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Standardisation of Vaccines, Toxins, and Antitoxins.

WE referred last week to the special measures proposed by Sir Mackenzie Chalmers's Committee for the control of the quality and authenticity of vaccines, toxins, antitoxins, salvarsan, and certain other drugs. What is there in the special circumstances of our time to justify a closer superintendence of the many new therapeutic substances now in common medical use? It might well have been supposed that in the vast technical developments of the last half century "big business" had, through the sheer excellence of its scientific methods, reached a plane where further public control was superfluous. Over a large area of the drug field this is true. If we look back for half a century we can trace, since the medical Acts, a steady growth in the technical standardisation of all the drugs used in medicine. The British Pharmacopœia itself came into existence because experimental pharmacology showed the need for precision of dosage and the consequent standardisation of drugs. The demand made by scientific medicine evoked the best powers of scientific chemistry. To-day there are few fields of applied science that can show greater precision of practice than the drugs now used as therapeutic substances. Standardisation, therefore, and control in one degree or another are accepted methods of securing the consumer not merely against fraud, but also against inertness and inefficiency in chemical medicines.

But within the half century there have arisen other products not capable of easy standardisation. It is only some thirty years since Koch produced his first "tuberculin." To those who remember the wild rush to Berlin to secure the magic poison and to inject it without afterthought, the memory is full of horror. The damage done by the indiscriminate use of tuberculin alone would justify severe restrictions on the use of all such toxins, and the antitoxins had also to pass their trial. It is only twenty-five years since von Behring's diphtheria antitoxin was given to the world. Immediately, in this and other countries, von Behring's processes of production were imitated, sometimes without his exactness of technique, and the result was here and there a serious disaster. For even the large firms had not evolved the superb machinery they now command, and every person that used the new antitoxin did so with uncertainty and misgiving. Steadily, as methods improved, standards of potency and purity improved with them. Fortunately, diphtheria antitoxin from the beginning was capable of very exact standardisation by controllable units. It was the model for all later antitoxic serums. Of such serums many have since been produced, and some have succeeded as cures. But still more recently the treatment by vaccines has grown by leaps and bounds.

When Koch's tuberculin, which is really a dead-germ vaccine, appeared, many of the "elder statesmen" of medicine prophesied a period of specialised vaccines of endless variety. The period is now upon us. The refinements of technique are almost incredible. Smallpox vaccine was for a century the pioneer. To-day every common cold has its vaccine. This is because bacteriology has been active, methods have grown in scientific precision, and clinical medicine has come to understand the therapeutic value of biological products. But these products vary in potency, in purity, and in danger. In careless hands they may do immense harm; in skilled hands, immense good. But if widespread use and possible occasional danger are relevant grounds for control, the case for the control of these biological products is as strong as the case for the control of other potent and dangerous drugs.

The Committee's remit covered, however, other substances perhaps as dangerous. Salvarsan is a type of product that cannot be adequately tested by direct chemical means. Its toxicity is a primary

factor, and this cannot be tested except biologically. During the war, on account of difficulties with imported salvarsan and its analogues, special provision was made for testing and standardisation. The Medical Research Council undertook the necessary work, and the history of the uses of salvarsan and its substitutes is one of the most striking chapters in the records of the war. What the war started this Committee proposes to continue.

Standardisation, therefore, of biological products and of the more dangerous chemical toxic drugs is loudly called for. As early as 1909 the General Medical Council approached the Government with the suggestion for "the establishment of a public institution for the pharmacological standardisation of potent drugs and of serums." The Medical Research Council within the last few years has actually carried out a certain amount of standardisation. The recommendations of Sir Mackenzie Chalmers's Committee are really only giving effect to views accepted both by scientific experts and by scientific manufacturers. The primary recommendations are that such products as we have named should be subject to supervision and control; that the controlling authority should be the committee of the Privy Council which at present controls the Medical Research Council; that this committee should decide from time to time what substances are to be brought under control and prescribe the methods of standardisation and testing; that the controlling authority should have to assist it an advisory committee representative of the different sections of the kingdom, as well as of the Navy and Army, the General Medical Council, the Medical Research Council, and the Pharmaceutical Society; that there should be a central laboratory under the management of the Medical Research Council for the preparation and maintenance of standards and the testing of market products; that control should include the licensing of manufacturers, the inspection of plant, premises, and processes, and the testing of the finished products; that the primary responsibility for seeing that products conform to standard should lie with the manufacturers; that test samples should be taken from time to time, and also that manufacturers should be required on occasion and for a period to furnish samples of every batch of a substance made. It is also suggested that imported products of the same order should be admitted only by licence, and subjected to equal tests.

In these recommendations and in the argument justifying them we find nothing that should interfere illegitimately with the well-established methods of private enterprise. Indeed, the Committee, in its recommendations, has the support of the leading manufacturing firms, which, with certain slight qualifications, welcome appropriate inspection and standardisation. The draft Bill embodies the recommendations in a workable form. It may require modification in detail, but in principle it seems adequate. It combines a sufficiency of central control with the minimum of trade restriction.

British Dyestuffs Corporation.

THE situation in which the directorate of the British Dyestuffs Corporation finds itself is a remarkable one. At the registration of this company in May, 1919, as a result of amalgamating British Dyes, Ltd., of Huddersfield, with Messrs. Levinstein, Ltd., of Blackley, the appointment of Sir Joseph Turner as commercial managing director, and of Dr. Herbert Levinstein as technical managing director, was designed to maintain the interests of both groups, and to benefit the united enterprise by the special contribution of knowledge and experience which each of these gentlemen was expected to make. At the meeting of shareholders in Manchester on Friday last it was announced that Sir Joseph Turner and Dr. Levinstein, while retaining their seats on the board, have been superseded as managing directors by Sir Henry Birchenough, the chairman of the corporation, Sir William Alexander, and Mr. Vernon Clay.

It is no reflection on the new managing directors to express the opinion that the position thus disclosed must arouse grave misgiving amongst all those who recognise the foundation of a self-supporting synthetic dyemaking industry as a matter of the greatest national importance. Disregarding the woeful absence of harmony which appears to be indicated, the aspect of this rearrangement which causes anxiety to chemists is the fact that, at a time when all the scientific knowledge and commercial energy available in this country should be correlated in a concerted effort to establish an industry which, more than any other, depends for success upon the combination of these factors, two of the most experienced practitioners should be removed from very intimate association therewith.

The proper and perfectly natural request for an investigation put forward by the shareholders met with a cold response from the board, and the

declaration by the chairman that a general meeting is not the occasion for an explanation of such peculiar circumstances is one with which many will sympathise; but the public is entitled to full information at the earliest convenient opportunity. Pending more precise knowledge of the facts, it would not be fair to the late managing directors, or to the board, to pass judgment on their action. If, however, as the published statements at present suggest, incompatibility of temperament is the cause, chemists will regard them as having failed in realising their responsibility to science at a critical juncture; on the other hand, the board can scarcely escape the reproach of having allowed an impossible situation to continue far beyond the point at which a surgical operation had become an obvious necessity. Having regard to the immense scientific and national interests which are involved in the ultimate success of this enterprise, and to the large sum of public money which has been invested in the corporation, its future conduct demands very careful scrutiny.

Alcohology.

Notes on a Cellar-book. By George Saintsbury. New edition. Pp. xxxi+228. (London: Macmillan and Co., Ltd., 1920.) 7*s.* 6*d.* net.

THAT constituent principle of all vinous or spirituous drinks which maketh glad the heart of man, no matter how diverse their origin—and this diversity is something astonishing—is commonly reputed to be alcohol. But since this word, in scientific terminology, has lost its original restricted meaning, and is now used generically to comprehend a multitude of substances, solids as well as liquids, the majority of which are not produced by fermentation, it is desirable to be more precise, and to say that this exhilarating principle is held to be the ethyl alcohol of the chemist. All alcohols are not toxic, although certain of the congeners of ethyl alcohol—such as methyl, propyl, and butyl alcohols—are highly poisonous—far more so, apparently, than ethyl alcohol. On the other hand, glycerin, which is regarded by the chemist as an alcohol, is non-poisonous. Other instances of non-toxic alcohols might be quoted.

The stimulating, as distinct from the toxic, effect on the normal individual of what we usually call alcoholic beverages is a very complex phenomenon. It is partly physiological and partly psychological. To begin with, the liquid must be pleasant, or at least not repugnant, to the senses. The physiological effect is probably not wholly due to the ethyl alcohol. Perfectly pure ethyl alcohol, in the sense in which the chemist understands the term "pure," is seldom seen, and is certainly never a commercial article. When produced by synthetic processes from inorganic materials it is devoid of all flavour; it is as characterless, indeed, as distilled water. To drink it would afford no pleasure to a sane person. The ethyl alcohol of all fermented liquids, whether they are distilled or not, is accompanied by a variety of substances, such as the alcohols chemically related to ethyl alcohol, as well as ethers, esters, aldehydes, and other products, originally, in the case of wine and cognac, contained in the must or juice of the grape, or, in the case of spirits, derived from the fermented wort of various grains. In the case of liqueurs and cordials, the composition is far more complex by reason of the flavouring or other ingredients present. Some of these may be factitious substances made to simulate natural products, but with widely different physiological properties. The main point is that the substances associated with the ethyl alcohol in wine, beer, spirits, liqueurs, cordials, etc., contribute their effect to the character of the beverage and also to its physiological action; they may, indeed, in certain cases overpower, or mask, that due to the ethyl alcohol alone.

The cult of alcohol is, however, too vast a subject to be treated at greater length in such a notice as the present. It is of an immemorial antiquity. As we are informed, it has occupied mankind at least since the days of Noah, who, in the words of the German song, was certainly "ein frommer Mann," as well as a husbandman. But there were tillers of the ground before the Flood, and even Cain may have planted a vineyard, for it is not expressly stated that Noah was the first to do so. In that case it may have occasioned the first recorded murder, *pace* Prof. Saintsbury, who fails to see any connection between crime and strong drink.

The literature of alcohology—that is, the literature which treats of the origin, nature, and properties of alcoholic beverages; which sings their praises and extols their benefits; or which, on the other hand, anathematises the wine when it is red, stigmatising it as a mocker, which biteth like a serpent and stingeth like an adder, and which curses strong drink as the source of woe and sorrow, of contention and babbling, of wounds without cause, and redness of eyes—is probably one of the most extensive in the

world. Thousands of volumes have been written upon the subject, and doubtless will continue to be written, for it is of perennial interest, as the book before us testifies.

Prof. Saintsbury does not profess to be more than an amateur alcohologist. His present treatise, if such it can be termed, has no pretensions to profundity. Serious books on wine, he thinks, have, as a rule, been rather dull, and to be dull on such a subject is worse than a crime—it is a blunder. He discourses freely and pleasantly, and with the lightest possible touch, concerning his reminiscences of the contents of a cellar, accumulated at various times during upwards of half a century, more in the interests of a refined hospitality than of winebibbing and the riotous eating of flesh, as the Wise Man has it. He tells us frankly what he prefers, and on what he sets little store. But he is too wise to be dogmatic. His preferences, he learns, are not always shared by others, and he fears he may occasionally wound worthy feelings by what he writes. To nothing is the old adage, *De gustibus,* etc., more applicable than to a man's drink. The Lord Derby who preferred the gout to a certain brand of sherry would doubtless find people to whom the wine was palatable. Prof. Saintsbury can, however, be emphatic enough at times. He has unmeasured contempt for what he denounces as the dishonesty of the so-called temperance party. To his mind "it is a question whether the most Jesuitical Jesuit of the most heated Protestant imagination has ever outdone a thorough-going temperance advocate in the endless dodgings and windings, suppressions and suggestions of his method." This is *trop de zèle*. There was no occasion to attempt to break a lance with the temperance party. Sensible men will agree with the author that *abusus non tollit usum* is a sufficient reply to what he terms "the unscrupulous exaggeration of partisans," and he would have been well advised to leave it at that. All temperance advocates are not fanatics or faddists, and the opinions of earnest, thoughtful, and conscientious men are worthy of respect. There is such a thing as intemperance in argument as well as in alcohol. Moreover, the spirit of self-denial which actuated thousands of men during the gravest crisis through which this country has ever passed is worthy of a more generous recognition than it receives. Prof. Saintsbury's arguments would have met with very short shrift at the hands of the late Sir Victor Horsley.

These apart, the book affords very pleasant reading, and an idle half-hour may be pleasurably spent in dipping into its pages.

Some Aspects of Psychology.

(1) *Educational Psychology.* By Dr. Daniel Starch. Pp. xi+473. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 14*s.* net.

(2) *The Psychology of Childhood.* By Dr. Naomi Norsworthy and Dr. Mary Theodora Whitley. (Brief Course Series in Education.) Pp. xix+375. (New York: The Macmillan Co.; London: Macmillan and Co., Ltd., 1920.) 10*s.* net.

(3) *Human Psychology.* By Prof. Howard C. Warren. Pp. xx+460. (London: Constable and Co., Ltd., 1920.) 12*s.* net.

(4) *Spiritualism and the New Psychology: An Explanation of Spiritualist Phenomena and Beliefs in Terms of Modern Knowledge.* By Dr. Millais Culpin. With an introduction by Prof. Leonard Hill. Pp. xvi+159. (London: Edward Arnold, 1920.) 6*s.* net.

THOSE who are by nature and training sufficiently eupeptic to digest a diet of well-prepared statistics will find Dr. Starch's "Educational Psychology" (1) to their taste, and will profit by its assimilation. Most English teachers prefer general impressions handed on by tradition from masters of their craft, and endorsed, as they think, by personal experience, to results expressed in coefficients of correlation. But some of them want to know what all this mass of statistical work really comes to, and how far it is helpful as a guide to practice. The author goes far to meet their requirements. After outlining the nature of the problems that arise, he deals (i) with the native equipment of human beings, and (ii) with the psychology of learning, first "in general," and then in the case of sundry recognised school subjects.

