by William Smith. It may be noted that the pioneers in the establishment of faunal sequences had no concern with doctrines of evolution; but Mr. Price states that those geologists who are "acquainted with scientific methods" have recently changed their views and accept a "new geology." When we find that the new geology accounts for an imaginary mingling of strata by the occurrence of a universal deluge, we realise that its scientific outlook is not younger than that of the Chaldees.

THE Albert Medal of the Royal Society of Arts, which was instituted in 1862 as a memorial of the Prince Consort, and is given annually for "distinguished merit in promoting Arts, Manufactures, or Commerce," has been awarded this year in duplicate by the council, with the approval of the president, H.R.H. the Duke of Connaught, to Sir David Bruce and Sir Ronald Ross, in recognition of the eminent services they have rendered to the economic development of the world by their achievements in biological research and the study of tropical diseases.

AT a meeting held recently at the Mansion House, a committee was formed with the object of providing a national memorial to the late Sir Ernest Shackleton. The aim is to establish some suitable memorial of a permanent nature, but the first object of the committee will be to provide for the education of Sir E. Shackleton's children and to take his place in supporting his mother. The balance that remains, after meeting these two obligations, will be devoted to the encouragement of exploration. The hon. treasurer of the memorial fund is Mr. Howard Button, 61/62 Lincoln's Inn Fields, London, W.C.2. Subscriptions may be sent to him or to any branch of the National Provincial and Union Bank of England.

IN order to commemorate the late Dr. W. S. Bruce, the polar explorer, a Bruce Memorial prize has been founded by subscription among his friends and admirers. The prize, which will take the form of a bronze medal and money award, is to be given from time to time for notable contributions to natural science in the nature of new knowledge resulting from personal visits to polar regions. The prize will be open to workers of all nationalities, with a preference for young men at the outset of their careers as investigators. Arrangements are being made to leave the selection of the recipients

of the prize to a representative committee in Edinburgh. Further subscriptions will still be welcomed by the hon. treasurer, Mr. A. N. G. Aitken, 37 Queen Street, Edinburgh.

THE resignation is announced of Sir George Beilby after nearly seven years' voluntary service as director of fuel research and chairman of the Fuel Research Board under the Department of Scientific and Industrial Research, which was established in 1917 to investigate the nature, preparation, and utilisation of fuel of all kinds. Dr. C. H. Lander has been appointed director of fuel research, and Sir Richard Threlfall, a present member of the Board, to be chairman. The Hon. Sir Charles Parsons will continue as a member of the Board for a further period. Sir George Beilby retains his membership of the Advisory Council of the Department, and has consented to act as honorary adviser to the Board. The following have been appointed additional members of the Board: Mr. R. A. Burrows, Sir John Cadman, Dr. Charles Carpenter, Mr. Samuel Tagg, Sir James Walker, and Prof. R. V. Wheeler.

IN his recent presidential address to the Institute of Physics, Sir J. J. Thomson gave some account of the work he saw during his recent visit to America in the research departments of some of the great manufacturing firms. These laboratories were established in the face of considerable opposition, but now the unanimous opinion appears to be that the research department is one of the most profitable in manufacturing concerns, and, however great the necessity for economy, its cost would be the last to be reduced. The scale of the laboratories is far greater than anything in Great Britain, and much of the work carried out is not merely what may be called development work, but is fundamental scientific work, worthy of a university laboratory. On the other hand, the American universities do not seem designed to produce a large number of men qualified to take up advanced research work. For example, few of the science students have the necessary equipment in mathematics, and the stern training which a good honours man in a great English university has to go through appears to be unknown. The system is doubtless good for the average man, but a successful research institute requires something more than the average man: it needs men with high scientific knowledge. In this regard, Great Britain has a distinct advantage which is sorely needed if it is to hold its own in competition.

THE annual conversazione of the Institution of Electrical Engineers will be held at the Natural History Museum, Cromwell Road, S.W., on Thursday, June 28, at 8.30 P.M.

IT is announced in the *Times* that Sir E. Wallis Budge, keeper of Egyptian and Assyrian antiquities at the British Museum, has been elected a foreign correspondent associate of the Lisbon Academy of Sciences.

A REPLICA of the portrait of Benjamin Harrison, painted a short time before his death by Mr. Cyril Chitty of Ightham, has been purchased by private subscription and presented to the Maidstone Museum. It has been placed in the room in which selected examples of Mr. Harrison's flint implements are exhibited.

THE annual general meeting of the Institution of Gas Engineers is to be held on June 26-28 in the City Hall, Belfast. At the first session of the meeting the Birmingham medal will be presented to Mr. W. Doig Gibb, and Mr. J. D. Smith, engineer and manager of the Corporation Gas Works, Belfast, will deliver his presidential address. A number of reports and papers will be presented to the meeting and discussed.

"NATIONAL Baby Week" will be observed on July 1-7, and we have received from the National Baby Week Council (117 Piccadilly, W.1) pamphlets explaining the object of baby week and how to organise a baby week celebration, and dealing with the activities of the Council. The Council desires to promote in the widest sense the safeguarding of infant life.

IT is stated in the *British Medical Journal* that Dr. Kleiweg de Zwaar, of Amsterdam, has instituted a triennial prize of the value of 2500 francs, which will be awarded for the first time in 1924 for the best work in physical or prehistoric anthropology during the preceding three years. Candidates should apply before November 1 to the Secretary, École d'Anthropologie, 15 rue de l'École de Médecine, Paris.

THE Society of Glass Technology has issued a provisional programme for its visit to France on June 30-July 6. The details of the meeting are being arranged by M. Delloye, of the Glaceries de St. Gobain, Chauny, and Cirey, and visits to a number of glass factories in and near Paris are promised. On July 2 there will be a joint meeting for the presentation and discussion of papers with the French Society of Civil Engineers, and it is hoped that Prof. H. le Chatelier will address the meeting.

THE centenary of the death of the famous horologist, Abraham Louis Bréguet, will be celebrated in Paris on October 22-27, by an exhibition of his works at the Musée Galliera, a special meeting at the Sorbonne, and a reception at the Hôtel de Ville. The Congrès National de Chronométrie will also meet in Paris in October, under the honorary presidency of M. Baillaud, director of the Paris Observatory, and of General Sebert. Besides discussing general questions relating to chronometry, the congress will aim at the formation of a Chronometric Union under the direction of the International Research Council.

THROUGH the great generosity of Mr. Charles Heape, of Rochdale, the Manchester Museum will shortly come into possession of a fine collection of native implements, ornaments, and weapons, which will add greatly to the value of the ethnological collection that it already possesses. The bulk of the specimens are drawn from the Pacific, but the collection also contains some objects from the Eskimo and from Egypt. The collection has been catalogued

by Messrs. Heape and Edge-Partington, and the catalogue was printed some time ago, and issued privately. It would be of great advantage to ethnology if, some day, this invaluable source of information should be reissued, if necessary by subscription. The collection contains a representative set of Polynesian weapons. There are also many examples of shell-work, especially of mother-of-pearl, which should be of great interest, and much that will be of considerable use to the student of ornament. When the exhibits are classified and exhibited they will form an excellent foundation for the study of the material culture of Oceania.

AT a recent meeting of the council of the Royal Agricultural Society, some account was given of the work in hand by the Society's Research Committee. Experiments are in progress in Leicestershire to test the value of basic slags and other fertilisers as measured by the increase in weight of cattle and sheep. Silage is to be made in clamps or pits at Cambridge and tower ensilage in East Suffolk, and the products are to be used next winter as feed for dairy cows; the effects of the silage on the yield and quality of the milk will be watched. Pig-feeding is also being investigated at Cambridge, where experiments will be made on the effects of grinding, soaking, and cooking on the nutritive value of maize, and on feeding with barley and potatoes, while similar trials will be made at the Harper-Adams Agricultural College on the value of home-grown products; in each case, the weight of flesh produced as well as its quality, will be investigated. The Research Committee of the Royal Agricultural Society is doing valuable work in thus supplementing the investigations carried out at research institutes and aiding in bridging the gap between the research worker and the practical farmer.

THE Société Française de Physique celebrates this year the fiftieth anniversary of its foundation, and to mark the event the Société is organising a National Physical and Wireless Exhibition which will be held in the Grand Palais, Paris, on November 30–December 17, concurrently with the Aeronautical Exhibition. The list of patrons, headed by the president of the Republic and the chiefs of the various ministries, includes leading personalities of the French scientific and industrial world. A guarantee fund of one million francs has been subscribed by eighty-two firms and individuals. The exhibition, which will embrace the principal scientific and industrial applications of physics, is to be divided into the following sections: Experimental physics; retrospective display of physical apparatus; radio-telegraphy and telephony; vacuum, X-ray and thermionic tubes; biological physics, physiology; telegraphy, telephony, signalling; various industrial and domestic applications of electricity; electro-chemistry; electric cables; glass, porcelain and other insulating materials; optics; photography, cinematography; illumination; rarefied and compressed gases; heating; metallurgy; acoustics; measuring and control apparatus; and instruction, books, reviews.

THE forthcoming meeting in London of the International Association of Navigation Congresses is an event of outstanding importance in shipping and port circles. The Congress will be held on July 2–July 6, and will be attended by numerous and influential delegates from all over the world, many of whom are contributing reports on matters of which they have expert knowledge. It is the thirteenth meeting of the Association; normally a congress is held every third year, but the regular sequence was broken by the War. The last meeting was at Philadelphia in 1912; consequently much interest and importance attaches to the revival of the gatherings after a lapse of more than ten years. The King has graciously accepted the position of patron; Lord Desborough is president, and there is a strong and influential British organisation committee. The subjects to be discussed include the following: (*a*) Inland navigation: the utilisation of waterways for the production of power and its consequences and applications; the influence of surface waters and subterranean sheets of water on the flow of rivers; and estimation of the water consumed for navigation and irrigation purposes, and the portion returned to the subterranean sheet of water. (*b*) Ocean navigation: the accommodation to be provided for ships in order to satisfy the future dimensions of vessels; mechanical equipment of ports; concrete and reinforced concrete: their applications to hydraulic works; means to assure their preservation and their water-tightness; the use of liquid fuel for navigation and its consequences; the utilisation of tides for the production of power for the working and lighting of ports; and the principal advances made recently in lighting, beaconing, and signalling of coasts, and standardisation (unification) of the languages of maritime signals.