The reader will probably turn with special interest to the treatment of certain large questions such as the inheritance of mental traits and the transference of training. As a result of a review of the statistical evidence so far to hand, Dr. Starch concludes that the ultimate achievement of any given individual is due to his inherited ability probably to the extent of from 60 to 90 per cent. and to actual differences in opportunity to the extent of only from 10 to 40 per cent. If, then, nature bears to nurture something like the proportion of three to one, and if there is but little statistical evidence in support of the cherished belief that the outcome of nurture in one generation is so transmitted as to contribute to the inherited nature of the next, it might seem that the *rôle* of the teacher is less important than he is apt to

claim. But one must remember that the proportion of inherited nature *that is actually realised* in any given individual depends in large measure on his nurture through education. That is where opportunity comes in. It may be true enough that equal opportunities for all do not produce equal abilities in all. None the less, educational opportunity does raise the realisable value of the inherited bequest in capacity, and that in no slight degree. How much we do not know.

As to transference, it is assumed on the "formal discipline" view that training of one sort affects capacities of other sorts, irrespective of identical elements, or of similarity in the activities developed. On the basis of a careful discussion, Dr. Starch concludes that, as a general estimate in the case of closely allied subjects, there is probably from 20 to 30 per cent. of transfer, and from that point down to a very small proportion or none in the case of subjects which have little in common. The book abounds in detail which is worthy of careful study. Few who follow the treatment with understanding and critical judgment can fail to profit in the practice of their profession.

"The Psychology of Childhood" (2) is a contribution to the Brief Course Series in Education published under the editorial supervision of Dr. Paul Monroe. Dr. Naomi Norsworthy, who began the work, and Dr. Mary Theodora Whitley, who has completed it since the death of her colleague, reflect the influence of Prof. Thorndike in the Teachers College of Columbia University, the scene of their activities. The text-book is written with a view to its use in normal schools, and presupposes some knowledge of general psychology. Statistics are freely used, and a section is devoted to the methods adopted in their employment; but the treatment, on the whole, is on lines which are sanctioned by custom, with chapters on sense perception, memory, imagination, habit formation, play, and so forth. Although the lines are familiar, there is a good deal of freshness and individuality. English teachers will read it with profit, but should do so, perhaps, with discretion. For the basis is, in the main, frankly physiological. The inheritance of an individual is in terms of structure in the nerve-system, not in terms of mental states. A baby is not heir to any ideas; he does not even inherit consciousness as such; what he does inherit is a complicated system of neurones acting and developing in accordance with certain laws of growth. A child acts as a human being rather than as an animal because he inherits a human nervous system. No matter how general a mental trait may be, no matter how minute its character, it is dependent on some connection of the neurones. Possibly Dr. Drever in Edinburgh might suggest to teachers in training some modification of the principles that are current in Columbia University.

It is quite clear from Prof. H. C. Warren's "Human Psychology" (3) that definitions advanced in Princeton would not find ready acceptance at St. Andrews. That is part of the trouble in this field of exposition. If in half a dozen textbooks on physics, or works in which physical concepts play a leading part, we found not only such a word as "acceleration," but even the word "physical," used in half a dozen different senses, we should be perplexed and perturbed. Unfortunately, something like this state of matters obtains in psychology. By "conation" Prof. Stout means this; Prof. Alexander that; Prof. Warren something else. For Prof. Titchener it has no scientific meaning. Even the word "mental" is in like case. What is for most psychologists distinctively mental—the flow of *ideas* (somehow defined)—is for Prof. Alexander typically non-mental; and while for some the mind *is* the "stream of consciousness" (in some sense), for others it is that which gives direction to the stream and, in part at least, makes it flow. Furthermore, the notion that what is mental or psychical is that which is revealed in consciousness—even this is rejected by the exponents of the "new psychology," who urge that its major part is concealed in the unconscious.

Much, of course, depends on the method of approach to the subject, from below through physiology or from above through philosophy. The one (from the other point of view) is either tainted with materialism or tinted by metaphysics. Prof. Warren takes the low-level route from the plains of biology and physiology; and if this method of approach is somewhat out of fashion in England to-day, that is no reason for refusing to one who travels along it with careful steps a patient, if critical, hearing.

For Prof. Warren psychology is the science which deals with the mutual interrelation between an organism and its environment. The interaction between them involves three stages—stimulation, adjustment, and response. Each single interaction is an experience, and the sum-total of such experiences makes up the mental life of the organism. The special structures and types of function which bring about the interaction constitute its mental (or psychical) organisation. The investigation of mental life is the study of experience, whether that experience be accompanied by

any discoverable consciousness or not. Experience may thus include behaviour and consciousness, but need not include the latter. Behaviour, or the action of the organism on its environment, is typically mental (as defined). Consciousness is the subjective accompaniment, or so-called inner aspect, of some, but not of all, modes of behaviour. In the more complex cases of adjustment we know far more about the conscious than the physiological aspect, though we have reason to believe that such an aspect is always present.

The thesis is worked out with commendable consistency; and what G. H. Lewes would have called the metempirical factor is rigorously excluded. One cannot here enter into details or follow up the definitions which the method of treatment carries with it. Since, however, conation bulks so large in much current English discussion, attention may be directed to the attenuated form it here assumes. "We may define conation as the mental state which accompanies any involuntary or automatic movement or any bodily position of which we are aware." It is simply the conscious correlate of behaviour itself. The place, if any, of consciousness in the causal nexus is not discussed.

Dr. Culpin's "Spiritualism and the New Psychology" (4) purports to give an explanation of spiritualist phenomena and beliefs in terms of modern knowledge. By modern knowledge is meant that version of Freudian hypothesis (as presented by Dr. Bernard Hart in his "Psychology of Insanity") which is recapitulated in the first four chapters. The book is brightly written, is flavoured with the spice of satire, and contains much criticism that is not only clever, but also pertinent and acute. It will do much to strengthen the conviction of those who are already convinced. Whether it will alter by a hairbreadth the belief of sundry others is open to question. Still, the missionary effort is warmly commended by Prof. Leonard Hill in an able introduction.

A touch of piquancy marks the position which Dr. Culpin seeks to defend. On one hand, there are certain phenomena which look *as if* disembodied spirits were concerned in their manifestation. On the other, there are certain phenomena which look *as if* memories were stored in "the unconscious." The author argues that wholly erroneous beliefs are founded on the former "as if," and that in the light of "modern knowledge" a valid explanation of them may be given in terms of the latter "as if," supplemented by one or two more of like nature. Whether "memories" in the unconscious are embodied or disembodied, and in what manner they are "stored," are problems on which no light is thrown. Now a crucial question for scientific thought is this: What is the justification in any given case for passing from "as if" to "is"? No doubt we all jump with fatal facility from one to the other, and fail to realise that "of course it obviously stands to reason that it must be so" falls very far short of "it is so." Dr. Culpin thinks that there is no justification for the *saltum mortale* of the spiritualist. Does he adequately justify his saltatory acceptance of memories, ideas, wishes, thoughts, and the rest, in the unconscious? He must, too, be well aware that there is another "as if" which puts in a claim to be an "is." Thus Prof. Warren (3) says:—

"The popular notion of memory is based upon too close an analogy with perception. Objects in the environment continue to exist even when we do not perceive them. Popular psychology assumes that 'memory objects' (memory images) persist in much the same way. It is true that something remains in the brain after the sensation ceases, which furnishes the basis for future memory images. But what remains is not a 'picture' of the object or event, but merely a record; it is a trace or set or retention effect of some sort in the structure of the neurones or synapses."

There are thus at least three "as ifs" which put in a claim for acceptance—that of Sir Oliver Lodge, that of Dr. Culpin, and that of Prof. Warren. The author's attitude towards Sir Oliver Lodge and his school is clear enough. One would like to know with greater definiteness his attitude towards Prof. Warren and his school. But perhaps their tenets do not fall within "modern knowledge." C. LL. M.

Physiology for Students.

Essentials of Physiology. By Prof. F. A. Bainbridge and Prof. J. Acworth Menzies. Fourth edition. Pp. viii + 497. (London: Longmans, Green, and Co., 1920.) 14*s.* net.

THE fourth edition of Profs. Bainbridge and Menzies's work differs but little from the previous one; only a few of the sections have been rewritten. As the authors state in the original preface, their object is "to bring together in a concise form the fundamental facts and principles of physiology." They certainly have succeeded, for they do not waste a word, if we omit the tables inserted in the section on the distribution of the cutaneous sensory nerve-endings. We cannot see that the knowledge of the actual minimal pressure stimuli in various parts of the body is of great importance, and these tables, in

our opinion, could have been omitted with no great loss, especially in a volume of this nature.

In some sections, on the other hand, the conciseness has been rather overdone. The chapter on muscle is somewhat condensed, especially the paragraph dealing with visceral muscle, which, as in many other text-books, is quite overshadowed by the record of experiments on the gastrocnemius of the frog. The paragraph on the reaction of the blood, containing, as it does, an explanation of hydrogen-ion concentration, could have been longer and clearer. This subject is usually a very difficult one for the average student, and requires a good deal of explanation. It would have been wise to devote a full paragraph to a description of what hydrogen-ion concentration means, especially as this term is coming into greater use every day.

The section on the gases of the blood is very full, and contains an account of all the recent work. Barcroft's differential apparatus is figured and explained. A very good feature of the book is the illustration of the text with representative tracings. This, we think, is very important for the proper understanding of a subject like physiology, which is, and always must be, practical. The presence of these typical tracings saves the reader from cramming facts, an obvious danger in such a concise book.

The chapter on the ductless glands is well illustrated by photographs of typical cases showing the effects of withdrawal of the various secretions. This is of advantage, as it impresses on the student the close relationship between physiology and the actual practice of medicine. The chapter makes mention of most of the recent important work in endocrinology—*e.g.* there is noticed the work of the Glasgow school under Prof. Noël Paton in connection with the parathyroids and guanidin.

On the whole, the book ought to prove useful for students going up for their second professional examination, after they have gone through the necessary practical classes.

Our Bookshelf.

Applications de la Photographie Aérienne. By L.-P. Clerc. (Encyclopédie Scientifique.) Pp. vi + 350 + xii + x plates. (Paris: O. Doin et Fils, 1920.) 7.50 francs.

IN the production of aerial photographs the results of diverse scientific investigators have been used, but even when the ideal photograph has been obtained, its value is small without a knowledge of its geometrical properties and of the methods by which it can be most fully employed. The present work deals mainly with the geometrical problems which form the foundation of the use of air-photographs for precise work, and it is the element of precision which makes the aerial picture so valuable. The book is divided into three parts. The first treats briefly of interpretation, and includes the calculation of the heights of objects from their shadows. The second part deals with stereoscopy, and is of great value. It covers the groundwork of the subject very fully, and will be invaluable in working out metrical methods in practice. The third part deals with metrophotography, and contains many of the results discovered by earlier workers in photo-surveys from balloons, together with new work. The general treatment suggests that the author has been more occupied with the theory of the air-photograph than with the results obtained in practice, and in his introduction he refers rather bitterly to the photographic organisation of the French Services. Whatever may have been the situation during the war, M. Clerc must have the satisfaction of knowing that his unique work will greatly assist the future development of scientific air-photography. H. H. T.

Essays on Early Ornithology and Kindred Subjects. By J. R. McClymont. Pp. vii + 35 + 3 plates. (London: Bernard Quaritch, Ltd., 1920.) 6*s*.

THE author has been diving in the rather muddy waters of early ornithology, and displays some of his treasures in a beautifully printed book. Marco Polo's *rukh* holds a position in bird-lore intermediate between the utterly fanciful and the badly misinterpreted, say between the Phœnix and the apodous Birds of Paradise. A mythological stream, taking its rise from the *simourgh* of the Persians, and a matter-of-fact stream, taking its rise from observations on some sea-eagle, united into one, which "floated the conception of the *rukh*." An anonymous narrative of the first voyage (1497) of Vasco da Gama to India contains a reference to the penguins and seals of what is now called Mossel Bay. A hundred years afterwards a scurvy-stricken ship found in an island in the bay "many birds called Pyncuins and Sea Wolves, that are taken with men's hands" (the baby *Otaria pusilla*?). The third study deals with the birds of the Banda Islands, where nutmeg-trees flourish; the fourth discusses the etymology of the name "Emu," the suggestion being that the Portuguese changed the Arabic name of the cassowary, "Neâma," into "uma ema." The identification of Australian birds mentioned by Dutch explorers in 1697 and of New Zealand birds observed by Crozet in 1772 has all the fascination of a clever game. Mr. McClymont's studies are what we should call luxuries, but they have the merit of scholarship and brevity. There are three fine plates, showing *Casuarius uniappendiculatus*, Blyth (*juv.*), from the British Museum; Hulsius's figure of an "Eme," an immature cassowary with two

wattles, probably *Casuarius galeatus*, Vieill.; and a Masked or Blue-faced Gannet (*Sula cyanops*, *S. personata*) from the Royal Scottish Museum.

The Elder Edda and Ancient Scandinavian Drama. By Dr. Bertha S. Phillpotts. Pp. xi+216. (Cambridge: At the University Press, 1920.) 21*s.* net.

THE publication of this important monograph on the Elder Edda furnishes a scientific basis for the interpretation of this collection of primitive Icelandic poetry. Up to the present the attempt to localise these poems by differentiating between the literary and historical outlook of the Norwegians and Icelanders has yielded contradictory results, and the same is true of the effort to establish a relative chronology of the poems by attributing cases of similarity of expression or even of metre to direct imitation. In short, the reliance on philology, and on philology alone, as a key to the problem has proved to be fruitless. The line of investigation now followed, based on recent work in connection with the drama generally, and particularly with that of the Greeks, promises more hope of success. The poems are now shown to have originated in primitive folk-drama, for the existence of which ample evidence is adduced. The Eddic poets failed to secure epical expression because they were hampered by this dramatic tradition. The book is not easy reading, because the author has tried to combine the historical with the literary interpretation, and its completion has been hindered by the loss of some notes and manuscript while she was engaged in war work. It is, however, a fine piece of literary criticism, and the translations of passages in the Edda which form an important part of the text are so good that it may be hoped that the author will supply a complete version of this remarkable collection of early poems.

An Introduction to Bacterial Diseases of Plants. By Erwin F. Smith. Pp. xxx+688. (Philadelphia and London: W. B. Saunders Co., 1920.) 50*s.* net.

THIS treatise, the first of its kind on the bacterial diseases of plants, is written by a recognised authority, whose work epitomises a considerable part of the history of the subject from the time when Burrill discovered, in 1882, that the fire-blight of apple- and pear-trees is due to *Bacillus amylovorus*. Since that time the number of known bacterial diseases in plants has greatly increased, and such diseases have now been described and studied in a large number of orders of flowering plants, as well as in Cycads and Pinaceæ. The first part of this work deals with the general relations of the bacteria to the host plants, the second part with methods of culture and technique—a field in which the author is a past master—while the main body of the work is devoted to a detailed study of fourteen selected diseases, including *Bacterium campestre*, the cause of black-rot in Crucifers; *Bacillus phytophthorus*, which produces a black-rot in potatoes; *B. amylovorus*, and *Bacterium tumefaciens*, the cause of crown-gall in many plants. The last-named produces tumours in the plant which the author, in his pioneer studies of cross-inoculation, has not hesitated to compare with cancer. The work is admirably illustrated, and will be of great service to all who are interested in plant pathology. R. R. G.

Highways and Byways in Northumbria. By P. Anderson Graham. Pp. xviii+380. (London: Macmillan and Co., Ltd., 1920.) 7*s.* 6*d.* net.

THIS volume is mainly of architectural and archæological interest, and should prove a delightful companion to all whose interests lie in those directions. Mr. Graham takes his readers up and down the country, missing little that is quaint or has the romance of age. Naturally, he has much to say about the Roman wall and Holy Island, but the book is well balanced, and shows no undue favour to any part of the county. There is some account of the wild cattle of Chillingham, and a few notes on the bird life of the Farne Islands, but otherwise natural history comes in for little notice. More than a hundred sketches by the late Mr. Hugh Thomson add to the charm of the book.

Botany with Agricultural Applications. By Prof. J. N. Martin. Second edition, revised. Pp. xii+604. (New York: John Wiley and Sons, Inc.; London: Chapman and Hall, Ltd., 1920.) 21*s.* net.

ALTHOUGH another introductory botanical text-book might seem superfluous, yet this one, written especially for agricultural students, has certain features which justify its existence. The first part is concerned with the structure and physiology of seed plants, and a useful feature is the almost exclusive use of plants which are of interest particularly to the farmer in the Middle Western States, where the work was written. The second part takes up all the plant groups, and again plants of economic interest are introduced in many instances. The final chapters form an elementary introduction to the subjects of ecology, variation, heredity, and evolution in plants. Many new drawings are introduced, and although they vary much in quality, some of them will form a useful addition to plant illustrations.

Phytoplankton of the Inland Lakes of Wisconsin. Part i. By G. M. Smith. (Wis. Geol. and Nat. Hist. Survey, Bull. No. 57, Scientific Series, No. 12.) Pp. iii+243+51 plates. (Madison, Wis., 1920.)

THIS work is a systematic treatment of the Myxophyceæ, Phæophyceæ, Heterokontæ, and the Chlorophyceæ, excluding the Desmidiaceæ, of the region mentioned. The large number of forms considered are well illustrated with line drawings, and several new genera and species are described.

Letters to the Editor.

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

Light and Electrons.

REFERRING to a paper of mine in the current April issue of the *Philosophical Magazine*, in which a possible generation of electrons is suggested, and assuming that the result obtained by the late Lord Rayleigh (*Phil. Mag.*, August, 1916) for the area of wave-front which can be tapped and have its energy extracted by an infinitely small resonator, viz. something comparable with λ^2/π, holds generally to a fair degree of approximation, the length of a ray of terrestrial sunlight sufficient for an electron is given by $l\lambda^2/\pi = 0{\cdot}01$ c.c., or $l = 3 \times 10^7$ cm. for $\lambda = 3 \times 10^{-5}$, which would pass in the thousandth of a second.

Perhaps Sir W. H. Bragg may be tempted to try whether corpuscles are still projected by radiation reduced in intensity, not continuously but intermittently, by a revolving slit. If there is a critical length of effective beam, it would be instructive to know it.

OLIVER LODGE.

April 3.

Relativity and the Velocity of Light.

As neither Sir Oliver Lodge (NATURE, March 17) nor Mr. Bartrum (March 31) appears to find my explanation very satisfying, may I further explain as briefly as may be how and why I consider that the Majorana experiments add valuable new knowledge to that previously yielded by the classical Michelson-Morley experiment?

In discussing this and similar questions there are two distinct avenues of approach. We may think and write in terms of the old-fashioned fixed æther, the FitzGerald-Lorentz contraction, and absolute time, or alternatively in terms of the four-dimensional continuum. But if Mr. Bartrum and myself, or either of us, embark on an argument in which we mix indiscriminately the conceptions of the two schemes, there is bound to be confusion and either apparent or real contradiction. I prefaced my mathematical argument (March 10) by the stipulation that we should "consider the problem in terms of an æther and a FitzGerald-Lorentz contraction." Mr. Bartrum, approaching the problem apparently in terms of the four-dimensional continuum, objects that I have not distinguished between a source and mirror "moving relatively to the observer" and the same appliances "at rest with the observer." My answer is that so long as I argue, as I was doing, in terms of an æther, etc., the distinction does not arise. The observer becomes immaterial, and may move or not as he pleases; the æther provides a fixed standard of measurement. My symbols u, v, α, β referred to velocities measured, in terms of unit-lengths mapped out in a supposed fixed æther, by synchronised clocks ticking absolute seconds. If we argue in terms of the old æther conceptions, such measurements are theoretically possible, although, of course, the relativist maintains that they are in practice impossible. If my argument is read throughout in terms of these conceptions, I believe it will be found consistent, and I hope it will be found convincing.

The problem can, of course, alternatively be stated and discussed in the language of relativity. The light-source of the Michelson-Morley experiment has a world-line AB and the mirror has a parallel world-line PQ. A light signal is sent from source to mirror and back to the source. Its emission from the source is represented by a point A on the world-line AB, its reflection by a point C on the world-line PQ, and its return to the source by a second point B on the original world-line AB from which it started. The Michelson-Morley experiment gives us knowledge of the absolute interval AB, but none at all of the position of C on the world-line PQ of the mirror. So far as the Michelson-Morley experiment alone is concerned, the directions of AC, CB in the continuum are unknown. My contention is that the experiments of Majorana fix these directions for us, and so fix the position of C.

In the problem under discussion the light signal moves entirely in a two-dimensional section of the continuum, namely, the plane containing the parallel world-lines AB and PCQ. Let us take x and ct for co-ordinates (not necessarily orthogonal) in this plane. These refer to a particular observer, and a second observer will use different axes and co-ordinates, the latter being related to x and ct by the ordinary Lorentz transformation. Because the equation $x^2 - c^2t^2 = 0$ is invariant for the Lorentz transformation, the pair of lines $x = \pm ct$ have the very special property that for every observer, no matter what his velocity of motion, they form the internal and external bisectors of the angle formed by his axes of length and time. A world-line parallel to either of these directions represents for each and every observer motion with the same velocity c, which each observer independently will call the velocity of light. Now Majorana's experiment showed in effect that the direction in the continuum of the world-line of light from a source or mirror moving relative to him was the same as that of the world-line of light from a source or mirror at rest relative to him. The directions were obtained by measuring their inclinations to the experimenter's special axes of time and space, but when the directions have been shown to be the same the observer's axes fade from view and the identity of direction becomes absolute. It now follows that the rays of light in a Michelson-Morley apparatus, moving with any velocity whatever, have world-lines parallel to these two special directions. Or, to come back to common language, both the outgoing and returning signals move with the velocity of light. The conclusion is, of course, subject to the limitations of Majorana's experiments—limitations which, it ought to be added, the author himself states with scrupulous care.

J. H. JEANS.

April 2.

A Difficulty in Einstein's Gravitational Theory.

IN order to obtain from Schwarzschild's equation

$$ds^2 = -\gamma^{-1}\delta r^2 - r^2\delta\theta^2 - r^2\sin^2\theta\delta\phi^2 + \gamma\delta t^2 \quad . \quad (1)$$

an expression for the gravitational deflection of light which is independent of direction, it is necessary, as pointed out by Prof. Anderson, to make the substitution $r = (2r_1 + m)^2/4r_1$, which gives

$$ds^2 = -\left(\frac{2r_1+m}{2r_1}\right)^4\left\{\delta r_1^2 + r_1^2\delta\theta^2 + r_1^2\sin^2\theta\delta\phi^2\right\} + \left(\frac{2r_1-m}{2r_1+m}\right)^2\delta t^2 \quad . \quad (2)$$

and for the velocity of light

$$\frac{2r_1-m}{2r_1+m}\left(\frac{2r_1}{2r_1+m}\right)^2.$$

Here r_1 is now regarded as the radius vector. The transformation, although it gives two values of r_1, can

in no way alter the apsidal progress determined by Einstein from (1). The "measuring rod," however, does not now alter in length for different orientations, which is a somewhat comforting result.

The gravitational potentials in (2) are not additive, and Prof. Eddington ("Report on Relativity," p. 59) proposes to get over the difficulty by neglecting squares of m/r_1 in (2), which would then give

$$ds^2 = -\left(1+\frac{2m}{r_1}\right)\left\{\delta r_1^2 + r_1^2\delta\theta^2 + r_1^2\sin^2\theta\delta\phi^2\right\} + \left(1-\frac{2m}{r_1}\right)\delta t^2 \quad . \quad (3)$$

so that the contributions of potential would be additive.

Unfortunately, neglecting squares of m leads to a change in the apsidal progress, and it appears that treating (3) as exact gives 4/3 times the apsidal progress calculated from (1). We cannot, therefore, neglect squares of m at an early stage without violating the observations which (1) or (2) was called in to explain. The adjustment is, in fact, so delicate in (1) that we may not approximate at all until the end of the calculation.

What, then, are the exact equations for two finite bodies m_1 and m_2, both mobile? Here we are not permitted to superpose any velocity which would reduce one of the bodies to rest. GEORGE W. WALKER.

Portsmouth, March 30.

I AM indebted to the Editor's courtesy for the opportunity to comment on the foregoing letter. In deciding whether an approximation is allowable, regard must be had to the problem to which it is to be applied. It is true that equation (3) neglects a term of importance in the motion of the apse, and is therefore not valid for the problem of the perihelion of Mercury; but there may be other problems for which the approximation can be justified. One of these is the calculation of the $G_{\mu\nu}$ for continuous matter on p. 59 of my "Report." My proof starts with the approximate calculation of the line-element in a sphere which is ultimately made *infinitely small*; I think that the justification of the neglect of m^2, given in § 36 is correct, though the argument is intricate, and I would welcome detailed criticism. But, for example, my formulæ are not sufficiently accurate to give the rotation of the apse-line of a particle moving freely through a diffuse spherical nebula.

Dr. Walker goes on to ask: What are the exact equations for two particles moving freely? He who can supply the answer will have solved one of the biggest mathematical problems of the theory. The problem of two bodies in Einstein's theory is an outstanding challenge, like the problem of three bodies in Newton's theory. The solution will give ds^2 *throughout all time*, and therefore incidentally the tracks of the particles which are the singularities of the solution. I am not satisfied that it has yet been proved that the tracks are periodic—that there is no dissipation of energy by the gravitational waves set up.

A. S. EDDINGTON.

Observatory, Cambridge, April 2.

Atomic Structure.

MY letter in NATURE of November 25 last has served a useful purpose by evoking the very interesting account of his new line of work which Prof. Bohr has given in the issue of March 24. But since he did not deal, and scarcely professed to deal, with my suggestion, perhaps I may try to make clearer what that suggestion is.

The success of Prof. Bohr's theory, and of Sommerfeld's developments of it, is sufficient evidence of the truth of its general assumptions, and therefore of the reality of the ideas on which it is based. "Fixed electron" theories have nothing to set against (*e.g.*) the weighing of the helium atom by means of its spectrum or the detailed prediction of the structure of the L-rays; moreover, those theories, as Prof. Bohr points out, are empirical and based on no general principle. But the superiority of the "orbital electrons" theory does not alter the fact that there are things which it is very difficult to reconcile with the view that the stationary states of an atom consist of electronic orbits of which the dimensions are comparable with 1 Å., and of which the periods are comparable with 10^{-16} sec.

The suggestion that I made is that, by means of a generalised principle of correspondence, the distinction between moving and fixed electrons might be abolished and the conceptions that have proved so fruitful in explaining spectra made available immediately for explaining also such things (if there are such things) as are only explicable by fixed electrons. Thus the distinction would be abolished if "time" had no meaning inside the atom. For the difference between electrons following an orbit and electrons fixed at points on that orbit can only be expressed in terms of temporal conceptions; if all such conceptions are totally invalid in dealing with problems of atomic structure the distinction vanishes.

Expressed in the very crude form demanded by brevity, such a suggestion will doubtless be deemed unacceptable, or even unintelligible. Here I would only mention two considerations, one special and the other general, that have led to it. First, very difficult questions can be asked (and have been asked by Stark) concerning what happens in the interval during which an atom passes from one stationary state to another, and during which it emits or absorbs homogeneous radiation. We might deny that such questions have any meaning, because there is no such thing as an interval during which the transition takes place. It is not merely that the interval is infinitesimally small or zero; it is that the conception of a time interval is not permissible when we are considering the process which we observe as change of radiant energy and explain as change of atomic structure. Secondly, the conception of continuity is very closely associated with that of time. The assumption of the older physics, that all fundamental theories (usually mistermed "laws") were to be expressed by means of differential equations, involved in all but a few instances (which can be explained away) that the variable with respect to which the integration of the equations was to be made, in order to compare the theory with experiment, was the "time." Now it is the characteristic and essential feature of Prof. Bohr's theory that the emission and absorption of homogeneous radiation, which is the outward expression of change of atomic state, is not to be described by a differential equation. Consistency seems to compel us to conclude that it is also not to be described ultimately in terms of conceptions in which "time" plays any part.

NORMAN R. CAMPBELL.

British Plants Available as a Source of Industrial Alcohol.