THE Museums Association will meet at the Guildhall, Hull, on July 9-13. On Tuesday morning, July 10, there will be an official welcome by the Lord Mayor, and the president, Mr. T. Sheppard, will give an address on "The Place of the Small Museum." Later, at the Hull Luncheon Club, the delegates will be entertained, and the president will give an address on "The Evolution of a Yorkshireman." A number of papers will be read upon various aspects of museum work, and there will be numerous social functions and visits to places of interest. On Friday morning, July 13, there will be an address on "American Museums" by a delegate from the American Museum of Natural History, New York, and also cinematograph exhibitions. In the afternoon one section will visit York and will be entertained by the Yorkshire Philosophical Society in the grounds there; another party will sail for Copenhagen on the s.s. *Spero*, and from a preliminary programme received from Dr. C. M. C. Mackeprang, of the National Museum at Copenhagen, it appears that the members will be received on Monday morning, July 16, at the National Museum and inspect the National Collections; they will be then entertained to lunch in the Museum. In the afternoon they will visit Rosenborg Castle and later will attend a reception at the Town Hall. On

Tuesday, visits will be paid to Thorvaldsen's Museum and the Museum of Applied Art. In the afternoon the National Art Gallery and the Zoological Museum will be visited, and later there will be a trip in the Danish Expeditionary ship *Dana*, which is under the charge of Dr. Petersen. On Wednesday, July 18, there will be a visit to the Open-Air Museum at Lyngby, a visit to the Natural History Museum in Frederiksborg Castle, where the members will be entertained to lunch, and later a visit to the famous castle at Elsinore. On the following day the members will visit the Glyptotheke, returning to Hull by the s.s. *Spero* on the same evening.

MR. I. H. N. EVANS, of the Federated Malay States Museums, Taiping, has written, for appearance with the Cambridge University Press, "Studies in Religion, Folk-lore, and Custom in British North Borneo and the Malay Peninsula," giving the results of research carried out in the years 1910–21. The same house will publish in the summer "The Banyankole," by the Rev. J. Roscoe. It will form the second part of the report of the Mackie Ethnological Expedition to Central Africa.

IN the chairman's report of the National Illumination Committee for 1922, now issued in pamphlet form, it is stated that the provisional definitions of photometric terms and units have now been adopted, and form the basis of a series to be issued shortly by the British Engineering Standards Association. The latter body has been invited to form a sectional committee on illumination. Reference is also made to the committee which is investigating the subject of motor-headlights, and, as a preliminary to suggestions, is considering the recommendations already made in other countries. The pamphlet contains an official translation of the French text of the photometric definitions.

Our Astronomical Column.

ANNOUNCEMENT OF A NEW COMET.—Mr. W. N. Abbot, the British schoolboy in Athens who recently announced the brightening of Beta Ceti, now reports the discovery of a comet on June 12. The Right Ascension is given as $15^h\ 13^m\ 4^s$, and the Declination 53° 26′ N., in the constellation Draco. As the telegram is not quite in the regular form, there is some doubt whether the Declination may not be the complement of the above, that is, 36° 34′. No further information is at present to hand.

PROPOSED SOLAR OBSERVATORY IN AUSTRALIA.—This observatory has now been planned for several years; a message, dated April 17, from Melbourne to the *Times* indicates that the arrangements are making considerable progress. The site has been chosen at Mount Stromlo, near Canberra, the federal capital.

Prof. Duffield, of University College, Reading, was then in Australia and was being consulted, together with the Astronomer Royal and Prof. Turner, on the question of the selection of a director. It was proposed that the new director, when selected, should be given an opportunity of visiting, among other observatories, the solar observatory on Mount Wilson. As that observatory takes the leading place in researches on solar physics, it is obvious that the director of the new observatory should be intimately acquainted with its methods, and should arrange a programme of work that would supplement the results obtained there. As the two observatories are some 90° apart in longitude, the Australian station could continue the record of interesting outbursts after sunset in California.

PHOTOMETRIC OBSERVATIONS OF THE PLANET MERCURY.—It is of considerable importance to measure the brightness of this elusive little planet, since the result has a considerable bearing on the estimate we form of the condition of its surface. The conditions for doing so are much easier in the tropics, owing to the shorter twilight, the prevalence of clearer skies, and the greater altitude of the planet. Mr. J. Hopmann, who visited Christmas Island for the recent eclipse, utilised the occasion to compare Mercury with neighbouring stars (Arcturus, Spica, Procyon, Regulus, Deneb, Denebola, etc.) and the planets Saturn and Jupiter. On September 5 it was brighter than Saturn by a whole magnitude, on November 5 even brighter than Jupiter, which was, however, lower down. It was seen at Malta on November 15 when only 12° from the sun.

Mr. Hopmann has reduced his observations to distance of Mercury from the sun 0·3871, from the earth 1·0, and obtains the formula $-0{\cdot}711$ mag. $+0{\cdot}03582$ mag. $(\alpha - 50°)$, α being the phase angle sun-Mercury-earth. The first term was given as $-0{\cdot}998$ mag. by Müller and Jost, their second term being practically the same as his. In other words, he makes the planet a quarter of a magnitude fainter, thus indicating a still lower albedo, and a condition of surface probably approximating to that of the moon (*Astr. Nachr.* 5220).

PHOTOGRAPHIC STUDIES OF NEBULÆ.—Mr. J. C. Duncan contributes his third paper on the studies of the form and structure of nebulæ from photographs made with the 100-inch and 60-inch reflectors and the 10-inch Cooke refractor in the years 1920 to 1922 to the *Astrophysical Journal* (vol. 57, No. 3). The previous papers appeared in volumes 51, p. 4, and 53, p. 392, of the same journal. The present communication is accompanied by eleven excellently reproduced plates. Evidence of the existence of dark nebulosity is found in N.G.C. 1977, M 78, the Trifid nebula, the dark objects Barnard 72, 92, 93, and 133, and the American nebula. Of great interest is N.G.C. 4038-4039, a bright spiral of unique form with faint extensions of extraordinary appearance. In a field the size of the full moon in Coma Berenices, the 100-inch telescope photographs no less than 319 small nebulæ. The object N.G.C. 6822 is found to be a mixture of stars and small nebulæ resembling the magellanic clouds.

In examining these reproductions taken with the great 100-inch mirror, one cannot but recall and admire the fine photographs which Dr. Isaac Roberts took with his small mirror of only 20-inches aperture. To take a case in point, it is interesting to compare the reproduction of the nebula N.G.C. 1977 in Orion taken with the 100-inch mirror with Roberts's reproduction in plate 17 in his volume of "Photographs of stars, star-clusters and nebulæ," taken in 1889 and published in 1893. The exposure for Roberts's photograph was 3 hours 25 minutes, while that with the 100-inch was 5 hours 40 minutes. There is very little difference between these photographs except the sharpness of the details and the greater contrast in light and shade, which in the 100-inch reproduction has been secured purposely by repeated copying.

Research Items.

ETHNOLOGY OF MALTA AND GOZO.—In the Journal of the Royal Anthropological Institute (vol. lii., 1922) Mr. L. H. Dudley Buxton publishes an exhaustive essay on the ethnology of Malta and Gozo. The skulls discovered in the course of excavation and examination of the existing population lead to some interesting conclusions. The First Race, the Megalith builders, are certainly akin to the early and present inhabitants of North Africa, Sicily, Corsica, Sardinia, and Spain, all belonging to the Mediterranean races. Their successors, the Second Race, exhibit Armenoid characteristics, and were probably immigrants from the eastern Mediterranean. Their arrival probably occurred towards the end of the Bronze or in the Early Iron Age. Armenoids with an admixture of Mediterranean blood, they probably came to Malta from Carthage. They may have destroyed the previous inhabitants, or they may have pursued methods of peaceful penetration. At any rate, they established themselves firmly in Malta, and all later introduction of foreign blood has failed to raise the variation. In later times there have been local variations, but the differences between Malta and Gozo are not greater than the differences between the general population of Malta and at least one, and possibly more, of the more isolated villages.

TREATMENT OF LEPROSY.—In a recent lecture delivered to the Royal Society of Arts and published in the Journal of the Society for May 18, p. 452, Sir Leonard Rogers dealt with the problem of leprosy. He estimates that at least three million lepers exist. The disease is communicable, though its infectivity is very slight, and isolation of the infective cases is the only practical preventive measure. Hitherto no effective treatment has been known; but during the last few years, and largely through the researches of Sir Leonard Rogers, certain derivatives of chaulmoogra oil, an old Indian remedy for tuberculosis and leprosy, have been found to exert a beneficial action, and many of the treated cases have lost all signs of the disease and appear to be cured.

GIARDIAS LIVING IN MAN AND OTHER ANIMALS.—*Giardia Lamblia* is a well-known protozoan parasite of the human intestine, and other similar parasites are met with in the intestinal tract of the rabbit, dog, and tadpole. It has been supposed, therefore, that man may become infected from these lower animals. In order to throw some light on this question, the various species have been critically examined by R. W. Hegner (*American Journ. of Hygiene*, vol. ii., No. 4, pp. 435 and 442). *G. duodenalis* from the rabbit and *G. canis* from the dog are considered to exhibit such differences in size, form, and structural details as to constitute species distinct from each other and from *G. Lamblia*. *G. agilis* from the tadpole is more like *G. Lamblia* than the two others, but is sufficiently different to constitute a distinct species. *G. alata*, another giardia from the tadpole described by Kunstler and Gineste, is considered to be identical with *G. agilis*.

CANCER IN PLANTS.—The exhaustive researches of Erwin F. Smith, of Washington, in the pathology of crown gall in plants have led him repeatedly to emphasise the resemblances between the abnormal growths which may be produced in plants by the experimental inoculation of *Bacterium tumefaciens* and malignant tumours in animals. According to his view, which is shared by Jensen, the bacteria provide the stimulus at the beginning of the disease, which is then continued by the stimulated but uninfected cells behaving as parasitic cells similar to cancer cells. A careful re-investigation of the facts by W. Robinson and H. Walkden in Manchester (*Annals of Botany*, vol. cxlvi., 1923, p. 299) does not, however, bear out this interpretation. They find that the careful examination of serial sections usually reveals the relatively close proximity of the causal bacteria to the proliferating tissues, and that there is no evidence that the cells continue to grow in an abnormal way when they are removed from the immediate influence of the bacterium. The analogy with animal cancer, in their view, wholly breaks down.

FRUIT-GROWING IN NORTH CAROLINA.—Supplement No. 19 to the U.S. *Monthly Weather Review* contains a discussion by Mr. Henry J. Cox, meteorologist, on "Thermal Belts and Fruit-growing in North Carolina," and an Appendix by Mr. W. N. Hutt, former State Horticulturist, on "Thermal Belts from the Horticultural View-point." The whole subject is treated with minute detail, specially screened temperature observations having been taken at several fruit orchards and at different positions on the slopes of the same orchard. The subject is well illustrated by plates and diagrams, and the results obtained are scientifically manipulated. Minimum temperature and its duration are the chief factors involved in the growing of fruit. Valley floors must in nearly all cases be avoided unless means are available for orchard heating, since on critical nights of temperature inversion the thermometer at the bottom of valleys often falls 15° or 20° F., and sometimes even 25° or 30° F., lower than higher up on the slope. Dense vegetation is responsible for great loss of heat through radiation, and a cultivated orchard is therefore warmer than one planted in grass. The topography of a region is paramount. The Appendix shows the differences of temperature at 16 stations, and a summary of the horticultural data, such as first bloom, full bloom, and bloom all shed, of apples and peaches, with the cause and date of injury where experienced, and the yield. Much of the damage sustained is due to cold-air traps or frost pockets. In some years a heavy yield of grapes is secured, while apples are a failure, this being due to the later blooming period of grapes. The apple tree is normally an alternate bearer, and the heavy drain on the energies of the trees one year is usually followed by a weaker bud development and lighter crop the following season.

MIOCENE CICHLID FISH FROM HAITI.—Prof. T. D. A. Cockerell describes and figures under the name of *Cichlasoma woodringi*, n. sp., an interesting fossil fish from the Miocene of Haiti (Proc. U.S. Nat. Mus., vol. lxiii. art. 7). Cichlid fish abound in South and Central America and in tropical Africa, while fossil representatives have been found in Algeria (Palæochromis) and in the Eocene of Wyoming (Priscacara). Six species or races of Cichlasoma are living to-day in Cuba, and the question arises whether these last are an invasion from the south or the remains of a once widely distributed Antillean fauna. Prof. Cockerell is inclined to hold the latter view.

THE FORMATION OF VITAMIN-A.—It has been known for some time that the only source of vitamin-A is the plant, and that the green parts are richer in it than the colourless parts are. Dr. Katharine H. Coward has carried the investigation further, and her results are given in two papers in the *Biochemical*

Journal (vol. 17, No. 1, 1923). She shows, first, that light is necessary for the formation of vitamin-A, although neither chlorophyll, carbon dioxide nor oxygen need be present. It can also be formed in the almost complete absence of calcium. A further clue was given by the apparent close association of the lipochrome pigments (carotene, etc.) with vitamin-A in various articles of diet. It had indeed been suggested that the two substances might be identical. But this was disproved by Drummond. The orange-yellow pigment, carotene, is well known as giving the colour to carrots. Dr. Coward found, however, that flowers, or parts of flowers, exposed to light, if they contained carotene, also contained vitamin-A, and that absence of the pigment meant absence of the vitamin. But both may be present in tissues not exposed to light, as in the root of the carrot. Evidence is given that the vitamin has been transported to the root from the leaves. Although the investigator ventures no hypothesis on the matter, it seems highly probable, from the necessity of both light and carotene for the production of vitamin-A, that the pigment acts as an optical sensitiser, similar to chlorophyll for the formation of formaldehyde. It would be of interest to know whether the rays absorbed by carotene are the most effective.

STRUCTURE OF CARBON MONOXIDE AND NITROGEN.—In an interesting paper in the Proceedings of the Physico-Mathematical Society of Japan for April, H. Nagaoka discusses the band spectra of nitrogen and carbon monoxide. He starts with the assumption put forward by Langmuir, that the external electron configurations of the two gases are very similar. The band spectra, which are presumably due to the external electrons of the molecule, should therefore be in close agreement. This is shown to be the case, with small differences indicating slight peculiarities of structure. The author then remarks that the ratio of the specific heats of the two gases cannot be accounted for on the assumption of Langmuir that the two nuclei are in the same cube (a difficulty pointed out by Partington in 1921), and he therefore proposes another model for the gases, in which two cubes are joined at an edge. This would give the correct value of 1·40. The two connecting electrons in the edge are pulled together by the nuclei, so that the resulting external electronic arrangement is that of two tapering six-faced figures connected by a narrow neck. The author points out that the values of the ratio of the specific heats can serve as a useful criterion in differentiating between possible and impossible electron configurations.

PHOTO-ELECTRIC CONDUCTIVITY OF CRYSTALS.—A number of contributions to our knowledge of this subject have been made during the past three years by Drs. B. Gudden and B. Pohl, of the University of Göttingen, in communications to the *Zeitschrift für Physik* and the *Physikalische Zeitschrift*, and a short summary of these is given in the issue of *Die Naturwissenschaften* for May 11. They find that all crystals with high refractive indices possess this conductivity, and that if, when withdrawn from the influence of light, they are insulators, when exposed to it they show an initial conductivity which is relatively large and proportional to the energy of the incident light. When the wave-length of the light is altered, the quotient of the quantity of electricity transmitted divided by the energy of the light incident shows the usual maximum at the wave-length of greatest absorption, but when it is calculated for the energy of the light absorbed, it continues to increase towards the longer waves and eventually becomes a linear function of the wave-length. Over this region the authors consider that the observations justify the conclusion that one quantum of light energy absorbed gives rise to one electron in the crystal.

AMMONIUM SULPHIDES.—Although a solution of ammonium sulphide has been in use in the laboratory for many years, the anhydrous substances are not well known. The solid compounds NH_4HS and $(NH_4)_2S$ were said to have been obtained by Bineau in 1838-39 by the interaction of gaseous ammonia and hydrogen sulphide in the required proportions by volume, but doubt was thrown on the formation of the second compound by experiments of Bloxam in 1895. The matter has been reinvestigated by Thomas and Riding, whose experiments are described in the May issue of the Journal of the Chemical Society. Anhydrous NH_4HS is best prepared by alternately passing ammonia and hydrogen sulphide into dry ether. Attempts to prepare $(NH_4)_2S$ were not very successful. The prolonged action of ammonia on the hydrosulphide in ether produced no sulphide, but on the addition of alcohol a yellow oil separated, which on standing gave some transparent cubic crystals, believed to be $(NH_4)_2S$. The research throws very little light on the formation of the latter substance, but the method of preparation of NH_4HS is a convenient one.

ABSORPTION SPECTRA AND ATOMIC STRUCTURE.—In the *Comptes rendus* of the Paris Academy of Sciences for April 23, M. Victor Henri derives from the study of the absorption spectra of a large number of substances, both in solution and in the state of vapour, some important conclusions bearing on Bohr's theory of atomic structure. He shows that the absorption spectrum of a solution may be either one composed of narrow bands (10-30 Å) disposed in regular series, or one of broad bands (200-500 Å); in a few cases both types of bands are present, but the narrow ones then occur only in the less refrangible regions. When the vapour of the substance is examined, the narrow bands of the solution are replaced by fine lines, while the broad bands of the solution appear also in the vapour as unresolved bands. He explains the narrow bands by the theory of quanta, the molecule being supposed to possess a series of stationary states, of which the energy is determined by the movements of the electrons, atoms, and the molecule. He distinguishes four cases. When the molecule contains only a single double bond, such as C=C, C=O, C=N, N=O, the other atomic groups in the molecule being all saturated, only broad bands are afforded either by the solution or the vapour. When the molecule is as simple as possible, but contains two or more groups with double bonds, narrow bands are given by the solution and fine lines by the vapour, distributed in series conformably to the theory of quanta. When the two double bonds are removed by the introduction of CH_2, the narrow bands run together and form wide bands both in the solution and the vapour. When the molecule is rendered more complex by the substitution of more and more complicated groups of atoms, the narrow bands of the solution enlarge and the fine lines of the vapour fuse together, so that eventually a complicated molecule shows only broad continuous bands. He therefore finally concludes that for molecules containing only one double bond, the first postulate of Bohr is inapplicable, only the second postulate being valid; whereas for molecules with two adjacent double bonds both postulates apply, the first being determined by the existence of an electric polarity in the molecule.

South-Eastern Union of Scientific Societies.

THE twenty-eighth annual congress of the South-Eastern Union of Scientific Societies was held at Maidstone on May 30-June 2 inclusive. Dr. Alex Hill occupied the presidential chair, in succession to Sir Charles F. Close. The headquarters of the Congress were at the Museum, where members were given every convenience by the curator, Mr. J. H. Allchin, and the assistant curator, Mr. H. J. Elgar.

The Mayor opened the meetings by welcoming members and delegates at the Town Hall, where the ancient maces and charters were exhibited and described by Mr. W. H. Day, one of the secretaries, and Mr. W. Dale. Visits followed to various ancient buildings in the town, of which the town possesses a large number. All Saints' Church was visited by more than a hundred members, and was described by Mr. Dale. The church was built in 1395 by Archbishop Courtenay and, although renovated in the last century, remains in practically its original condition, showing in its fine, delicate and lofty columns and its windows the best of the perpendicular characteristics. A very fine set of the original oaken sedilia, with elaborately carved canopies, were seen, and about a score of ancient miserere seats in the choir, which when tipped up have a small seat beneath, giving a sort of rest for tired singers and others. Hard by is the Archbishop's Palace, a stately Elizabethan building, now used as a welfare centre, with wainscoted rooms and old carving. The interesting building known as the tithe barn, with external stone staircase, was also seen. Near at hand and completing the group of ecclesiastical buildings is the massive gateway to the old monks' college, while all were close to the slope leading down to the Medway, much used in early days for travel and transit. The refectory of the Guild of Corpus Christi, in Earl Street, dating from the fourteenth century, was next visited. As a fine piece of mediæval architecture, it deserves a better fate than to be used by a brewery for the making of barrels. It is in dilapidated condition, but the fine roof and the beautiful windows give an idea of its former magnificence. It has a dole window. For nearly three centuries it was occupied by the Grammar School until 1871. Another party of members visited at the same time the bacteriological and chemical laboratories of the Kent County Council, under the guidance of Dr. C. Ponder and Mr. F. W. F. Arnaud.

Dr. Alex Hill's presidential address was on "Antipodean Flora," and in this he gave some interesting facts of the mimicry practised by certain plants observed by him during his journey round the world. Reference was made to the possibility of the isolation of the Australian flora having been accomplished by the dividing-up and the shifting of the land-masses of the Indo-Australian continent in accordance with what has come to be known as Wegener's theory. The means by which eucalyptus and other trees adapt themselves to a rainfall of 8 or 9 inches were described. Exploring the caves at Yallingup, the root of a jarrah tree was met with which had gone down 120 feet in search of water.