THE production of cheap alcohol for industrial purposes is a subject much under discussion at the present time, and in considering the question of available materials from which it could be obtained the following notes may be of interest.

Apart from the mangel and sugar-beet, it is im-

portant to observe to what a large extent sugar is present as a reserve material in many of the ordinary root crops such as the turnip, swede, etc., and in the other varieties of the genus Brassica. It is not generally recognised how much of the nutritive value of cauliflowers, cabbages, brussels-sprouts, etc., is due to the large amount of reserve sugar which these plants contain, and this sugar is not present in the edible parts only, but more particularly in the stalk and petioles, which are extensively used as storage organs.

No quantitative analysis has been undertaken to determine the amount of sugar present in these organs, but a qualitative test with Fehling's solution indicates that the amount of sugar must be considerable. This sugar is directly fermentable by yeast, no hydrolysation being required. If the stem or petiole is crushed under water and boiled to ensure the complete liberation of the cell-sap, and yeast added at a convenient temperature, alcohol can readily be detected by the iodoform test. By the same process it is easily demonstrated that fermentable sugar is also present in the petioles of the swede and turnip.

It is suggested that in the many thousands of tons of cabbage stalks and petioles and of the petioles of the turnips and swedes, at present a by-product of farms and market-gardens, we have a suitable and readily available material which could be collected and utilised as a source of industrial alcohol.

We learn from the returns of the Ministry of Agriculture for 1919 that more than 72,000 acres were devoted to the cultivation of cabbage, sprouts, cauliflower, and broccoli; and upon a single farm in the North of England as many as 40,000 cabbages were grown in the year 1920. The returns of the Ministry of Agriculture estimate that 14,200,000 tons of turnips and swedes were grown in 1920. When these crops are harvested an enormous residue must be annually wasted which would be capable of producing a very large quantity of fermentable sugar. The amount, of course, would fall far short of commercial requirements, but it would be by no means negligible, and might materially add to our resources for the production of alcohol in this country, reducing the importation of raw substances for that purpose, and possibly to some extent also the importation of petrol.

Moreover, many other plants could also be utilised. Comparatively little attention seems, at present, to be given to our native plants which store up large quantities of starch or sugar as reserves. In the Gramineæ sugar is largely employed as a reserve material, and it is not surprising to find that the rhizomes of the couch-grass (*Agropyron repens*) and the uni-internodal corms of the bulbous oat-grass (*Arrhenatherum avenaceum*) possess a large sugar-content, the maximum amount being present in autumn or early winter. This sugar varies with the season of the year; in autumn it is chiefly cane-sugar, which on the approach of spring is converted into glucose previous to being utilised by the plant. In either case the reserve sugar in these plants is fermentable by yeast without any further preparation. Both these grasses are pernicious weeds, and large quantities are annually eradicated from the land.

Another source of raw material worth mentioning for the production of alcohol is the starch which occurs so abundantly in the rhizome of the bracken-fern (*Pteris aquilina*). Although it would seem that this carbohydrate cannot be rendered available for human food, further research may indicate a method for its profitable utilisation for power alcohol, and it may be pointed out that a natural process of hydrolysation would take place in the spring as a necessary part of the plant metabolism. At the present time there are many hundreds of acres covered with bracken which might with advantage be reclaimed for agricultural purposes, and the first stage in this reclamation might well be the eradication of the Pteris rhizome for utilisation in the production of alcohol.

Investigations at the present time tend largely to concentrate upon synthetic processes, or to the exploration of new plants which could be grown for the production of alcohol, or to the extension for this purpose of the acreage of food-crops such as potato, beet, etc. The object of this letter is to direct attention to the enormous amount of suitable materials ready to hand and at present overlooked and unutilised in our own country. The plants already enumerated could be added to (*e.g.* the roots of the spear thistle, *Carduus lanceolatus*, contain an abundance of inulin), and no doubt systematic search would reveal many more which could be exploited for their unsuspected and valuable carbohydrate reserves. The amount in the aggregate would be very considerable, the cost of collection and manufacture would be relatively small, and an asset might thus be secured which would help towards the solution of a pressing industrial problem.

M. C. POTTER.

Armstrong College, Newcastle-upon-Tyne,
March 9.

Relativity, Space, and Ultimate Reality.

As one who has studied very carefully, so far as his mathematics will take him, the various points of view brought together in NATURE of February 17 by the great exponents of the doctrine of relativity, may I have space to express the conviction that the pressing need at the present stage is a clarified conception about the nature of pure space in relation to objectivity or subjectivity? Let me define the contention.

There is little difficulty now about the modest and reasonable earlier demands of the relativists that spatial directions are significant only in relation to matter, that time cannot be dissociated from space, that we have no criterion of absolute motion, and the like. According to these representations space is contingent upon the existence of matter and energy, so that: extinguish the physical universe, and space as an objective reality vanishes too. But the relativists seem now to be taking the opposite point of view, and in the attempt, so powerfully controverted by Sir Oliver Lodge, to geometrise physics they indicate that space, instead of being conditioned by matter, is itself the foundation of matter and physical forces—which are merely the "outcome of the geometry of the universe," as Prof. Weyl puts it. Herein there seems to lie a discrepancy in the relativist position which needs clearing up.

Now I take it that the following propositions will be conceded:—(1) The geometries of Riemann in any number of dimensions are in themselves purely mathematical conceptions; (2) the particular geometry which fits our actual physical universe constitutes a space-time system of four dimensions; and (3) our sole experience concerning the objectivity of space is derived from the property of matter which we call *extension*, involving the notion of distances. But where are we if we discard a universal connecting medium, a sub-material "æther" connecting all bodies in the universe as a necessary physical condition of every gravitational and electromagnetic field? Banish the æther, and the only physical reality between the members of the solar system is light occupying otherwise "empty space"—a conception difficult to entertain and to reconcile with the relativity of pure

space. A connecting æther, sharing with atomic matter the property of extension, does appear to be necessary to render distance and space between the heavenly bodies objective reality. The æther can, apparently, be reconciled with the Einstein equations.

Relativity has, at any rate, rendered the inestimable intellectual service of bringing physics into contact with metaphysics. In respect to questions of ultimate reality we do appear to some extent to be drifting into a position of philosophical idealism. It is evidently in relation to mind that the physical universe acquires its fullness and richness, and certain qualities of matter can scarcely be thought of as standing alone apart from mind. A case in point is beauty, a quality which was referred to by Sir Oliver Lodge in NATURE of February 17. Beauty differs from the grosser qualities of matter in that its objective foundations, namely, various harmonious dispositions and groupings of parts, are only incidentally, not directly, the expression of physical forces. Consequently, beauty as beauty is relative to mind, a subjective reality, and the sense of it in man a faculty of the spirit.

L. C. W. BONACINA.

27 Tanza Road, Hampstead, N.W.3,
March 20.

Molecular Structure and Energy.

IN some recent communications on the structure of molecules based on the Lewis-Langmuir theory the question of the energy of molecules seems to have been left out of account. The models for halogen molecules proposed by Prof. A. O. Rankine (Proc. Roy. Soc., 1921, February), for example, whilst they agree well with the viscosity data, are not in agreement with the specific heats of the gases. The models of the nitrogen and nitric oxide molecules proposed by Langmuir, and those of the carbon dioxide and nitrous oxide molecules proposed by Rankine, are also at variance with the specific heats of these gases.

A molecule composed of atoms rigidly attached in line should have a ratio of specific heats of 1·400. Carbon dioxide and nitrous oxide are assumed to have three atoms in line. The value of c_p/c_v for these gases is of the order of 1·300. If nitrogen consisted of molecules as pictured by Langmuir, *i.e.* having two nuclei inside one perfect sphere, the ratio of specific heats would be 1·667. The value of c_p/c_v for nitrogen is 1·40.

I intend to develop this matter in a little more detail, but it seems worth while pointing out that a discrepancy appears to exist between the facts and the latest theory of atomic and molecular structure, at least as I understand it.

J. R. PARTINGTON.

East London College, Mile End Road, E.1,
March 26.

Oceanographic Research.

ONE can cordially agree with Dr. Annandale and Major Sewell as to the importance of all such intensive local work as they refer to in their letter in NATURE of March 31, p. 139; but is it oceanography?

"The investigation of the fauna of the Chilka Lake . . . a minute, almost isolated, fragment of the ocean" (to use their own words) seems exactly the type of excellent marine biological investigation which has been carried on by many institutions, committees, and individuals in various parts of the world (not the British Empire alone) in the past. Long may such continuous local work flourish and become enlarged in scope by the addition of those hydrographical and biochemical researches which should enable us to understand better the causes of the observed faunistic distribution.

But these intensive studies of relatively small areas can scarcely be said to touch the great problems of the wide oceans as a whole, and cannot be regarded as an alternative to occasional more general expeditions making traverses of large areas and deep seas. The British Empire has interests beyond the coastal waters of the continents. By all means let us encourage local and minutely detailed work, and also advocate, when the time is opportune, that wider investigation of the open oceans which, in the opinion of many of us, might add much knowledge in various branches of science. W. A. HERDMAN.

Biological Station, Port Erin, April 4.

Why do Worms Die?

THE middle of March saw the slaughter of millions of worms. Morning by morning the pavements, roads, and pathways were strewn with the dead. Great and small, young and old, of every known species and genus, from Lumbricus to Dendrobæna, lay prone. Even if they were able to reach the pasture, lawn, or grass-plot alive, they had not the power to burrow and recuperate. What caused their death? I have asked the question for thirty years, but have never found the answer.

Four main theories have been advanced. They are killed, folks say, by (1) parasites, (2) cold, (3) rain, or (4) poison.

The first theory has long been maintained. It was held by Darwin ("Vegetable Mould," p. 14), who said that worms were affected by a parasitic fly. The parasites of worms are of very many kinds, but I have collected large numbers of dead and dying worms and examined them with care, yet have found nothing abnormal in this direction. Since worms are cold-blooded creatures they can endure a low temperature without suffering. Moreover, they are often found dead in the spring when the temperature recorded for the night has not been below 34°.

Darwin (p. 125) speaks of Mr. Scott's surprise when told how long they could endure being submerged, "as he did not know how long worms could survive beneath water." It is practically impossible to drown them in a brief time, such as is allowed for their slaughter day by day at this season of the year. And yet in some way showery weather seems to be essential. After March 21 no showers fell at night, and no worms lay dead in the morning.

There remains the miasma theory. "Nature uses poison gas," says the speculator. This theory would seem good if worms were found dead on tarmac roads, but not on gravel paths, and if they died in a similar way all the year round. But such is not the case. Thus every theory seems to fail.

The worms appear to be paralysed. They crawl at first with vigour, then the rate of progress declines. Eventually they cease to move, die, swell in places or along the whole length of the body, and ultimately become the prey of various scavengers, but are totally ignored by the birds.

It seems clear that the conditions required are warm days and evenings, moisture in the way of showers during the night and early morning, and then a cold snap, but not necessarily a frost. Does the combination of cold and moisture paralyse them? Are the dorsal pores choked? Or are they exhausted in their efforts to regain their closed burrows? At present I am unable to carry out the research and experiments upon which alone a satisfactory judgment can be based. Has anyone ever found the answer? HILDERIC FRIEND.

"Cathay," Solihull.

Stellar Magnitudes and their Determination.[1]

By H. SPENCER JONES, Chief Assistant, The Royal Observatory, Greenwich.

II.—APPARENT MAGNITUDES: (*b*) PHOTOGRAPHIC.

WITH the application of photography to astronomy it was inevitable that attempts should be made to determine apparent magnitudes by photography. Visual observations are slow, for every star must be compared individually, and the telescope reset for each. Photography effects a great economy in observing time at the telescope, for when a plate is secured its measurement may be undertaken at any convenient time. The photographic plate, however, is sensitive to a different region of the spectrum from the human eye; if a blue and a red star appear of equal brightness to the eye, the former will be recorded as much the brighter by the photographic plate. The photographic and visual scales of magnitude will therefore not agree with one another. The difference, photographic *minus* visual magnitude, for any star is called the "colour-index" of that star, providing as it does a measure of the colour of the star; the redder the star, the larger is its colour-index.

The determination of photographic magnitudes is based upon the two following conventions: (i) the light ratio shall be the same as that adopted for visual magnitudes, its logarithm being, therefore, 0·40; (ii) for stars the spectra of which are of the type Ao in the Harvard classification (*i.e.* in which the most conspicuous feature is the Balmer series of hydrogen lines), the photographic and visual magnitudes shall be equal. If this holds for stars of, say, the 6th magnitude, it will hold also for stars of all magnitudes, by (i). Stars which are bluer than type Ao have small negative colour-indices; those which are redder have positive colour-indices, the values for the reddest stars being larger than two magnitudes.

The accurate determination of photographic magnitudes is a problem which is much more complicated than it appears upon the surface, and beset with many difficulties. It consists essentially of two distinct problems: the absolute determination of the magnitudes of a suitably chosen series of stars, and the extension of this series to determine the magnitudes of other stars by comparative methods. Although much work has been done at Harvard, Mount Wilson, Greenwich, and elsewhere, there remain discordances which require further investigation before photographic photometry can be regarded as having been placed upon a definite and satisfactory basis.

The area around the North Pole has been chosen in the northern hemisphere as the most suitable area for the absolute determinations, as it is always available for use for comparative methods. A sequence of stars has been chosen by the Harvard observers, called the "north polar sequence," which are graded in magnitude so as to provide the necessary basis for comparison, and the magnitudes of these stars have been carefully determined by the use of various methods. The difficulty of the absolute determination of these magnitudes is increased by the complication introduced by the law of photographic action. It has been found that, for a given light intensity, I, the photographic effect produced does not increase uniformly with the time, so that the same photographic effect is not obtained by, say, doubling the intensity and halving the time of exposure. In fact, the relationship between the intensity and the time of exposure required to produce a given photographic effect is of the nature $I^q t$=a constant, where q is a constant for any given type of plate, but has different values for different types, although averaging somewhat about 0·8. Now most of the methods of determining absolute photographic magnitudes depend upon successive exposures given on the same plate, some means being employed to reduce the intensities during one of the exposures. It is clear that, for all photometric work, the times of the two series of exposures must be exactly equal, and then the comparison of the images obtained from the two exposures only involves the assumption that the intensities which in equal times produce equal photographic effects must be equal.