The morning session of the second day of the meeting was devoted to botanical papers, and Sir David Prain spoke on "The Story of some Common Garden Plants," the potato, the artichoke, and others being dealt with. A paper by Mr. Robert Paulson on the "Fungus Root" followed. In the afternoon three excursions were arranged. Geologists went to the Aylesford gravel pits and to a Kentish Rag quarry. Botanists followed Dr. A. B. Rendle on an enjoyable ramble, while a large party visited Allington Castle, by permission of Sir Martin Conway. A castle is thought to have occupied the site in Saxon times, and to have been demolished by the Danes prior to their traditional defeat at Aylesford. Owned by Harold Godwin's brother, Ulnoth, it passed into Norman hands and was rebuilt. As it appears to-day, it is for the most part the work of Sir Stephen de Pencester, who fortified it in the reign of Edward I., in about 1281. Tudor additions were made. The famous Sir Thomas Wyatt was once the owner, and as leader of the rebellion to oppose the Spanish marriage of Queen Mary, he suffered the usual fate on its failure. Tennyson lays the first scene of the second act of "Queen Mary" in the court of Allington Castle. In the evening the Mayor and Mayoress (Councillor and Miss Wallis) received the Union in the Museum.

The third day was devoted to papers in connexion with the Regional Survey Section. Mr. Victor F. Branford gave an address on "The Natural and the Social Sciences," a paper which will later be printed in full. A lecture by Mr. F. W. F. Arnaud on "Vitamins" reviewed the history of the discovery of these elusive bodies and showed the present position of our knowledge of the subject. Botanical and archæological excursions followed. The famous Coldrum burial-place was visited, and a description given by Mr. W. H. Cook. Halling burial-place followed, where the site was shown from which the only Aurignacian skeleton found in this country was exhumed, and where true implements of that culture were found. In the evening a lecture by Mr. Reginald A. Smith, of the British Museum, was delivered on "Prehistoric Man in Kent." The most ancient remains, those found by Benjamin Harrison, of Ightham, are well represented in the Maidstone Museum.

On the morning of the last day of the meeting, a masterly address was given by Prof. E. B. Poulton on "Recent Advances and Discoveries in the Study of Entomology." The afternoon was devoted to visiting various megalithic remains in the district. The "Countless" Stones proved of great interest. They consist of about twenty large and small stones, and appear to be the thrown-down remains of more than one dolmen, or, as was suggested, of a double row of standing stones. Some of them are sarsens, but the majority are apparently Greensand or Wealden sandstones. An old record was found, showing that they were thrown down by a farmer by the aid of gunpowder towards the end of the eighteenth century. Kits Coty House was next seen, and a description given by Mr. W. Dale. The "house" is fenced round and is now safely looked after by the Office of Works. The stones are probably sarsens and have been shaped to the necessary requirements of the builders. Discussion ensued as to the origin of the name the dolmen bears. The guide-book derivation from Catigern was not thought quite satisfactory. It is said that a shepherd named Kit made it his dwelling, and it may once have been Kit's Cottage. The so-called White Horse Stone was then visited, another sarsen about which some fantastic romance has been weaved. A noticeable point about these megaliths is that they bear many cup-shaped hollows, but geologists agree that these may be due entirely to weathering. *Helix lapicida* was found on the White Horse Stone.

The Congress was very successfully carried through, and the local secretaries, Messrs. W. H. Day and J. W. Bridge, were congratulated upon the arrangements they had made.

The Constitution of the Alloys of Iron and Nickel.

THE joint paper by Dr. Hanson, of the National Physical Laboratory, and Mr. J. R. Freeman, jun., of the United States Bureau of Standards, on the above subject, presented at the May meeting of the Iron and Steel Institute, is one of great value. Of the elements used for alloying with iron for scientific and industrial purposes, none is more important than nickel. Moreover, the fact that it is an invariable constituent of meteoric iron, which may be regarded as a natural nickel-iron alloy, has invested the question of the equilibrium of these two elements with a high degree of interest. Its determination, however, has presented serious problems, due, on one hand, to the high melting ranges of the alloys and consequent pyrometric difficulties, and, on the other hand, to the difficulty of preparing the alloys free from carbon. Three years ago Dr. and Mrs. Hanson carried out a revision of the constitution of these alloys at temperatures below 900° C. The present publication completes this work right up to the liquidus of the system.

The alloys were prepared by melting the purest materials available in a "carbon ring" furnace; 50-gram melts were made in crucibles of fused alumina enclosed in a refractory muffle made of a mixture of China clay with 10 per cent. of alumina. Purified nitrogen was passed into the muffle to prevent oxidation of the melt. In taking cooling curves the melts were inoculated by means of a sawdust of iron or nickel for the pure metals or a mixture of the two for the alloys, which prevented supercooling. Platinum rhodium thermo-couples suitably protected were used for determining the temperatures, but they rapidly deteriorated with use, and in the case of the alloys rich in iron, possessing the highest melting points of the series, it was necessary to discard from one to two inches of the wire at the bulb end after each determination and remake the junction. The authors succeeded in keeping errors in temperature measurement, due to couple contamination, within 2°.

The results are shown in diagrammatic form in Fig. 1.

It will be seen that, starting from pure iron, the liquidus curve drops from 1530° to 1502° at a concentration of about 5·8 per cent. of nickel. Over this range δ iron separates. The solidus is the line AEB. Within this triangle liquid and crystals co-exist. The area AEG represents the limits of existence of δ iron. Below G δ iron inverts to γ. It is somewhat remarkable that this transformation is rapidly raised by the addition of nickel, as shown by the line GE, and 3 per cent. of this element is sufficient to raise the transformation point by 100°. The line EFB represents the equilibrium between δ iron, γ iron and liquid, and its meaning may be expressed in the following way:—Solid E (δ iron) + liquid (β) react to form solid F (γ iron). The exact position of the point F has not yet been determined. The experiments thus indicate that the maximum solubility of nickel in δ iron is 3 per cent, and that this occurs at a temperature of about 1500°.

To the right of B there is an entirely different state of affairs. The liquidus curve drops continuously and much more slowly than hitherto from B to a minimum at C (1436° C.), the trough being very shallow, and then rises continuously to D, the melting point of pure nickel (1452° C.). Over the whole of this range there is complete miscibility between the metals in the solid state. Nickel, therefore, is much more soluble in γ than in δ iron, and the alloys consist when just solid of a continuous series of solid solutions. The solidus between B and D has, however, not been determined by experiments and is shown dotted. The authors state, however, that it is very close to the liquidus line, and throughout the range from B to D, all the alloys have very sharp freezing points similar to those of pure substances. Clearly, therefore, the temperature range between the liquidus and solidus is very small.

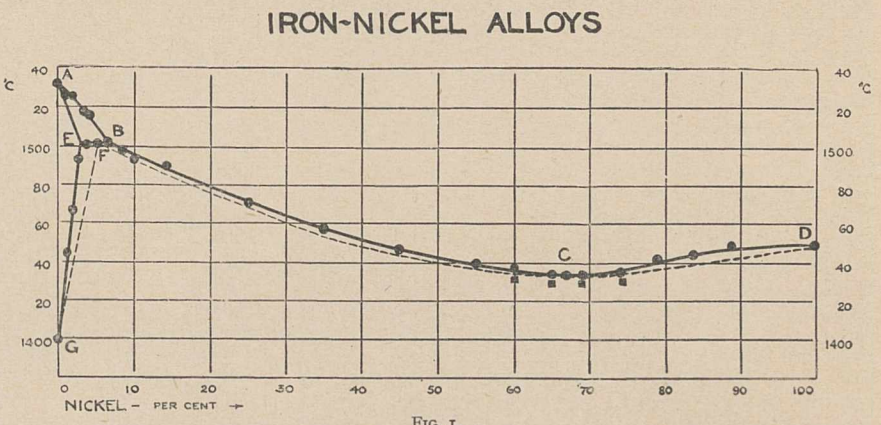

FIG. 1.

It is always difficult to determine the exact position of the minimum point of two curves of shallow inclination, and between 65 and 70 per cent the freezing point curve was found to be approximately constant, so that the exact location of C cannot be stated nearer than between these limits. Within the same range a second and smaller arrest point was observed between 2° and 5° below the liquidus. These are shown in the diagram. The authors have carefully tested whether these indicate the existence of a eutectic, but with negative results, and their conclusion is that C is the composition corresponding to a minimum in the freezing point of a continuous series of solid solutions.

In the latter half of the paper an account is given of attempts made to differentiate by means of the microscope between δ and γ iron, and to establish the fact that the change from one to the other is accompanied by a recrystallisation of the material. Transformations in iron and iron-nickel alloys take place so rapidly on cooling, that it is impossible to preserve by quenching the δ and γ modifications. Accordingly attempts were made to stereotype the structures existing at high temperatures by a vacuum etching of polished surfaces previously prepared. No clear indications, however, were obtained, and the surface markings on the specimens after this treatment were very complex. Experiments were carried out on polished specimens placed in narrow silica tubes filled with nitrogen at 20 mm. pressure, which were inserted in a furnace at 1300° C. Two tubes were used. After two hours at the above temperature, one of them was removed and cooled quickly, the other was raised rapidly

to 1450° C. (within the δ range) and similarly cooled. On examination, a striking difference in structure between the two was found, constituting evidence that there is a distinct change in crystal structure at the δ to γ transformation. This may be regarded as a confirmation of Westgren's conclusion,[1] based on X-ray analysis, that δ and γ iron are constitutionally different. He found that the former has a body-centred and the latter a face-centred cubic lattice. H. C. H. C.

[1] Journal of the Iron and Steel Institute, 1922, No. 1, p. 241, and NATURE, June 24, 1922, p. 817.

The Indian Eclipse Expedition, 1922.[1]

THE story of an expedition to observe the total eclipse of the sun, seen under the most perfect atmospheric conditions, but which failed to achieve any results, is described by Mr. Evershed in the report before us. Mr. Evershed's programme was of a high-class order, and those who know him and his great ingenuity in the construction and manipulation of astronomical apparatus will share his regret at his extreme misfortune on this occasion.

Originally Mr. Evershed proposed to occupy the Maldive Islands as his observing station, but, owing to difficulties of transportation, he and his party went to Wallal, near Broome, situated on the north-west coast of Australia, and joined Dr. Campbell's expedition. For the Einstein effect he took out with him a 12-inch photo-visual lens particularly well adapted for this problem, giving, as he states, "a large field of good definition and a larger scale than the lenses used previously, or that would be likely to be used by other expeditions." It was worked in conjunction with a 16-inch cœlostat, and it was the erratic behaviour of this instrument that spoilt the results. In spite of constructing a new tangent screw and refiguring the teeth of the driving sector to secure better driving qualities, the fifteen seconds exposure plates showed movement of the star images and poor definition of the corona due to the bad driving of the cœlostat. Two short exposure plates were badly fogged "in some unexplained way" over two-thirds of the surface, but otherwise the remaining portion showed the ends of the coronal streamers beautifully defined.