If, then, the photographic effects produced by a series of stars in the first exposure are denoted by:—

$$i_1, i_2, \ldots, i_s, i_{s+1}, \ldots i_n,$$

and by the same stars in an equal exposure, in which the brightness has been reduced in a proportion equal to a difference of Δm in magnitudes, are:—

$$i'_1, i'_2, \ldots, i'_r, i'_{r+1}, \ldots i'_n,$$

then, if $i_s = i'_r$, it follows that the magnitudes of stars r and s differ by Δm. In this way, differences of magnitude are determined, as in the case of visual observations with a photometer. The zero of the magnitudes must be chosen in accordance with the convention referred to above.

In practice, of course, it rarely happens that two stars can be found the photographic intensities of which in the two cases are exactly equal. The procedure usually adopted is to estimate the photographic effects against an arbitrary scale, and then to use the known fact that the two images of any one star correspond to a magnitude difference, Δm, in order to determine the values of the scale intervals. The magnitude of every star can then be read off.

Various devices have been used to reduce the intensities by a known amount. One method, which has been extensively used at Greenwich, is

[1] Continued from p. 146.

to place over the object glass of the telescope a coarse grating of parallel wires; from the dimensions of the grating the magnitude difference between the principal and first diffracted image can be calculated. Thus one of the Greenwich gratings, illustrated in Fig. 3, which has wires of diameter 1·72 mm., and a total grating interval of 7·0 mm., produces a magnitude difference of 2·66*m*. An enlargement of a portion of a photograph obtained by this grating is shown in Fig. 4.[2] It will be seen that the first diffracted images are round, but that the second diffracted images are elongated by dispersion, and not suitable for comparison. The use of the grating has the advantage that all the information required can be obtained from one exposure, the principal and diffracted images corresponding to two series of images differing by a known magnitude. Any possibility of

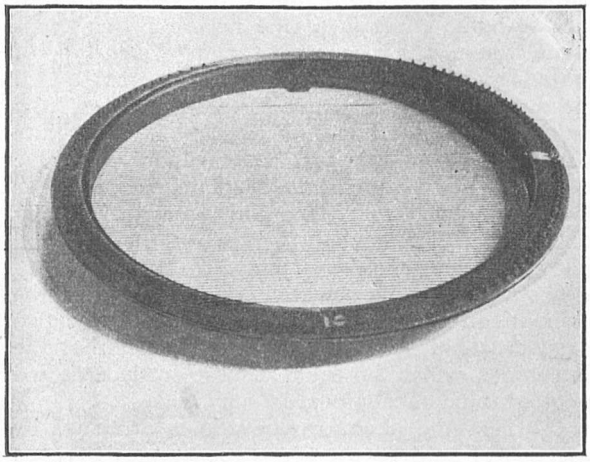

FIG. 3.—Diffraction grating used in stellar photometry.

error, which might otherwise be introduced owing to a change in atmospheric conditions between the exposures, is thus avoided. Other methods which have been employed, principally at Harvard and Mount Wilson, consist in using wire-gauze screens, or rotating sectors, the reduction in luminosity being measured by a photometer in the laboratory in the first case, and calculated in the second case, or in the reduction of the aperture by circular diaphragms. Although the latter method changes the diffraction pattern of the images, no disturbing effects seem thereby to be produced; it is, however, objectionable in the case of a refractor, as the light passes through different parts of the object glass in the two cases, and the difference in absorption introduces errors. Other methods have been employed, but less frequently than those just referred to. It is not convenient to reduce the magnitude too much at one step, as errors are liable to arise. A reduction of about 5*m* is a practicable limit. If stars of a wide range of brightness need to be compared, it is preferable to make the comparison by two steps.

The diameters of the star images increase with the length of exposure. The images are compared with a scale obtained by giving exposures, preferably with the same instrument, on a real or artificial star, the length of the exposures being so graduated that the difference in magnitude between consecutive images is very nearly constant. The sizes of the star images are compared with those of the scale, interpolation to tenths being made between the scale images. The comparison becomes difficult for very bright or very faint stars, so that it is customary to measure only those images which come within a certain interval of the scale; for the brighter and fainter

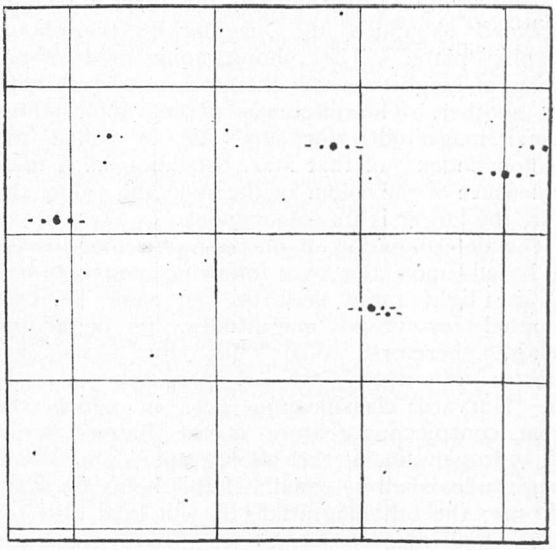

FIG. 4.—Portion of photograph obtained with diffraction grating.

stars, shorter and longer exposures respectively must be given. Corrections have to be determined and applied for the distance of the star image from the centre of the plate, and for atmospheric absorption, the latter as in the case of visual photometry. The former correction arises from the curvature of the field; if focussed exactly at the centre, the edges of the plate are not quite in focus, so affecting the size of the images. It is convenient to make the focus come somewhere between the centre and the edge of the plate.

In this way the magnitudes of the stars comprising the north polar sequence have been determined. There is a good accordance between the several determinations of the magnitudes in the range 10*m*–15*m*, but in spite of the extensive investigations which have been made, there remain systematic differences between the magnitudes obtained for the brighter stars at Mount Wilson and Harvard which exceed 0·25*m*, and this discordance illustrates how much more

[2] On account of the difficulty o. reproducing satisfactorily faint star mages, Figs. 4 and 5 are not actual reproductions of photographs, but are drawn from the photographs. For this reason some of the images do not appear as true discs.

difficult is the absolute determination of apparent magnitudes than might be gathered from the above brief account of the theory.

The magnitudes of stars in other areas are based upon those of the north polar sequence. The procedure involves photographing the area in question and the pole area upon the same plate, giving the same exposures, and then comparing the two sets of magnitudes against an arbitrary scale, using the known magnitudes of the pole stars to standardise the scale. Actually, it is customary to expose on the pole, then to give two exposures on the field, followed by another exposure on the pole. In this way the effect of any uniformly progressive change in the sky during the time occupied in taking the plate is eliminated. A portion of a photograph showing a comparison of the polar area with another area is reproduced in Fig. 5. In this figure the pole stars can be distinguished by the fact that the displacement between the two images is not parallel

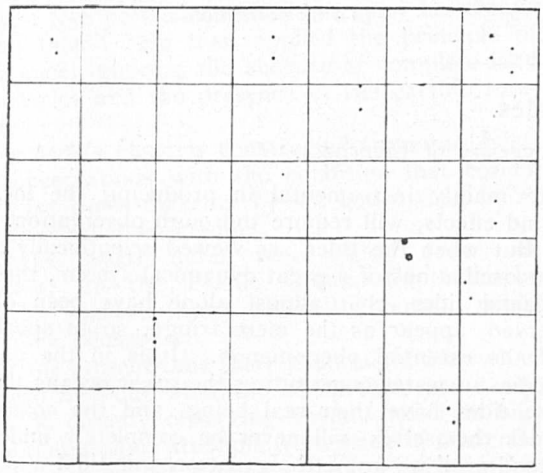

FIG. 5.—Portion of photometry plate showing pole and field stars.

to a *réseau* line. An alternative method of measurement is to measure the diameters of the star images in a micrometer. For a wide range of magnitude, the relationship $m = a + b\sqrt{d}$, in which a, b are constants, and d is the diameter of the image of a star of magnitude m, is found to hold. The constants a and b can be determined by a least squares solution, using the data obtained from the stars of known magnitude.

A slightly different method of procedure is to take photographs at some distance out of focus, the plate meanwhile being given slight periodic motions in two perpendicular directions by means of a device invented by Schwarzschild, and called by him a "Schraffierkassette." The central portion of the image so obtained is uniformly grey; the plate is measured in a comparator, the central portion of the image being seen surrounded by a grey field, the density of which can be varied, produced by a plate with a uniformly graduated density. The position of the latter is varied until the tint of the star image matches that of the surrounding field. The readings can be standardised by stars of known magnitude. This method possesses the advantage that it is not appreciably affected by bad definition, whereas when images in focus are being dealt with, bad definition causes woolly edges, and the images are not then exactly comparable with those of the scale.

Either a reflecting or a refracting telescope may be employed for the determination of photographic magnitudes. Owing to the absorption produced by the object glass of a refractor, there is a slight relative difference, depending upon the colour of the star, between the magnitudes obtained by the two types of instrument. The differences in magnitude can be expressed as a linear function of the colour-index, and the constants of the relationship require to be determined for each instrument from a comparison of the results obtained from white and red stars. The phenomenon becomes of some importance when the scale of magnitudes is extended to faint stars, for it has been shown by Seares that the faint stars are, on the average, considerably redder than the brighter stars. The effect of this will be to give systematic errors in the case of a refractor equivalent to the errors that would be introduced by the use of an incorrect light ratio.

It is of interest to compare the numbers of the brightest stars down to a limiting magnitude of $7{\cdot}0m$ in the case of visual magnitudes with the corresponding numbers in the case of photographic magnitudes. The visual estimates were made at Harvard, the photographic at Greenwich.

Total Number of Stars to Various Limits of Magnitude.

	Visual	Photographic
Brighter than 1·0	11	11
,, ,, 2·0	38	41
,, ,, 3·0	111	138
,, ,, 4·0	300	454
,, ,, 5·0	950	1,480
,, ,, 6·0	3,150	4,750
,, ,, 7·0	9,810	14,960

The brightest star, both visually and photographically, is Sirius; its spectrum is of type Ao, so that both visual and photographic magnitudes are $-1{\cdot}6m$.

The economy in observing time effected by the application of photography to the determination of magnitudes has resulted in visual magnitudes being determined by photographic methods. This is effected by the use of isochromatic plates in conjunction with a yellow filter, which is found by experiment to give a spectral-intensity curve similar to that of the normal human eye. This can be tested by means of the magnitudes determined visually with a photometer, and the visual-scale can then be continued to magnitudes much fainter than those which have been determined visually. For distinction, it is customary to call the magnitudes so determined "photo-visual" magnitudes; photo-visual magnitudes of the stars of the north polar sequence have been determined at Mount Wilson down to a limit of $18m$, much

fainter than would ever have been possible by ordinary visual methods.

The photographic and visual or photo-visual magnitudes of a star having been observed, the "colour-index" is at once obtained. There is a marked dependence of the colour-index upon the spectral type of the star. The basis of the classification of the spectra of stars adopted at Harvard, and now universally accepted, was entirely independent of magnitude or colour considerations, and depended solely upon the type of spectrum. The spectra of the types B, A, F, G, K, M were found to show in this order a progressive change from bright-line to absorption spectra, and the order is intimately bound up with the problem of stellar evolution, and also with the temperature of the stars. The colour-indices found in three separate investigations for stars with spectra of different types are given in the table, together with the temperature of the stars, derived by Russell on the hypothesis that the stars radiate as black bodies. In accordance with the convention on which photographic magnitudes are based, the colour-index for type Ao is zero in each investigation.

Colour-Index.

Spectrum	King	Parkhurst	Schwarzschild	Temperature
				°
Bo	−0·32	—	—	20,000
B_5	−0·17	−0·21	−0·20	14,000
Ao	0·00	0·00	0·00	11,000
A_5	+0·19	+0·23	+0·20	9,000
Fo	0·30	0·43	0·40	7,500
F_5	0·52	0·65	0·60	6,000
Go	0·71	0·86	0·84	5,000
G_5	0·90	1·07	1·10	4,500
Ko	1·16	1·30	1·35	4,200
K_5	1·62	1·51	1·80	3,200
M	1·62	1·68	—	3,100
N	—	2·50	—	2,300

It will be seen that the colour-index increases almost uniformly from class to class, and that when either the photographic or visual magnitude, and either the colour-index or the spectral type, are given, it is possible to determine the remaining data with very little uncertainty.

(To be continued.)

Ocean Tides.

By PROF. J. PROUDMAN, University of Liverpool.

THE tides of the oceans form the most magnificent dynamical phenomenon of our planet, and yet we are extremely ignorant of even their main characteristics. It is only in the immediate neighbourhood of land that they become directly observable, and it is practically only here that they have hitherto been observed.

Much has been done in the way of recording coastal tides and in analysing the records obtained, yet very much more remains to be done even for the purpose of preparing accurate commercial predictions. In this connection the most urgent need is the study of the meteorological effects. Owing to these effects, the tide in a harbour on any day may be several feet different from that due to astronomical causes, which alone appears in the tables of predictions. Now this is of the very gravest concern to harbour authorities, for, in docking a large vessel, to get less water than was expected may be very serious, while to refrain needlessly from docking through fear of this possibility is a fruitful source of delay and expense. And this is merely an instance.

The up-and-down motion of the water-surface is accompanied by oscillating currents. Much rough information is in existence concerning the nature of these currents near land, having been gathered chiefly by naval authorities, as it is of the utmost importance in navigation. But the number of places at which accurate observations of currents have been made with modern instruments is extremely small. No such observations are on record, for example, for the Irish Sea. When the problem of predicting the meteorological effects comes to be tackled in a way likely to lead to success, these shallow-water currents, which are mainly instrumental in producing the local wind effects, will require thorough observation.

But when the tides are viewed scientifically as the oscillations of a great dynamical system, these coastal tides, that almost alone have been observed, appear as the mere fringe, so to speak, of the essential phenomenon. It is in the vast bodies of water constituting the great oceans that the tides have their real being, and the coastal tides themselves will never be completely understood until we know the great oceanic tidal movements. The meteorological disturbances may arise wherever the tides arise, and we want to know, for instance, what effect certain meteorological conditions over the Atlantic will have on the tides in our harbours.

On the side of pure science many problems of wide geodynamical and cosmical interest require as data a knowledge of the ocean tides.

Now it is believed that not a single accurate observation of either tidal elevation or tidal current has ever been made in the deep water of any of the oceans. The best knowledge we possess of mid-ocean tides consists in observations on the shores of oceanic islands, and even this knowledge is not nearly so complete as we could wish.

Mathematically, the tides are "determined" by the size and shape of the ocean basins and certain astronomical data, but the complete solution of the problem is not within the sight of the present generation of mathematicians. If all the possible free oscillations of the oceans could be discovered, then the actual tides could be calculated with ease by a principle which is a generalisation of that of resonance.

Various guesses have been made as to the

nature of the ocean tides, and these have produced several different charts of cotidal lines. By a cotidal line is meant the locus of all points of the ocean surface at which high water occurs at the same instant. The best known of these charts are those of Whewell and Harris, but quite recently a new set of cotidal lines for the world has been published by Sterneck (*Sitz. Akad. Wien,* Bd. 129, 1920).

Whewell's chart was based on the hypothesis that in the Southern Ocean, where the parallels of latitude meet with no great land barriers, powerful tidal waves follow the sun and moon and send off-shoots up the Atlantic, Pacific, and Indian Oceans. Many serious objections have been urged against this.

Harris's charts are based on the principle of resonance, but the details of the application have been rejected by some high authorities. Harris sought in every ocean for regions which, if completely surrounded by land and not subject to the earth's rotation, would have twelve hours for their longest free period of oscillation; and he always found them! He then applied the principle of resonance, ignoring the absence of complete land boundaries and the presence of the earth's rotation.

Sterneck's chart is constructed from the existing observations with the condition that cotidal lines for times differing by six hours shall be as nearly parallel as possible.

These charts differ very widely from one another. In the Pacific Ocean, for example, Harris places three no-tidal points, whilst Sterneck places six.

At the present time there is no method by which we can find out what the ocean tides are except that of directly observing them, and it is high time that serious attempts were made to this end.

If the proposal made by the president of the British Association at Cardiff ever materialises, and a fully equipped oceanographical expedition results, it is very much to be hoped that means will be found of measuring tidal elevations and currents. If trustworthy observations could be made at only a few mid-ocean stations, the light they would throw on the great tidal movements would be enormous. And, even if this very desirable object proves impracticable—for it will probably require new methods and instruments—it is understood that the expedition would often be in water sufficiently shallow for the methods and instruments already developed. Also, the parties of observers which it is hoped might be landed at the most remote islands could obtain tidal records of very great value.

Hitherto, off-shore tidal observations have been restricted to shallow water, but it has to be confessed that in this country very little attention is being paid to the work. No gauge-records of off-shore elevations appear to have been published by any British authority, though trustworthy records are said to have been taken by the French. In this connection we may mention that there is a discrepancy of about 40 miles between the charts of cotidal lines for the Irish Sea as published by the Admiralty and those of many foreign authorities. Very few British current-meter observations have been published, though in recent years the Scandinavians have worked hard at providing the means of taking them. Bell Dawson has done a notable work in Canadian waters, but where is the band of current measurers in this country that can compare with Nansen, Ekman, Pettersson, Jacobsen, Witting, and Helland-Hansen of the Scandinavian countries?

Now, although with the instruments that men of other nationalities have developed we may hope to learn a great deal from the suggested expedition whenever it comes into shallow water, yet preparations ought to be in progress for work in deeper water. Quite near to our shores we could have a small expedition which, besides teaching us much about our own tides, would ever strive to observe in deeper and deeper water, devising such modifications of methods and instruments as the deeper water required, and improving methods and instruments for such depths as had proved practicable at all. It is greatly to be feared that no such efforts are being made.

Obituary.

JOHN BURROUGHS.

THIS veteran naturalist and poet died suddenly while in a train near Buffalo on March 29, within a few days of his eighty-fourth birthday. He was born, a farmer's son, at Roxbury, New York, on April 3, 1837, and had the advantage of a rural education. After about twenty years as school-teacher, journalist, Treasury clerk at Washington, and auditor of United States national banks, he bought a farm at West Park, on the Hudson, and spent the rest of his life fruit-growing, observing, and writing. Year after year he wrote delightful and distinctive essays on natural history and country life, which were received with well-deserved popularity. Mention may be made of "Wake Robin" (1871), "Winter Sunshine" (1875), "Birds and Poets" (1877), "Locusts and Wild Honey" (1879), "Pepacton" (1881), "Fresh Fields" (1884), "Signs and Seasons" (1886), and the list might be continued to his "Breath of Life," published a few years ago.

Burroughs also wrote poems and more than one study of Walt Whitman, whom he knew intimately, and for whom he had an enthusiastic reverence. "Whitman: a Study" is certainly a very remarkable book of its kind, and to the influence of Whitman and Emerson it seems just to say that John Burroughs owed much.

Everything that Burroughs wrote was a work of art; he had a picturesque, melodious style without preciosity, and he kept close to his own experiences of wild Nature and country life. Burroughs had a strongly developed scientific mood, but his essays are not so much informative as appreciative, expressing a sympathetic interest in common things and the endless novelty of the seasons. While he had an almost fiery dislike of those who read the man into the beast in a facile way, making an often tawdry homunculus of many a common creature, he had himself a great gift in getting near the character of the birds and animals he studied. It was the true inwardness of Nature-study that Burroughs expressed—a well-informed love of the country. The manner in which he expressed this is probably unsurpassable, and we do not know why his writings should ever grow old.

WE regret to announce the death of PROF. RUTHERFORD J. PYE-SMITH on Wednesday, March 23, at the age of seventy-three years. Prof. Pye-Smith was educated at Guy's Hospital, and became F.R.C.S. in 1875. In the following year he went to Sheffield as a general practitioner, and rapidly made a name for himself as a surgeon. At that time the epoch-making work of Lister on antiseptics was revolutionising surgery, and Prof. Pye-Smith was one of the pioneers of the new methods in England. On the constitution of Sheffield University he was elected professor of surgery, a post which he held until his retirement a few years ago, when he received the title of emeritus professor and the honorary degree of Ch.M. He also represented Sheffield University on the General Medical Council, where his practical experience of the problems of medical education was greatly appreciated.

Notes.

THE KING has been pleased to approve the award of the Royal medals of the Royal Geographical Society as follows:—Founder's medal to Mr. Vilhjalmur Stefansson, for his distinguished services to the Dominion of Canada in the exploration of the Arctic Ocean; and Patron's medal to Gen. Bourgeois, Senator for Alsace, Membre de l'Institut, for his long and eminent services to geography and geodesy as Director of the Service géographique de l'Armée, and president of the Conférence Internationale de la Carte du Monde au Millionième. The council has made the other awards of the society as follows:—The Murchison grant to Comdt. Maury, for his surveys in the Belgian Congo; the Back grant to Miss Marion Newbigin, for her contribution to geography, particularly of the Balkans; the Cuthbert Peek grant to Capt. J. B. L. Noel, for his reconnaissance of the eastern approaches to Mount Everest and other geographical work; and the Gill memorial to Lt.-Col. M. N. MacLeod, R.E., for his contribution to the theory of survey from air photographs.

A SELECTED series of specimens in illustration of the Neolithic industry from the stone-axe factory of Graig-lwyd, Penmaenmawr, will be exhibited at the rooms of the Royal Anthropological Institute, 50 Great Russell Street, W.C.1, on April 20–23. During the recent investigation of this important site, which was carried out by a committee of the institute, the actual work of excavation being under the direction of Mr. S. Hazzledine Warren, a mass of valuable material was obtained. This included what is probably the finest series of specimens illustrating the manufacture of a stone axe that has ever been found. It is hoped that a more extended exhibition may be arranged where more space is available; but as this is at present uncertain, those who are interested in prehistoric man should not miss the opportunity of examining the selected series. At the close of the exhibition typical series of the implements will be distributed to various museums throughout the country.

THE terms of the resolutions which it is proposed to submit to the Committee of Ways and Means of the House of Commons to fulfil the Government's promise to safeguard British industries have been issued as a White Paper (Cmd. 1219) under the heading "Safeguarding of Industries." In the first resolution it is proposed that an import tax of $33\frac{1}{3}$ per cent. be levied for five years on articles which come under the categories of optical instruments, chemical glassware, scientific and technical instruments of precision such as galvanometers, pyrometers, etc., ignition magnetos, tungsten and its products, and synthetic organic chemicals with the exception of dyestuffs, irrespective of the country from which they may be imported. The second resolution aims at protection from "dumping," and no time-limit for its operation is given. If such articles are exported to the British Isles at prices below the cost of production, or if depreciation of currency enables foreign manufacturers to sell such goods here at prices below those at which they can be profitably manufactured in this country, an additional import tax of $33\frac{1}{3}$ per cent. of the value of the article is suggested. Such articles imported from Germany would thus be subject to a tax of 50 per cent. of their value by the operation of the reparation measures, a further $33\frac{1}{3}$ per cent. under the first resolution and another $33\frac{1}{3}$ per cent. under the second, making in all an import tax of $116\frac{2}{3}$ per cent. of the value as determined by the wholesale price obtaining in the country of origin.

A PATHETIC document reaches us by way of Canada referring to the distressed condition of a number of retired university professors in Vienna. Among those in greatest need are some annuitants whose names are world-famed. Not everyone whose pension fails can easily start life again as an agricultural labourer. By analogy with the desolated French towns taken over by corresponding English cities, the Continental universities might be allotted to English universities for support; for example, Cambridge might offer to

educate the children of Viennese professors. Better still, the botanists might look after botanists, the chemists after chemists, and this assistance might be organised through our learned societies. The poverty and want of the Vienna intellectuals are confirmed by reports received through the Emergency and War Victims Relief Committee of the Society of Friends (hon. secretary, Miss Ruth Fry, 27 Chancery Lane, W.C.2) in correspondence with their outpost at Singerstrasse 16, Wien I. There is book-hunger as well as food-hunger, and for the relief of the former an Anglo-American Library for Central Europe has been formed (hon. secretary, B. M. Headicar, London School of Economics, Clare Market, W.C.2). Readers of NATURE might offer scientific papers and transactions and short-circuit correspondence by direct communication. The Austrian League of Nations Union (hon. secretary, Herr Arthur Müller, Oesterreichische Völkerbundliga, Burgring 9, Wien I.) is preparing to act as trustees for funds to be devoted to the technical education of the youth of Vienna.

INDIA at the present moment is in a stage of transition, and the form her institutions will take for the next few generations depends on the success of certain enlightened men who are striving against great odds to combat prejudice, ignorance, and self-interest. A clear lead was given to the industries of the country by the work of the Indian Industrial Commission, and in the case of the chemical industries by that of the Chemical Services Committee which was appointed as an outcome of the Commission. Nevertheless, when one reads reports such as that recently published by the Bengal Chamber Committee on the suggestions put forward by the Chemical Services Committee it is difficult to believe that there is any real grasp of the needs of the moment, and that inter-provincial jealousies may not, after all, seriously affect the industrial development of the country. In these circumstances it is pleasant to record the appearance of the first number of the *Journal of Indian Industries and Labour* (Calcutta, published by order of the Government of India), which, in accordance with the foreword written by Sir Thomas Holland, is "one step towards provincial co-operation" and "a medium for communicating to a wider public . . . information that will assist private enterprise." The articles are interesting and well written, a particularly useful feature being the summaries of industrial intelligence by the Director of Industries of each province. On the whole, there is little call for criticism excepting perhaps a statement on p. 5 that cellulose can be converted into starch, which is, to say the least of it, premature. Everyone concerned with this useful and admirable production is certainly to be congratulated.

THE eleventh annual May lecture of the Institute of Metals will be delivered at 8 o'clock on Wednesday, May 4, at the Institution of Mechanical Engineers, by Prof. T. Turner, who will take as his subject "The Casting of Metals."

WITH a portion of the funds at their disposal the trustees of the Captain Scott Memorial Fund have decided to establish a Polar Research Institute in connection with the new department of geography in the University of Cambridge. In an article entitled "The Future of Polar Exploration" in the *Geographical Journal* for March Mr. F. Debenham gives some details of the scheme. The object is to have a place not only where the results of polar expeditions can be worked out and the manuscripts and log-books deposited, but also where all information in the form of books and samples of equipment can be collected ready for examination. It is hoped eventually to provide a library, map-room, and museum of polar gear and equipment. The funds allotted by the trustees are sufficient for the foundation, but they will not extend to the purchase of material and collections. An institute of this kind developed on the lines suggested would be of service to polar explorers of the future, and the fact that many members of Capt. Scott's scientific staff, including Dr. E. A. Wilson, were from Cambridge gives that University a special claim to have the institute. At the same time Cambridge will find it difficult even with adequate funds to make collections of polar maps and literature equal to those now available in various libraries in London or Edinburgh.

SOME interesting questions relating to the influence of environment on culture in the Congo area were discussed by Mr. E. Torday in a paper on the Batetela read at a meeting of the Royal Anthropological Institute on March 15. The Batetela, having migrated from their original eastern home and penetrated a region of West African culture, exhibit a quaint mixture of East and West African, of forest and grassland culture, mixed with beliefs and customs borrowed from the Akela, the Baluba, the Arab, and even the European. Part settled in the grassland between the Lubefu and the Lomami, while others migrated to the great forests on the banks and north of the Lukenye River. Mr. Torday traced in detail the differences in culture between the grassland dwellers, the Sungu, the forest dwellers, the Bahamba, and a third section, the Olemba, whom he considered as the nearest to the original type of Batetela. In the discussion which followed the reading of the paper both the president, Dr. W. H. R. Rivers, and Prof. Elliot Smith pointed out that Mr. Torday's evidence was equally important for the question of the diffusion and contact of cultures. They instanced the practice of cicatrisation, which showed a combination of two elements, as a result of which the cicatrices were arranged in linear patterns, and had afforded Prof. Elliot Smith the only parallel for an example of cicatrisation on the skin of a woman found in Nubia dating from 2000 B.C.