The second main effort of the expedition was to photograph with large dispersion the spectrum of the corona on the east and west limbs simultaneously, in order to determine the displacement of the green corona line due to the solar rotation, and to secure a more accurate wave-length of this line. Here again disappointment was experienced, for the corona line did not appear at all on any of the plates owing, probably, to the unusual faintness of this radiation at this eclipse. Perhaps Mr. Evershed rather courted disaster on this occasion, as it is generally conceded that during the time at and near a minimum of solar activity this radiation is also near a minimum of brightness.

[1] Report of the Indian Eclipse Expedition to Wallal, Western Australia, by J. Evershed, F.R.S. (Kodaikanal Observatory, Bulletin No. 72.)

It will be remembered that the Greenwich expedition to Christmas Island purposely eliminated the use of a cœlostat in its work by taking out a complete equatorial photographic telescope. This was done because experience at the eclipse of May 29, 1919, seemed to suggest that the definition of the star images on the astrographic plates was poor, owing probably to the distortion of the cœlostat mirror by the heat of the sun. Mr. Evershed's view regarding the employment of a cœlostat is that it is "good for the Einstein effect. For only with a cœlostat is it practically possible to get an adequate scale." That he is emphatic on the point is shown by his statement that "the question of the cœlostat mirror introducing complications is, I think, a bogy. Plane mirrors can now be constructed of large size and perfect figure, and experience with mirrors, good and bad, has shown that little is to be feared from distortion of the surface when the silvering is fresh and good, and simple precautions are taken."

In the opinion of the present writer, the great drawback to the use of a mirror during eclipses, whether mounted as a cœlostat or siderostat, is due to the change of figure of the plane surface of the mirror, which causes an alteration in the position of the focus of the object glass. On many occasions during eclipse expeditions, although extreme care had been taken to secure a "perfect" focus on star spectra at night (the mirror then being comparatively cool), the focus was quite different for the solar spectrum during the daytime. Thus during eclipse work it was always found most necessary to watch very carefully the disappearing crescent of the sun on the ground glass almost right up to the time of totality, and if necessary alter the position of focus accordingly.[2]

It is satisfactory to note that Mr. Evershed did not return to India with an empty bag. During a short stay at Broome on the return journey he set up the 16-inch siderostat and 12-inch lens and succeeded in obtaining a good high dispersion spectrum of Canopus and Achernar to use in connexion with his work on the spectrum of Sirius.

During this expedition Mr. Evershed was ably assisted by Mrs. Evershed and by Mr. Everson of the physics department of the University of Western Australia. WILLIAM J. S. LOCKYER.

[2] See Phil. Trans. Roy. Soc. A, vol. 198, p. 406.

Liberal Education in Secondary Schools.

ON Saturday, June 9, a conference of educationists in Yorkshire was held in the University of Leeds under the presidency of the vice-chancellor, Sir Michael Sadler, in response to a widespread desire to discuss certain questions affecting the supply of full-time education for boys and girls beyond the age of eleven years, and the choice of subjects in the School Examinations. In order to make the conference widely representative of educational opinion in Yorkshire, invitations were issued to the local education authorities, the universities, the training colleges, secondary schools, associations of secondary and elementary teachers, and other persons of educational experience. Upwards of 270 representatives attended the conference and were welcomed by the pro-chancellor, Mr. E. G. Arnold.

In an introductory speech, the chairman referred to the growing desire for wider opportunities of a liberal education in various parts of the world. This desire cannot be wholly explained as due to self-regarding motives. Ambition for advancement is no doubt a strong motive, but is not in itself

blameworthy, especially when cherished by parents for their children. Sir Michael Sadler believes the movement has its counterpart in the movement towards greater freedom in self-government, and its deepest sources lie in a desire for liberty and the more generous development of human personality. Enlightenment and self-discipline are the two inseparable sides of a true liberal education. The force behind the desire for such an education is so powerful that it is the part of wisdom not to disregard it. He thinks that a liberal education begins away back in elementary education and extends beyond the limits of university education; that some of its indispensable factors cannot be tested by examination; and that it may be secured through diverse curricula, provided that in every curriculum a humanising spirit prevails.

Certain resolutions were thereafter submitted to the conference. After a lengthy and interesting discussion, in which a large number of delegates took part, the following motion was adopted: "That representations be made to the Board of Education urging the pressing need of further provision (by legislative change, if necessary) for the full-time education of boys and girls up to the age of sixteen, to include instruction of varying types." To this was added an addendum in favour of the pressing need of joint action between elementary and secondary branches of the Board of Education with the view of such provision and the closer combination of elementary and higher education. It is perfectly evident that there exists a large body of opinion in Yorkshire strongly in favour of greater facilities for education beyond the age of eleven and up to the age of sixteen. It is not so clear that opinion has definitely crystallised out as to the form this education should take. County Alderman Jackson, chairman of the West Riding Education Committee, expressed the opinion that the atmosphere of the mine and factory is not suitable for children between fourteen and sixteen; at that age they should be in cultured surroundings, and without doubt he expressed the views of an overwhelming majority of those present.

On the question of greater variety in curricula a discussion arose as to the desirability or otherwise of creating a new type of school in which instruction might be given of a kind different from that now normally offered in the secondary school. It was argued with some cogency that such a school might come to be looked upon as a school inferior in grade, providing an education of an inferior type, notwithstanding the suitability of the courses of instruction provided by it for the particular purpose. There is the danger, too, of segregating one class of children. Undoubtedly the great bulk of the pupils who would attend such schools would be drawn from the elementary schools. It is quite evident that many members of the conference would view with disfavour any further differentiation of schools while accepting the principle of greater differentiation of curricula. Obviously to them the logical position is to demand a common name for all full-time education, whatever its type, between the ages of eleven and sixteen.

Sir Henry Hadow, vice-chancellor of the University of Sheffield, in an interesting speech introduced a motion which, while welcoming the greater freedom in the choice of subjects for the First School Examinations now allowed by the Joint Matriculation Board of the Northern Universities, expressed the opinion that there should be greater freedom in regard to the groupings of courses for the Higher Certificate. The motion was agreed to unanimously.

Rothamsted Experimental Station.

ANNUAL VISITATION.

AT the invitation of Lord Bledisloe, chairman of the Lawes Agricultural Trust Committee, a number of guests representing various agricultural interests visited the Rothamsted Experimental Station on Wednesday, June 13, for the annual inspection of the fields and laboratories.

The morning was occupied in a tour of some of the experimental plots, including two of the classical fields—Broadbalk, on which wheat is grown continuously, and Hoos, where barley is similarly grown. These have been for many years of the utmost value and interest to agriculturists in general, and the opportunity was taken to show the visitors some of the other plots laid down to test points that had, directly and indirectly, arisen from the results of these classical experiments. Among these may be mentioned the top-dressing series, designed to ascertain how the yield of the crop is influenced by spring dressings of artificial fertilisers applied in varying amounts and at various times; the malting barley series, in which the relation between malting value and manurial treatment is being examined; and the residual value of different manures on the succeeding crops. On this latter field the crop this year is clover, and the beneficial effect of previous organic manures, in particular cake-fed dung, is most striking.

After luncheon Lord Bledisloe briefly reviewed the purpose and recent progress of the Station. He laid stress on the care that is taken to avoid the erection of water-tight partitions between the scientific worker and the practical farmer, without in any way limiting the work of fundamental investigation, on which the application of science to agriculture is of necessity founded. Lord Bledisloe also referred to a number of the external activities of the Station, as indicative of the efforts made to keep in touch with the whole life of the countryside.

Sir E. J. Russell, director of the Station, then gave his statement on the work of the Station during the past year. The reorganisation of the laboratories has been completed, and the experimental work on the farm will shortly follow suit. Very considerable progress has been made in extending the outside centres: the experimental fields on the Woburn Farm are now in charge of Rothamsted, and Dr. Voelcker, who for many years has been in charge at Woburn, has consented to continue the work. Through the generosity of Mr. E. D. Simon, the use of an extensive farm—Leadon Court, Herefordshire—has been given to the Station, and under the management of Mr. J. C. Brown an extensive trial of the soiling system is being carried out. In addition, the Station has many centres on farms throughout the country, at each of which a repetition of a carefully designed experimental programme is being carried out. By this means it is possible in a comparatively short time to obtain trustworthy information on the degree to which the results of field trials at Rothamsted are modified at centres possessing different soil and climatic conditions. The work is being carried out at present on malting barley and potatoes with especial reference to the action of artificial fertilisers, and wherever possible the aid and support of the industrial organisations concerned have been enlisted.

Passing on to the work in progress in the laboratories, Sir John discussed it under its three main headings,—the cultivation of the soil, the feeding of the crops, and the maintenance of healthy conditions of plant work. In connexion with the work on soil cultivation and the physical properties of the soil, he stated that the Empire Cotton-growing Corporation has given a substantial sum for the development of this work, as it is convinced that questions of soil physics are of great importance in those parts of the Empire where cotton is grown. Among other recent developments are apicultural investigations and work on the control of insect pests by means of parasites. The New Zealand Government has been supplied with parasites of certain pests,—the earwig, pear slug larvæ, and pear leaf midge,—which cause extensive damage in that country.

Sir Matthew Wallace also spoke of the value of the work at Rothamsted to the practical farmer. He compared the present wave of agricultural depression with that of 1880 when he started farming, and said that the comparison made him optimistic for the future. The close relations that must exist between research centres and agricultural colleges if both are to keep ahead of the times were alluded to by Principal M. J. R. Dunstan, of the Royal Agricultural College, Cirencester. Mr. George Dallas, of the Workers' Union, said he was very greatly encouraged by the attention now being devoted by the Ministry of Agriculture and Stations like Rothamsted to the improvement of the lot of the farm labourer. He expressed the opinion that the recent increase of educational facilities will be of great benefit to the whole industry, and further it will help to prevent the departure of the best and keenest men from the land.

In the afternoon the visitors made a brief inspection of the work in progress in the laboratories.

New Principle of Therapeutic Inoculation.

IN collaboration with L. Colebrook and E. J. Storer, Sir Almroth Wright published in the *Lancet* (February 24, March 3 and 10) an elaborate communication which is an expansion of a special lecture delivered before the Royal Society of Medicine in November 30, 1922. It is entitled "New Principles of Therapeutic Inoculation."