ONE more stage in the study of the smaller Oligochæts is marked by the publication of a paper by Welch on "The Genera of the Enchytræidæ" (Trans. Amer. Micro. Soc., vol. xxxix., January, 1921, pp. 25–50). The author recognises 16 genera and approximately 325 species, and supplies a useful bibliography. As there is no country in which these "pot-worms" flourish more luxuriantly than in Great Britain, where about a dozen genera are found, with a vast number of species, this guide to classification should prove valuable to systematists in this country.

IN a short note on the fresh-water isopods known as *Asellus aquaticus* (*Ann. Mag. Nat. Hist.*, ser. 9, vol. v., 1920) Prof. C. Chilton directs the attention of English naturalists to a recent paper by Dr. E. G. Racovitza, who has shown that under the name *aquaticus* two distinct species have been included. This name is retained for the commoner species which has been fully described and figured; the other species has been named *meridianus*, and Prof. Chilton records examples from Tunbridge Wells. For the differences between the species the reader is referred to Prof. Chilton's note or to Dr. Racovitza's paper in *Arch. Zool. Expér.*, vol. lviii., 1919.

SOME years ago the authorities of the American Museum of Natural History founded a journal for the purpose of arousing public interest in the work of the museum. Brightly written by members of the museum staff, and marvellously illustrated, that journal has earned for itself an honoured place all over the world. We might well follow the lead America has set us in this matter. The latest issue (vol. xx., No. 5), among other good things, contains a most interesting article on the unicorn and its horn by the director of the museum, Dr. Frederic A. Lucas, and another, no whit less readable, by Dr. W. D. Matthew on Canadian dinosaurs, while Mr. Malcolm Anderson contributes a most instructive account of North China in winter.

IN his presidential address (printed in *Science* for January 21 last) before the Zoological Section of the American Association for the Advancement of Science at its Chicago meeting Prof. W. M. Wheeler discussed the subject of organisation in research as it appears to a biologist, and pointed out some of the dangers attending post-war efforts in this direction. He mentioned the array of instincts, emotions, and interests on which the activities of the investigator depend and the great diversity of mental aptitude which necessarily accompanies the genius for different types of research. Prof. Wheeler claims that any organisation dealing with research should refrain carefully from interfering in any degree with the free expression of the individual's exceptional aptitudes in his own way. In these days when the amateur in scientific research is passing we need to beware of fettering in any way by Government or other interference the activities of the professional scientific man.

A HUMAN embryo obtained by Dr. Vernon Favell on the fourteenth day after the commencement of the missed menstrual period, and described by Prof. Bryce at a recent meeting of the Anatomical Society of Great Britain and Ireland, is of outstanding interest in that it presents a human stage theoretically essential, but not actually seen hitherto. The stage represented is that in which the amnio-embryonal rudiment is solid and connected to the blastocyst wall by a cellular stalk. The specimen consists of a relatively large blastocyst around which moderately extensive areas of plasmodi-trophoblast can be seen. Within the cavity are many scattered amœboid cells, the forerunners of the extra-embryonic mesoderm. The yolk-sac vesicle is relatively small, and a large, somewhat scattered group of cells lies between it and the amnio-embryonal rudiment. The latter consists of an undifferentiated cell mass with spaces suggestive of a process of vacuolisation and connected to the blastocyst wall at one point by a band of cells. The majority of early human embryos previously described have been of necessity in a more or less pathological condition, and the appearances seen cannot be regarded as strictly normal. Prof. Bryce makes no claim that his embryo is exceptional in this respect. He interprets the specimen as one in which the trophoblast vesicle has continued to grow, while the embryonic rudiment has lagged behind or ceased to develop, but has been preserved in an early phase of its differentiation. Further study of the specimen will undoubtedly furnish valuable information, and its detailed description is awaited with considerable interest.

THE final report of the Grain Pests (War) Committee has been drawn up by Prof. W. A. Herdman and was issued during February of the present year. The Committee was appointed by the Council of the Royal Society in June, 1916, as the result of correspondence with the Board of Agriculture, in which the latter requested the Royal Society to initiate investigations "in relation to the damage done to grain by insects." The report gives a concise summary of the conclusions arrived at as the result of the various lines of research carried out. It emphasises the serious importance to the Empire of the elimination of grain pests and the necessity for bringing into being a permanent body capable of dealing with all organisms causing destruction to grain and other stored products. It is hoped that the Department of Scientific and Industrial Research will see its way to make an annual grant of money in order to provide the salaries and equipment of two or three officers specially selected for carrying out researches on those problems which are admittedly urgent. Probably by means of the judicious expenditure of a relatively small sum of money for a few years a great deal of valuable foodstuffs would be saved from destruction by insects and other grain pests.

THE essential characteristics of United States climates is the subject of an article by Prof. R. de C. Ward, of Harvard University, in the *Scientific Monthly* for December last. For descriptive details the United States is subdivided into climatic districts, and these are called the Eastern, the Gulf, the Plains, the Plateau, and the Pacific; with the three last-named a further subdivision between north and south is suggested by the difference of latitude. Temperature, rainfall, and other climatic conditions are given in fair detail for the several districts, and a comparison is made of the different advantages for fruit-growing, farming, and general agriculture. The movements of storms and cyclonic disturbances necessarily enter largely into the general explanation for rains experienced, the disturbances travelling generally from west to east. The article gives a very general idea of the different meteorological conditions which prevail in various parts of the United States, especially with regard to temperature; on the whole, it is shown

to be highly favoured in general climate. The space given to the article is necessarily too limited for great detail.

THE December issue of *Terrestrial Magnetism and Atmospheric Electricity* contains the preliminary results of the magnetic survey of the Indian and Southern Oceans carried out by the United States survey ship *Carnegie* during the summer and autumn of last year. The values obtained for the deviation of the compass over the south-easterly course traversed from Colombo to a point about 10° west of the Straits of Sunda differ little from those given in Admiralty Charts 3776 and 3777 for 1917, but over a considerable area of the Indian Ocean directly south of Ceylon, between latitudes 25° and 35° S., the westerly deviations are a degree or more greater than those given in the charts. From this region to Fremantle, and thence to a region in latitude 50° S. directly south of South Australia and Victoria, the new observations agree with the charts, but in the latter area the easterly deviations given in the charts are about 1° too small. For the rest of the course to New Zealand the observations agree fairly well with previous records.

IN an address to the students of Faraday House on February 25 Sir Philip Dawson discussed the possibilities of electric traction in connection with heavy railway work. He considered that many railway engineers laid too much stress on standardisation, and this was preventing progress. Great harm can be done by excessive standardisation. The solution advisable for one line of railway might be quite unsuitable for another. He thought that the French Government had made a mistake in standardising 1500 volts direct current for electric traction. Germany, Sweden, and Switzerland had adopted 16,000 volts alternating current as the standard pressure. The United States has not yet introduced any legislation, and side-by-side extensions are going on of 3000-volt direct-current systems and 11,000-volt single-phase alternating systems. Few realised the amount of power required for electric traction, *e.g.* a train going out of Victoria Station took 2000 kw. (2680 h.p.), and Sir Philip calculated that of the total demand for electricity in the London area contemplated by the Electricity Commissioners about half would be required for the railways. When the suburban electrification of the Brighton system was completed it alone would require 50,000 kw. There had been practically no interference with telegraph and telephone circuits by the large currents used on this railway.

AN illustrated account of the new works at Canning Town belonging to the British Glass Industries, Ltd., appears in the *Engineer* for February 25. These works are already in partial operation, and are designed to be the largest glassworks in Great Britain. The plant will consist of nine units, each complete in itself as a glass factory, and the total output of bottles or jars when the works are in full operation will be approximately 600,000 a day. To obtain this output continuous shifts will be employed. The plant is being laid out in conformity with modern practice, including mechanical mixing and the latest types of melting furnaces and gas-producer and annealing plants. Pyrometric control of temperature is employed in both the melting and annealing furnaces. It is claimed that there is only one fully automatic bottle-making machine in existence—the Owens—all the others requiring the addition of a separate device for feeding the glass into the machine. The type installed at the Canning Town works is the Daubenspeck, which is designed for making wide-mouthed bottles; this machine is made by Messrs. Fraser and Chalmers, of Erith.

AN illustrated account of a new type of crankless steam engine appears in *Engineering* for March 11. This engine has been constructed to the designs of Mr. A. G. M. Michell, the inventor of the Michell thrust-block. The engine is enclosed in a cylindrical casing, and the rotating shaft is co-axial with the casing. At the centre of the shaft is a swash-plate, *i.e.* a plate with its plane inclined to the shaft axis, 62·5° in the experimental engine, but to be made 67·5° in future. There are eight cylinders, four on each side of the swash-plate arranged round the shaft with their axes parallel to the shaft axis. Opposing pistons are connected together by a bar crossing the outside of the swash-plate. Each of the eight pistons bears against the side of the swash-plate through a Michell thrust-pad. The engine is uniflow, *i.e.* steam acts on one side of the pistons only, and steam is admitted to the cylinders by means of two rotating disc valves, one at each end of the casing, and exhaust at the end of the outer stroke takes place through ports uncovered by the pistons. The design lends itself to very perfect balancing, and tests show that the designed speed of 1200 r.p.m. can be greatly exceeded. The cylinders are each 5 in. in diameter, and 0·92 indicated h.p. per cylinder per 100 r.p.m. has been obtained. The success of this experimental engine is due to the Michell pads, for which the coefficient of friction is of the order 0·002.

OWING to the shortage of edible fats in Germany during the war, attempts were made to produce fatty acids from natural hydrocarbons of the paraffin type which were obtained by the distillation of lignite. The progress made is reviewed in the *Chemical Trade Journal* for December 4 last and in the Journal of the Society of Chemical Industry for February 28. Many processes have been described, and the conclusion arrived at is that, although success does not appear to have been attained, the conversion shows promise. Two main groups of methods have been used: (1) The synthesis of fatty acids from hydrocarbons of low molecular weight, such as ethylene and acetylene, by polymerisation and oxidation, and (2) the partial degradation and oxidation of hydrocarbons of high molecular weight. In the Zelinsky process a chlorinated hydrocarbon was treated by the Grignard reaction for the production of fatty acid. This process is said to have been in use in Germany in the later years of the war. Harries treated unsaturated hydrocarbons of high molecular weight with ozone, decomposed the ozonides with steam, and transformed the resulting peroxides into fatty acids by treatment with

caustic alkali. The most promising method, however, is the direct oxidation of a hydrocarbon mixture such as petroleum or paraffin wax by atmospheric oxygen in presence of a catalyst consisting of a resinate of vanadium, manganese, etc. In this process, due to Franck, a net yield of 70–75 per cent. of fatty acids suitable for soap-making, esterification to produce fats, and other purposes is claimed. The process was in operation on a technical scale.

MESSRS. A. GALLENKAMP AND CO., 19–21 Sun Street, E.C.2, have issued a revised catalogue of electric furnaces suitable for a variety of laboratory purposes. The advantages possessed by electric furnaces are evidently receiving due recognition, for Messrs. Gallenkamp state that they have sold more than 1100 furnaces during the past five years. The construction of these furnaces is very simple; a tube or muffle of fused silica is wound with a resister wire and the exterior well lagged to diminish heat loss. Such furnaces are capable of temperatures up to 1000° C.; beyond this point it becomes necessary to employ platinum-foil windings and refractory tubes or muffles.

MESSRS. BERNARD QUARITCH, LTD. (11 Grafton Street, W.1), have just issued a catalogue (No. 362) of second-hand books and periodicals ranging over a variety of subjects. The sections most likely to interest readers of NATURE are those devoted to botany, early science, natural and physical sciences, and periodicals. In the latter there are many sets and long runs, some not otherwise easily procurable. Among the items are *Annales de Chimie et de Physique* (1789–1909), the *Journal of Botany* (vols. i.–xlvi.), Philosophical Transactions of the Royal Society (1665–1918), and Transactions of the Zoological Society of London (1833–1915). There is also a set of the publications of the Ray Society (1844–1915).

ERRATUM.—Mr. W. J. Perry writes:—"In the article in NATURE of March 31 entitled 'The Development and Spread of Civilisation,' I inadvertently put 3700 B.C. for a date that should be 3400 B.C."

Our Astronomical Column.

RECENT BRILLIANT FIREBALLS.—Mr. W. F. Denning writes that he has received twenty-five accounts of the brilliant fireball of March 16, and has been able to revise his preliminary deductions, which were based on scanty data. The height of the object was from about 68 to 25 miles from over Moffat to Berwick, path 81 miles and velocity 11 miles per second, radiant point at 72°+12°. The average of a number of estimates of the duration of flight was 7½ seconds. The radiant point does not correspond with any known shower in March, and the position shows that the fireball was overtaking the earth in its orbit and moving with very slow apparent velocity. It is curious that so many fireballs appear to be revolving in direct orbits, but the fact seems clearly proved on ample evidence. It is also a significant feature that many fireballs of the slow-moving type exhibit radiants which are situated on or near the ecliptic.

Splendid fireballs were also observed on March 25 13h. 13m. and March 29 7h. 27m. G.M.T. from the metropolitan district and south-eastern counties. A number of descriptions have been received, but few of them are exact and accurate. The approximate real paths derived from the best data available at the time of writing are:

G.M.T. h. m.	Height at first. Miles.	Height at end. Miles.	Path. Miles.	Velocity. Miles per second.	Radiant. ° °
March 25 13 13	67	56	88	—	181–29
29 7 27	61	47	71	12	48–9 62–10

The former appears to have a possible connection with the comet of 1264, for which Prof. A. S. Herschel computed a radiant at 182·5°–28° on March 25. This comet was a brilliant one, and passed within two millions of miles of the earth's orbit.

The past month of March has furnished large fireballs of unusual numbers and interest, and the popular idea has been to ascribe them to the oncoming comet of Pons-Winnecke, though, as a matter of fact, no connection whatever can be proved.