The new principles may be best understood by a brief reference to the older principles which they are intended to augment or replace. In the therapeutic inoculation for infective disease, it has hitherto been the custom, following Sir Almroth Wright's earlier work, to inoculate the infected individual with a vaccine prepared with the virus with which the individual is infected. While the results in chronic infections have been on the whole excellent, there has been disappointment in the cases in which a heavy infection of a septicæmic type occurred. This was due to a certain extent to the fact that the elaboration of specific protective substances was a matter of time, and the state of the individual might be such that he was incapable of elaborating protective substances at all.

For a long time, however, it was known that non-specific bacteria, or indeed substances not bacterial in origin at all, might be employed to augment quickly the patient's resistance by a process, it was thought, of leucocytosis and phagocytosis. While not agreeing with this suggested action, Sir Almroth Wright, by many new and ingenious technical methods, shows that what he calls an "epiphylactic" response may be evoked by bacteria which are not identical with those with which the patient is infected. This epiphylactic response occurs when inoculation is made into the blood *in vivo* or even *in vitro*, and takes place immediately by an extrusion of opsonic and bactericidal elements from the leucocytes—an ectocytic rather than a phagocytic process. These ectocytic substances are polytropic in character, *i.e.* they act not only on the homologous but also on heterologous bacteria.

There is, in fact, a non-specific immunity, and it is this which Wright and his collaborators aim at producing to tide the patient over the critical days of his severe infection. The process adopted is named "immuno-transfusion," and consists of the incorporation of healthy human blood which *in vivo* or *in vitro* has been made, by inoculation, to develop an adequate epiphylactic response and is laden with protective substances. In this process it is clearly pointed out that quantitative determinations are of the utmost importance, as a dose of antigen optimal for one patient may be highly detrimental for another. The methods recommended are complicated, and treatment of severe cases of generalised sepsis, if it is to be successful, must lie in the hands of highly trained serologists.

University and Educational Intelligence.

ABERDEEN.—The Blackwell prize for 1923 has been awarded to Mr. F. C. Diack, the subject of the essay being "The Sculptured and Inscribed Stones of the North-east and North of Scotland."

The University Court has appointed the following lecturers to the newly instituted grade of reader in their respective subjects: Geography, Mr. J. M'Farlane; bacteriology, Dr. J. Cruickshank; public health, Dr. J. P. Kinloch; embryology, Dr. A. Low.

Prof. C. R. Marshall has been appointed John Farquhar Thomson lecturer on "The Human Body" for the year 1923–4.

CAMBRIDGE.—Mr. J. Barcroft, King's College, Dr. Adrian, Trinity College, and Dr. Hartridge, King's College, have been reappointed reader in physiology, University lecturer in physiology, and University lecturer in the physiology of the senses respectively; Mr. A. H. Peake, St. John's College, and Mr. T. Peel, Magdalene College, have been reappointed as demonstrators of mechanism and applied mechanics. Senior studentships have been awarded by the Royal Commissioners for the Exhibition of 1851 to D. Stockdale, King's College, and J. H. Quastel, Trinity College.

SHEFFIELD.—An anonymous gift of 20,000*l.* has been accepted by the University for the purpose of founding an undergraduate scholarship and a number of post-graduate scholarships. The undergraduate scholarship is to be in the faculty of pure science, and is restricted to boys from King Edward VII. School, Sheffield. The post-graduate scholarships are to enable graduates to pursue research in ferrous or non-ferrous metallurgy.

AT a meeting of the trustees of the Albert Kahn Travelling Fellowships Foundation on June 14, Mr. W. Randerson was elected to the fellowship for 1923. Mr. Randerson was educated at the Imperial College of Science, South Kensington, and during this year has been a research fellow of the Salters' Institute of Industrial Chemistry; recently he obtained the degree of M.Sc. (London) for a thesis on the chemistry

of the soil solution. The value of the award, which is to enable a student of proved intellectual attainment to enjoy a year's travel for research, is again to be 1000*l*.

THE British Research Association for the Woollen and Worsted Industries is to award shortly a number of research fellowships and advanced scholarships. The fellowships, which are tenable in the first place for one year, are of the annual value of 200*l*. The advanced scholarships, also of one year's tenure, carry a maintenance grant, and are designed to afford opportunity for specialisation. They are tenable either in Great Britain or abroad. Applications for fellowships must reach the secretary of the Association at Torridon, Headingley, Leeds, before July 21, and should contain particulars of the candidate's training and experience.

AN article by Mr. H. A. L. Fisher in the *Empire Review* for June surveys the progress of education in the Empire since 1911, the date of the last Imperial Educational Conference. It has been marked in the Dominions by a development of university and college influence even more remarkable than the similar development in Great Britain, and by a quite noticeable family resemblance between the expedients adopted in the various parts of the Empire for dealing with school and college problems. As examples of this resemblance he cites the Ontario Continuation Schools enactment modelled on the British Act of 1918, the raising of the school age in Alberta to 15, Tasmania's new separate infant department, and Queensland's extended scheme of medical inspection. There has been likewise a very general augmentation of teachers' salaries, but this has failed conspicuously to meet the needs of the situation in sparsely populated tracts of country. The Director of Education in Manitoba writes of inexperienced girls placed in charge of district schools because capable men willing to accept such posts can no longer be found. Australia organises either correspondence classes or itinerant teaching. New Zealand employs group supervising teachers. In Canada, as in the United States, there has been an important movement in the direction of concentrating children of rural areas in central schools. Mr. Fisher concludes his article with a prophecy that during the next decade the four most important tasks will be the development of adolescent education in Great Britain, the strengthening of the Arts Faculties in Canadian universities in such a way as to save these institutions from degenerating into mere groups of professional schools with predominantly materialistic motives, the raising of the matriculation age in India, and "such reforms (including in the first place the geographical concentration of the higher teaching in the Arts and in Pure Science) as may enable London University to take its rightful place as one of the great High Schools of the Empire."

IN a paper on methods of college teaching read to the Association of Land Grant Colleges of America, an interesting sketch was given by Dr. W. W. Charters of experiments carried out by him as professor of education in the Carnegie Institute of Technology. When he joined the Institute some three years ago he found that while many of the experienced teachers in the four divisions—Engineering, Industries, Fine Arts, and Women's College — had worked out excellent methods of teaching by themselves, many of the younger members of the staff, who had had no specific and formal training in methods, needed guidance which it became his duty to provide. Finding nothing for the purpose in books on teaching methods, the authors of which concern themselves almost exclusively with elementary and secondary education, he organised a weekly seminar and made the instructors who enrolled for it draw up lists of their duties and difficulties. He thus obtained a list of 14 real practical difficulties. He next made a list of 30 of the best teachers in the faculty, and the members of his seminar class were let loose on the chosen 30 to wrest from them the secret of how to handle the 14 difficulties. The professors surrendered at discretion, and the storm troops returned stimulated by the encounters and laden with intellectual spoil, which they proceeded to hammer out into a pamphlet which has been in use ever since. In the following year in the course of a similar campaign, undertaken with the object of elucidating the difficulties of getting students to think, it was found that inductive sciences such as chemistry and physics afforded less opportunity than others for practice in reasoning. This was attributed to the technique of investigation being so refined and the equipment so elaborate that principles have to be for the most part merely verified by students without being re-discovered. In the third year difficulties in shop and laboratory teaching were dealt with. Great stress is laid by Dr. Charters on the value of the weekly seminar for inexperienced teachers, to be followed when practicable by criticism of actual performances.

THE report for 1921–22 of the Commissioner of Education of the United States, who, by the way, is an old Rhodes scholar and graduate of Oxford, shows that if the Federal Government's appropriation for his Bureau—the Education Office of the Department of the Interior—is, as he says, "infinitesimal," it is nevertheless made to go a long way. Education in the States enjoys the ministrations of 48 Boards of Education or their equivalents, each of the sovereign States determining for itself the amount and character of the instruction provided for the children of its citizens: "This is as it should be, for the genius of the American people will probably never accept the idea of a centralized national system of public schools." In the circumstances invaluable service can be rendered by an unbiased, disinterested agency which "makes available to all the States the experiences of the most progressive and the achievements of the most highly endowed." Of the services rendered by the Bureau the conduct of surveys of State school systems and of universities and colleges, whether individually or by groups, is, the Commissioner says, probably the most far-reaching in effect. This work has grown very rapidly during the past two years. Among the developments recorded are: the new radio broadcasting service, which, as a means of reaching the general public, particularly parents and taxpayers, has proved cheaper than printing, reaches its audience quicker, reaches the mass of people who will not read printed articles, is more effective because it establishes more intimate contact, and, above all, educates public opinion *continuously*; promoting co-ordination of schools of commerce with schools of engineering with the view of improving methods of marketing at home and abroad; stimulating special training for foreign service, both Government and commercial; organising home-reading circles on the lines of the National Home Reading Union in Great Britain and associations of parents and teachers. Of interchange of students between countries the Commissioner says, "It is a desirable practice making for permanent peace and international comity, and is encouraged by every progressive nation. There are at least 10,000 foreign students in our institutions of higher learning and probably as many more in secondary schools."

Societies and Academies.

LONDON.

Royal Society, June 14.—C. **Chree**: Magnetic phenomena in the region of the south magnetic pole. Magnetographs were in simultaneous operation from April to October 1912, at the base stations of the British and Australasian Antarctic expeditions on opposite sides of the south magnetic pole. A comparison is made of the regular diurnal inequalities and the amplitudes of the absolute daily ranges of the magnetic elements at the two stations. The data show the remarkable sensitiveness of the regular diurnal variations in high latitudes to the presence of magnetic disturbance. The results are also applied to the question of a suitable criterion for the daily activity of magnetic disturbance.—O. R. **Howell**: The catalytic decomposition of sodium hypochlorite by cobalt peroxide. The rate of decomposition of sodium hypochlorite solution by cobalt peroxide is directly proportional to the amount of peroxide present. It is accelerated by sodium salts and (in the case of sodium chloride) is directly proportional to the square root of the concentration of sodium ions present. The mechanism of the reaction probably consists in the linkage of hypochlorite ions to the positive oxygen, and sodium ions to the negative oxygen of the peroxide, with immediate decomposition of the quadrivalent oxygen compound. With a fixed amount of hypochlorite the rate is then proportional to the degree of adsorption of the sodium ions. The rate is retarded by alkali and the retardation is proportional to the adsorption of hydroxyl ions. The average temperature coefficient of the reaction between 25° and 50° is 2·37 and the Arrhenius activation coefficient E is 16,574. The catalyst is not affected by any of the common catalytic poisons.—N. M. **Hosali**: On seismic waves in a visco-elastic earth. Seismic waves are subject to damping and dispersion dependent on the period. For each type of wave—dilatational, distortional, or surface—there exists a minimum period below which a wave cannot be transmitted, and for any period above the minimum two distinct waves can be propagated, one heavily damped and slow travelling and one lightly damped and quick travelling. Observations indicate that if the material in the outer layers of the earth obey the theory here developed it should have a viscosity of order 10^8 or 10^9 C.G.S. units. This would have no appreciable effect on the velocity of propagation of earthquake waves.—J. W. **Landon** and H. **Quinney**: Experiments with the Hopkinson pressure bar. With a bar of uniform diameter the pressure wave produced by detonation of gun-cotton is considerably distorted as it is propagated, but the rate of distortion decreases as the wave travels along the bar. Pressure falls away rapidly as distance from the axis of the bar increases. To determine the maximum pressure produced in the detonation of gun-cotton the bars were submitted to special heat treatment in the hope that overstrain might be reduced. A substantial improvement was observed except in so far as the life of the bars was increased. The highest maximum pressures recorded were 117 tons per square inch for a 1-ounce gun-cotton primer in contact with the end of the bar, and 82 tons per square inch with the primer $\frac{3}{4}$ inch away from the end. These results were obtained with a short bar of $\frac{3}{4}$-inch diameter. With concrete bars the phenomena exhibited are the same in general as with steel bars, except that the front of the wave appears to be entirely obliterated, and only the part in which pressure is less than the crushing stress of the concrete is propagated along the bar.—S. F. **Grace**: Free motion of a sphere in a rotating liquid at right angles to the axis of rotation. The density of the sphere is equal to that of the liquid, and the motion a small disturbance from one of uniform rotation like a rigid body. The motion of the centre of the sphere is wholly in a plane perpendicular to the axis of rotation, and the disturbed motion of the liquid is symmetrical with respect to this plane. The path of the centre of the sphere is a spiral with a definite pole. The sphere winds round the pole in a direction opposite to that of the rotation of the liquid, the motion being such that the time of a complete turn tends to become constant and equal to one-half the time of a revolution of the undisturbed liquid. At points along the prolongation of the polar axis of the sphere the motion is parallel to the equatorial plane and is a maximum at the sphere. Parts of the solution are not applicable for large values of time.—B. F. J. **Schonland**: The passage of cathode rays through matter. The absorption of cathode rays of velocity 6×10^9-$1{\cdot}2\times10^{10}$ cm./sec. in various metals has been studied with an arrangement designed to eliminate interference from secondary rays and to measure both the fraction of the beam passed through and that actually absorbed in the foil. The latter fraction varies with thickness and velocity in the same manner for all elements; the nature of the variation of the former depends upon the absorbing material. The results are explained by applying the theory of absorption due to Bohr, with which they are in quantitative agreement.

Association of Economic Biologists, April 27.—C. M. **Wenyon**: Recent observations on parasitic Protozoa in animals and plants. Certain parasitic Protozoa, such as the Coccidia, and some Hæmogregarines, which are inhabitants of the intestinal canal or wall of the intestine of vertebrates, and pass from host to host in the encysted form which escapes in the dejecta, have become so modified in the course of evolution, that they are no longer transmitted by means of cysts but are carried by bloodsucking invertebrates. It is probable that the well-known parasites of malaria are modified Coccidia. Intestinal flagellates, such as Trichomonas, which are normally inhabitants of the lumen of the intestine, may occasionally enter the blood stream. Reichenow has shown that in the lizard the entry of the intestinal flagellate Eutrichomastix into the blood may lead to infection of the mites, which again give rise to an intestinal infection of lizards which devour them. Similarly flagellates of insects like the flea or flies which usually live only in the invertebrate, may establish themselves in the intestines of vertebrates which eat them. Thence they may invade the blood of the vertebrate and are undoubtedly ingested by blood-sucking insects. It is possible that the parasite of the disease "Kala azar" of man may be an insect flagellate which enters man by way of the mouth, gains access to his intestine, and thence invades his tissues. Plants may be infected in like manner, for flagellates of the typically insect type have been found in various species of Euphorbia and other plants, and it has been shown by Franca that they are derived from bugs which feed upon the plants. M. S. G. **Breeze**: Some causes of sterility in Solanaceous plants due to Protozoa and Chytridiaceous parasites. The plants investigated were varieties of potato and petunia, and the following points were noted: (1) An Amœba, similar to *Amœba gleba*, attacks potato flowers virulently though without

any outward sign. The tissues are hypertrophied and turgid. (2) Chytridiaceous zoospores (probably synchytrian) occur in anthers in half-grown buds of Up-to-Date potatoes damaged by the Amœba; and some of the Amœbæ may migrate to the adjacent ovarian tissue; the zoospores swim to and fro by an anteriorly directed flagellum. Associated with the above is a spore-bearing bacillus with rounded ends, probably a saprophyte. (3) "Bird's eye" bodies in petunia and potato ovaries are regarded as possibly a phase of (2), and therefore synchytrian parasites.

Zoological Society, May 29.—Dr. A. Smith Woodward, vice-president, in the chair.—C. Tate **Regan**: (1) Some deep-sea fishes taken by the *Dana* Expedition, under the leadership of Dr. Johannes Schmidt. The fishes belong to the very rare and little-known genera Gigantena and Stylophorus, which agree in having telescopic eyes placed close together and directed forwards. (2) The skeleton of Lepidosteus, with remarks on the origin and evolution of the lower neopterygian fishes.—C. F. **Sonntag**: The comparative anatomy of the tongues of the mammalia.—IX. Edentata, Demoptera, and Insectivora.—S. **Maulik**: New cryptosome beetles.

PARIS.

Academy of Sciences, May 28.—M. Albin Haller in the chair.—Charles **Moureu**, Charles **Dufraisse**, and Ph. **Landrieu**: The principle of a general method for determining the calorific capacity of solids and liquids. Application to the determination of the water equivalent of calorimetric bombs.—P. **Villard**: A hydrate of iodine. Iodine and water, compressed with oxygen or nitrogen to 150 atmospheres, give crystals of a hydrate of iodine. The crystals are crimson-violet, strongly contrasting with the brown colour of the aqueous solution of iodine.—M. **Wallerant**: Extract from a note of M. Astbury. The structure of the crystal of tartaric acid, determined by the X-ray method, is in agreement with the views expressed by Pasteur in 1860.—Charles **Depéret**: The glaciations of the valleys of the French Pyrenees, and their relations with the fluvial terraces. From observations in the Ariège, Garonne, Neste, Aure, Gare de Pau, and Gare d'Ossau, there is complete identity between the Alps and Pyrenees for the number and periods of extension of the quaternary glaciers.—M. Henri Villat was elected a corresponding member for the section of mechanics in the place of the late R. Ariès.—René **Garnier**: Uniform functions of two independent variables defined by the inversion of an algebraic system of total differentials of the fourth order.—N. **Saltykow**: The methods of integration of partial equations.—M. **Angelesco**: Certain biorthogonal polynomials.—H. **Milloux**: Infinite series of functions and meromorphic functions with asymptotic value.—Charles N. **Moore**: The generalised Fourier series of non-integrable functions.—J. **Haag**: The problem of Schwarzschild in the case of a curved universe.—F. **Gossot** and R. **Liouville**: The principles of internal ballistics.—Jean **Chazy**: The secular effects of the theory of relativity in the planetary movements.—J. **Le Roux**: The field of gravitation.—A. **Luthy**: The ultra-violet spectrum of glyoxal. In hexane solution, this substance gives a series of narrow absorption bands in the ultra-violet; no compound of the aliphatic series has hitherto been known to give narrow absorption bands in the ultra-violet.—Guillaume C. **Lardy**: The ultra-violet absorption spectrum of diacetyl. In alcoholic solution previous observations have shown only a band in the violet and another in the middle ultra-violet. In hexane solution the author has found narrow bands. These bands are not so clearly separated as the narrow bands shown by glyoxal in the same region.—F. W. **Klingstedt**: The ultra-violet absorption spectrum of paraquinone. This substance shows in hexane solution fourteen narrow bands in the visible part of the spectrum between the green and the violet. In addition, in the middle ultra-violet there is one large band, and in the extreme ultra-violet ($\lambda = 2410$) there is one very strong band.—Albert **Colson**: Contribution to the laws of solubility.—A. Ch. **Vournazos**: The bismuthamines, a new class of bodies. These substances are obtained by the interaction of bismuth chloride (bromide or iodide) and an ammonia (or amine) salt in an organic solvent. As a typical example, the compound $BiCl_3I(NH_4)$ is obtained by the action of $BiCl_3$ on a cold solution of ammonium iodide in acetic acid. It forms silky transparent needles, decomposed by water.—Alfred **Gillet** and Fernand **Giot**: An application of the antioxygen power of the polyphenols: increase of fastness to light of dyes on the fibre. All the acid azo dyes, both on wool and on cotton, are relatively protected against the action of air under the influence of light by the *o*- or *p*-diphenol function, whether the latter is, or is not, a part of the molecule of the dye. Some eosin dyes behave similarly, but the nitro dyes, triphenylmethane derivatives, and basic colours are not protected.—Paul **Corbin** and Nicolas **Oulianoff**: Certain characters of the Hercynian fold in the Servoz-Les Houches region (Arve valley).—Conrad **Kilian**: The folds of the crystalline schists of Ahaggar; the Saharides.—René **Souèges**: The embryogeny of the Geraniaceæ. Development of the embryo in *Erodium cicutarium*.—G. **Hamel**: The limit of vegetation in the Channel according to the dredgings carried out by the *Pourquoi-Pas?* No algæ were found at depths greater than forty-five metres, and it concluded that at greater depths than this all vegetation, with the exception of diatoms, and plankton, is absent.—Jules **Stoklasa**: The origin of the nitrate deposits of Chili. According to one hypothesis, the nitrate deposits result from the accumulation of excrements and bodies of animals: another view (C. Noellner) is that the nitrates arise from the accumulation of submarine plants, since these plants contain iodine, and iodine is an invariable constituent of "caliche." The author gives reasons for regarding a volcanic origin as more probable than either of the preceding hypotheses.—J. **Lopez-Lomba** and Mme. **Randoin**: The state of scurvy produced by a complete regime in biochemical equilibrium, deprived only of the factor C.—W. **Kopaczewski**: Surface tension, swelling, and narcosis.—R. **Argaud**: The sclerogenic rôle of the giant cells.

WASHINGTON.

National Academy of Sciences (Proc. Vol. 9, No. 4, April).—R. L. **Moore**: Concerning the cut-points of continuous curves and of other closed and connected point-sets.—J. **Belling** and A. F. **Blakeslee**: The reduction division in haploid, diploid, triploid, and tetraploid Daturas. During the first division in the pollen-mother-cells of diploid, triploid, and tetraploid Daturas, homologous chromosomes are usually connected by their ends. Non-reduction occurs generally only in haploid plants. The volume of cytoplasm in the pollen-mother-cells is nearly proportional to the number of haploid groups present.—T. **Ellinger**: The variation and inheritance of milk characters. The records of a herd of 700 cows at Tranekjaer

Castle, Denmark, which consisted originally of Red Danish dairy cattle and Jersey cattle, are discussed. The yield during the first 10-week period of milking appears to be the most trustworthy measure of a cow's milk-yielding qualities. The records of the cross-bred cattle (F_1) show no indication of any single Mendelian factor in the inheritance of milk characters.—A. R. **Olson** and G. **Glockler**: The critical and dissociation potentials of hydrogen. A heated platinum filament covered with calcium oxide in a vacuum tube containing purified dry hydrogen at 0·1 mm. of mercury pressure was used as the source of electrons. The beam of electrons passed through platinum stops to which varying accelerating and retarding potentials could be given, and fell on an ionisation cylinder connected with a quadrant electrometer. The dissociation potential of hydrogen appears to be 3·16 volts; eight breaks occur in the current-potential curves, five of which correspond with lines of the Lyman series.—G. L. **Clark** and W. **Duane**: (1) The reflection by a crystal of X-rays characteristic of chemical elements in it. Crystals of the compounds KI, KI_3, CsI, CsI_3, and CsIBr have been investigated and X-rays characteristic of iodine, cæsium, and bromine have been identified which obey the regular laws of crystal reflection. The method used is to determine the position of peaks in the ionisation curve by rotating the crystal (corresponding to reflections from the various planes), and, setting the ionisation chamber at one of these peaks, to move the crystal and the ionisation chamber, the latter at twice the rate of the former. A series of peaks are obtained referring to one set of planes alone. For KI, wave-lengths of these correspond with the Kα and Kβ wave-lengths of iodine. The distance between the 100 planes is $3·53 \times 10^{-8}$ cm. KI_3 is found to be a cube slightly distorted with the edge $4·70 \times 10^{-8}$ cm. long. CsI_3 appears to be a rhombic crystal with cæsium atoms at each corner and iodine atoms at the centre and at points equidistant from the centre along the body diagonals. $CsIBr_2$ is also a rhombic crystal. (2) On the abnormal reflection of X-rays by crystals. Reflections of X-rays have been obtained from potassium iodide which are not in accord with the usual laws of crystal-reflection. The peaks caused in the ionisation curve are termed "X-peaks." For small deviations of the X-ray beam, the X-peak is outside that due to the 130 planes; for larger deviations, it is between those due to the 100 and 130 planes. The X-peak does not appear unless the incident beam contains X-rays of shorter wave-length than those in the K-series of iodine.—G. L. **Clark**: The significance of the experimentally determined crystal structures of the alkali polyhalides. It appears from X-ray analysis of the polyhalides KI_3, CsI_3, $CsIBr_2$, $CsICl_2$, that the three halogen atoms lie a diagonal of the crystal lattice, the heaviest in the centre; the metal atoms are at the corners. Other polyhalides are closely related chemically and crystallographically, and probably have similar structures, apparently closely related to the simple halide unit cubes, the halide group replacing a halogen atom. The size of the metal atom determines the dimensions of the unit cell and thus the relative stabilities of the polyhalides of the group.—E. B. **Wilson**: Electric conduction: Hall's theory and Perkins' phenomenon. Perkins has shown that the addition of a negative charge to a conducting strip of graphite decreases the conductivity. This is contrary to what might be expected on a free electron theory of conduction, but can be explained on Hall's theory of conduction by streams of electrons and ions, the latter taking a predominant part.

Official Publications Received.

Report of the Director of the Royal Observatory, Hongkong, for the Year 1922. Pp. 17. (Hongkong.)

Department of Commerce: U.S. Coast and Geodetic Survey. Serial No. 225: Reconnaissance and Signal Building. By Jasper S. Bilby. (Special Publication No. 93.) Pp. v+77. (Washington: Government Printing Office.) 30 cents.

Smithsonian Institution: United States National Museum. Bulletin 100: Contributions to the Biology of the Philippine Archipelago and Adjacent Regions: Ophiurans of the Philippine Seas and Adjacent Waters. By Prof. Rene Kœhler. Pp. x+486+103 plates. Bulletin 124: The Type Species of the Genera of Chalcidoidea or Chalcid-Flies. By A. B. Gahan and Margaret M. Fagan. Pp. iii+173. 15 cents. (Washington: Government Printing Office.)

Report of the Aeronautical Research Institute, Tôkyô Imperial University. No. 1: Hikôki ni taisuru Kaze no Hôkô to Hayasa wo kirokusuru Kikai (An Instrument to measure the Direction and Speed of Wind relative to an Aeroplane). By Tamaru-Takurô. Pp. 23. Y. 0.50. No. 2: A New Air Velocity Calculator. By Toyotarô Suhara. Pp. 25-31. Y. 0.70. No. 3: On the Diurnal Variations of Winds in different Coastal Stations of Japan. By Torahiko Terada and Tatuo Kobayasi. Pp. 33-85. Y. 1.10. No. 4: On the Decay of Vortical Motion in a Viscous Fluid. By Kwan-ichi Terazawa. Pp. 87-135. Y. 0.90. No. 5: On the Distribution and Variation of Temperature in the Cylinder and Piston of an Aircraft Engine. By Toyotarô Suhara and Naozo Sato. Pp. 137-170. Y. 1.20. (Tôkyô: Maruzen Kabusiki-Kwaisya.)

Neue Denkschriften der Schweizerischen Naturforschenden Gesellschaft (Nouveaux Mémoires de la Société Helvétique des Sciences Naturelles). Band 53. Pp. xx+402+54. Band 54. Pp. iv+291+32 Tafeln. Band 55. Pp. viii+149. Band 56. Pp. vi+128+28 Tafeln. Band 57. Pp. xi+325. Band 58. Pp. viii+251. (Basel, Genf and Lyon: Georg and Co.)

Statens Meteorologisk-Hydrografiska Anstalt. Årsbok, 4, 1922. 2: Nederbörden i Sverige. Pp. 173. (Stockholm.)

Diary of Societies.

MONDAY, JUNE 25.

SOCIETY OF BIOMETRICIANS AND MATHEMATICAL STATISTICIANS (at University College), at 8.—Dr. T. H. C. Stevenson: The Social Distribution of Causes of Death in England and Wales.

ROYAL SOCIETY OF MEDICINE (Odontology Section), at 8.—L. E Claremont: Case of Fibro-Cystic Disease of the Lower Jaw.—Dr. A. Hopewell-Smith: Two Odotomes; Some Observations on the Histology and Pathology of the Dental Pulp.

ROYAL INSTITUTE OF BRITISH ARCHITECTS, at 8.30.—Presentation of the Royal Gold Medal.

TUESDAY, JUNE 26.

IMPERIAL EDUCATION CONFERENCE (at Institution of Mechanical Engineers), at 8.—Miss L. De Lissa: Recent Developments in Infant Education and their Connexion with the Work of the Elementary Schools.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—de Barri Crawshay: Exhibit of Eoliths from the South Ash Pit on the Kentish Chalk Plateau, and of Stone Implements from Mesopotamia.—S. Hazzledine Warren: The Palæolithic Succession of Stoke Newington.

SOCIOLOGICAL SOCIETY (at Royal Society), at 8.15.—Dr. E. Jenks: The Function of Law in Society.

WEDNESDAY, JUNE 27.

ROYAL SOCIETY OF ARTS, at 4.—Annual General Meeting.

ROYAL SOCIETY OF MEDICINE (Surgery Section), at 5.30—Dr. W. Mayo, Sir Berkeley Moynihan, J. Sherren, G. Grey Turner, and A. J. Walton: Discussion on the Surgery of the Hepatic and Common Bile Ducts.

IMPERIAL EDUCATION CONFERENCE (at Institution of Mechanical Engineers), at 8.—Lt.-Gen. Sir Robert S. S. Baden-Powell, Bart.: The Boy Scout and Girl Guide Movement.

THURSDAY, JUNE 28.

ROYAL SOCIETY, at 4.30.—Prof. V. H. Blackman, A. T. Legg, and F. G. Gregory: The Effect of a Direct Electric Current of very Low Intensity on the Rate of Growth of the Coleoptile of Barley.—Miss R. M. Tupper-Carey and Prof. J. H. Priestley: The Composition of the Cell Wall at the Apical Meristem of Stem and Root.—L. J. Harris: The Titration of Amino- and Carboxyl-Groups in Amino-Acids, Polypeptides, etc.—Dr. M. S. Pembrey, N. W. MacKeith, W. R. Spurrell, E. C. Warner, and H. J. Westlake: Observations on the Adjustment of the Human Body to Muscular Work.—F. A. E. Crew: Studies in Intersexuality. II. Sex-Reversal in the Fowl.—Prof. W. Finkler: Analytical Studies on the Factors causing the Sexual Display in the Mountain Newt (*Triton alpestres*).—Prof. G. A. Schott: The Scattering of X- and γ-Rays by Rings of Electrons—The Effect of Damping of the Incident Radiation.—Major P. A. MacMahon: A Class of Transcendents of which the Bessel Functions are a Particular Case.—Dr. L. C. Martin: The Photometric Matching Field.—Prof. G. P. Thomson: Test of a Theory of Radiation.—Dr. A. Ll. Hughes and P. Lowe: Intensities in the Helium Spectrum.—A. A. Dee: The Effect of Quenching from above the Carbide Transition Temperature upon the Magnetism of Steel.—T. S. P. Strangeways and H. E. H. Oakley: The Immediate Changes observed in Tissue Cells after Exposure to Soft X-Rays while growing *in vitro*.

INSTITUTION OF ELECTRICAL ENGINEERS (at British Museum (Natural History)), at 8.30.—Annual Conversazione.

ROYAL SOCIETY OF MEDICINE (Urology Section), at 8.30.—Prof. C. G. Cumston: Certain Points in Connexion with Nephritis.

FRIDAY, JUNE 29.

SOCIÉTÉ DES INGÉNIEURS CIVILS DE FRANCE (British Section) (at Institution of Mechanical Engineers), at 8.30.—M. Barrillon: The Port of Rouen and the Lower Seine.