ANOTHER INVESTIGATION OF THE EINSTEIN SPECTRAL SHIFT.—The *Comptes rendus* of the Paris Academy of Sciences for March 7 contains an investigation by M. A. Perot, communicated by Dr. H. Deslandres. The investigation is based on a study of the magnesium spectrum. The wave-lengths in Ångström units of the lines b_1, b_2, b_4 in the arc at atmospheric pressure were found to be 5183·614, 5172·690, and 5167·340 respectively.

Tests were then made at different pressures, and it was found that the value of $d\lambda/\lambda$ per atmosphere is $1{\cdot}35/10^6$ for b_2 and $1{\cdot}67/10^6$ for b_1, so that comparison between b_1 and b_2 should give the pressure of the region where the spectral lines are produced. In this manner, by a discussion of solar and arc spectra obtained by photography in the year 1911, the value of the pressure of the absorbing layer on the sun is found to be equivalent to −6 cm. of mercury ± 20 cm. Of course, the pressure cannot actually be negative, but it is inferred that it is very low, and, consequently, that nearly the whole of the atmospheric term $1{\cdot}35/10^6$ must be applied to the solar measures of b_2 to make them comparable with the terrestrial ones. The value of $d\lambda/\lambda$ for sun *minus* arc is then $(1{\cdot}16+1{\cdot}35)/10^6$, in good agreement with the Einstein value, which is $2{\cdot}12/10^6$. The author has failed to notify the regions of the sun to which the measures apply. This should have been done, in view of the considerable differences for different regions found by Mr. Evershed and others.

NOVA AQUILÆ III.—In the Journal of the Manchester Astronomical Society for the sessions 1917–20, which has recently been received, there appears a valuable series of photographs of the spectra of Nova Aquilæ III. taken by Mr. C. F. Butterworth with a 6·3-in. prismatic reflector. The period covered is from June 10 to November 14, 1918, and thirty-six photographs are shown taken on twenty-two days distributed fairly evenly over this period. Although the dispersion obtained was extremely small (243 Å.U. to 1 mm.), the photographs are evidently good enough to stand considerable enlargement and show plenty of detail. The general sequence of changes in the spectrum is well shown, and many of the smaller details—such as the complex structure of the hydrogen bands—may also be detected. The series as a whole forms a useful addition to the observations already published concerning this important nova. In addition, Mr. Butterworth gives a table of measures of the breadths of the more important bright bands at four different stages of the star's career.

The Galvanometric Measurement of Human Emotion.[1]

By DR. A. D. WALLER, F.R.S.

WE are all of us familiar, subjectively within ourselves, objectively by the behaviour of our neighbours, with the signs and symptoms of emotion, and with the fact that such signs and symptoms are more or less under voluntary control and can be suppressed or simulated at will. We are moved to or from an object we may desire or fear. We are moved to laughter or to tears by events witnessed and imagined; and whereas all men are moved in the mass by the same general motives of light and dark, food and hunger, love and hate, we know by everyday experience that no two men react in identical fashion to the same motives.

1. Physiologically, all emotions are expressed as neural outbursts from the central nervous system through efferent nerves to muscles and glands; emotion, in general, results in intensified physiological activity at the periphery of the body—muscles and glands, heart and blood-vessels, the face and eyes and skin. A movement of surprise, a palpitation of the heart, a blush, a pallor, a shiver, a rush of tears, a dilated pupil—all these and other signs of emotion consist in sudden local intensifications of the chemical exchanges that are in constant operation between the living cells of the body and the fluid medium by which they are surrounded. We know indeed that all such chemical exchanges are controlled through efferent nerves, and we speak of this control as their trophic action, but we are scarcely prepared at the present day to recognise the close association between signs of emotion and the phenomena of nutrition.

2. The physical sign of emotion is known to psychologists as the psycho-galvanic reflex. It was first definitely revealed to us twelve years ago by Veraguth,[2] of Zurich, and has since then formed a favourite subject of study by many later observers whom I shall not attempt to enumerate. I joined in the hunt four years ago,[3] and was very quickly satisfied that this physical sign affords the most convenient possible gauge and measure of human character and of human temperament, seeing that it declares *how much* a given subject is moved by his thoughts and feelings. A spot of light showing the movements of a galvanometer connected with the palm of the hand exhibits the fluctuating emotions of the person to whom the hand belongs, and if the person be an ordinary normal person it is only the palm of the hand, and not any other part of the skin of the upper extremity, that shows the response. My first point is, then, that the emotive response is, *par excellence*, a palmar phenomenon, and I shall, as my first and chief experiment, undertake to demonstrate this point. (Experiment.)

3. Mr. X. Y. has been good enough to lend himself to my purpose. His hand and his forearm are connected with each of two galvanometers and two Wheatstone bridges. The round spot belongs to the hand circuit, the square spot to the forearm circuit, and balance can be adjusted in each circuit separately by suitable manipulation of the two resistance boxes. In both cases the wiring is such that increased conductivity of the hand or of the forearm gives movement of the spots to my right, *i.e.* any emotive impulses from the brain down motor nerves to the hand or to the forearm will cause deflection to the right. Let us watch the two spots for a while. I expect you to see that the hand spot behaves irregularly, whereas the arm spot creeps steadily across the scale without showing any of the vagaries of the round spot.

You realise now why I have been at trouble to show the simultaneous behaviour of *two* spots. With only the hand in circuit of one galvanometer you should at first have felt doubtful whether the movements you saw were really due to emotive discharges, and not to otherwise imperceptible muscular twitchings such as are perceived and utilised by thought-readers. It would otherwise have been desirable to set up some very delicate form of myograph to satisfy this doubt. I shall show you presently, by asking the subject to make a least possible movement of one of his fingers, that the round spot—*i.e.* that indicating the electrical resistance of the hand—shows a deflection which is due to a minute disturbance of contact, and, therefore, takes place in the direction opposed to that of an emotive response. I am sure you will realise with me what a mercy it is that the deflection by slight, often quite unavoidable, movement is, in general, the contrary of that of the emotive response.

4. But to return to our experiment. The subject is at rest; both spots are reasonably steady, but by reason of his past experience he knows that an evil moment is approaching. As you may see by the irregular movements of the hand spot, he is beginning to worry, making a picture in his mind of the pain he is about to undergo by steel or fire, and, obviously, this disturbance of quietude creates a condition that is not favourable for recognising or measuring the disturbing effect of any real interference with his comfort. The emotive effects of my threatening language must be allowed to subside. You cannot expect to study rings made by throwing a stone into a pond unless the pond is quiet; you must wait for it to get still. When he comes to rest Mr. X. Y. will react smartly and obviously in response to the suddenly threatened pin-prick or to a real pin-prick. (Trials by pin and matches. Real and imaginary pin-pricks and burns.)

You now, perhaps, feel fairly well satisfied that the statement made a few minutes ago is correct. In the upper limb of a normal person emotive responses to slight excitations are confined to the palm of the hand. The only other part of the body in which they occur is the sole of the foot, but this I shall ask you to take on trust; it really is not necessary that the actual evidence should be brought into court. It would merely be a repetition of what you have just witnessed; and this lantern-plate (Fig. 1) will, after all, afford us the quickest, as well as the most conclusive, evidence.

5. I shall venture to trespass just a little further upon Mr. X. Y.'s endurance to make good one further point, although it is a point that you may already have noticed.

This palmar emotive response is, in my view, to be regarded as caused by a sudden augmentation of electrical conductivity in a membrane or membranes in the fourth arm of the Wheatstone square. That augmentation of conductivity is to be understood as

[1] A discourse delivered at the Royal Institution on February 4.
[2] "Das Psychogalvanische Reflexphenomen." (Berlin, 1900.)
[3] "The Galvanometric Measurement of 'Emotive' Physiological Changes." Proceedings of the Royal Society, B, vol. xc., p. 214, 1917.

produced by a sudden dilatation of ultramicroscopic pores in this membrane or membranes. I am not speaking of visible pores, but of invisible pores such as are postulated in theories of electrical conduction and of osmotic phenomena. I imagine that these invisible pores suddenly dilate when the emotive impulse through efferent nerves reaches the living membrane, just as we see the pupil of the eye dilate with an emotion of surprise. And with this image in my mind I find it extremely interesting to recognise and measure what a very long time it takes for any given stimulus to produce its effect. It takes two seconds before the threat of a pin-prick—or, for the matter of that, an actual pin-prick—or a single induction shock, brings about the sudden dilatation of pores or increased permeability and the increased electrical conductivity that are signified to us by the movement

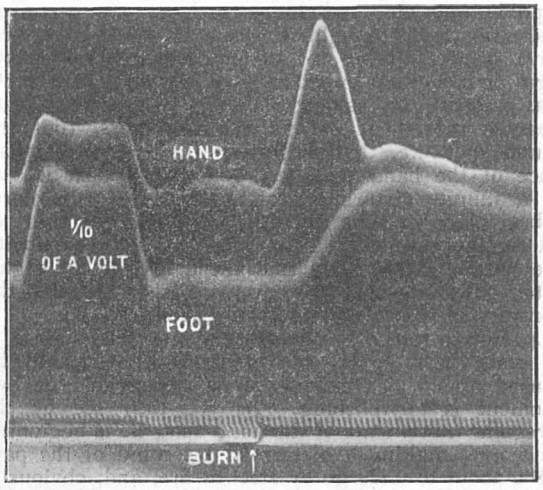

FIG. 1.—This photogram is the simultaneous response of the HAND and of the FOOT of a normal subject, and is given as an example to illustrate the method of investigation by double response. In this example it is evident: (1) that the response occurs sooner and is of shorter duration in the hand (palm) than in the foot (sole) From the time record it can be seen that the lost times in the hand and in the foot are respectively 2 and 4 seconds (approx.), and the durations of response 15 and 40 seconds (approx.). A closer approximation to true time values would require a quicker record to be taken for the lost times and a slower record for the durations. (2) That the response is greater in the hand than in the foot. This magnitude is measured by reference to the initial deflections made by passing a current from $\frac{1}{10}$ volt through each of the two circuits. In this example the hand response is approximately $\frac{1}{10}$, and the foot response approximately $\frac{2}{10}$. The rate of movement of the plate is shown (not very distinctly) in half-seconds. The portion shown in the figure occupied about 45 seconds. A similar procedure by simultaneous double response is required for the mapping out of the body-surface. Obviously the comparison between right and left sides, upper and lower extremities, distal and proximal parts, flexor and extensor aspects, is to be carried out with far greater expedition and certainty by double than it could be by single records.

of the spot of light. How is this long lag of two seconds to be accounted for? Does it occur on the afferent side? Assuredly not. A delay of this sort might be expected to amount to at most one-fifth of a second. Moreover, if we miss out the afferent side altogether, and bring about the response by an artificial explosion down efferent nerves, we shall find the same long delay of two seconds between the muscular movement and the emotive movement, both of which are taking place at the periphery. Therefore, the chief business of the long delay takes place at the periphery, in the skin of the palm of the hand, and its great length is a token that we have to do with impulses conveyed, not along cerebro-spinal, but along sympathetic nerves We may find time later to discuss the question whether these are vasomotor or secretomotor or trophic nerves.

6. *Dreams* are subjective phenomena occurring in the subconscious state, with which we are all familiar during sleep, and during the hypnotic state, and in the state called "trance." We are familiar also with innumerable objective signs of such subjective phenomena in the shape of descriptions of dreams and in the behaviour of sleep-talkers and sleep-walkers, and, above all, in the extraordinary cases of spiritualistic mediums. These last stand highest in the scale of sensitiveness.

The relative magnitudes of response to a real pin-prick and to a fictitious pin-prick vary with different people under different conditions, but in general they may be divided into two categories, whom we may call *positives* and *imaginatives*.

Positives—in whom little or no disturbance is caused by the threat of a pin-prick, and a real pin-prick is required before any response takes place.

Imaginatives—in whom a large response occurs to the threat—larger, it may be, than the response to the real fact. In not a few of this imaginative class it is almost impossible to take a pure observation of response to fact, for they begin to respond as soon as the operator makes the slightest movement, or else the response is a large one, compounded of fear followed by fact. Here is a confirmatory experiment in evidence of what may be characterised as a dwindling fear and its revival by fact. (Experiment.)

All men (and, judged by their behaviour, animals also) are more or less imaginative. The kind of diagram you have just seen would represent the responses of nine out of ten of my present hearers to a series of threats with a real shock interpolated in the series. Many of us had an opportunity a few years ago of studying upon our friends and upon ourselves the signs and symptoms of fear during German air raids upon what they called the fortified city of London. The noise and disturbance occasioned by these raids, the false alarms and the warnings by maroons and sirens, afforded a unique opportunity for the exact galvanometric study of the emotions aroused by various kinds of noises. From the purely scientific point of view the opportunity could not be neglected of studying the psychophysical phenomena brought to our doors—phenomena that could not be expected again within the same lifetime. So from the air raid of September 21, 1917, to the last and most prolonged visit of Whitsuntide, 1918, I enlisted the services of volunteers to sit quietly, connected by wires to a galvanometer, and on two occasions I had sitters arranged in connection with recording apparatus which was set going a few minutes before the noise began, so that the emotive response during the whole affair was recorded. Let me show you two or three photographs (Figs. 2 and 3).

These photographs are not merely of interest on their human side, but also have this definite scientific value, that they afford measured records of the largest emotive responses that I have ever witnessed. The responses commonly observed in the laboratory are at most 10 per cent. changes; these air-raid responses have been at least 200 per cent. changes, which I cannot reproduce artificially by any means I care to employ.

7. But to return to our different classes according to sensitiveness. We classified people as positives and imaginatives according as they exhibited greater response to fact or to fiction. Apart from this criterion, we might undertake to arrange people as more or less imaginative according as they give larger or smaller responses to certain standard threats, as of

a pin-prick or the lighting of a match. High in the scale of imaginatives we not infrequently meet with people who can at will either keep quiet, or think thoughts and see visions and hear words of purely imaginary existence without objective physical substratum. It is very interesting to watch the galvanometric signs of subjective phenomena—interesting to the onlooker, but far more interesting to the subject

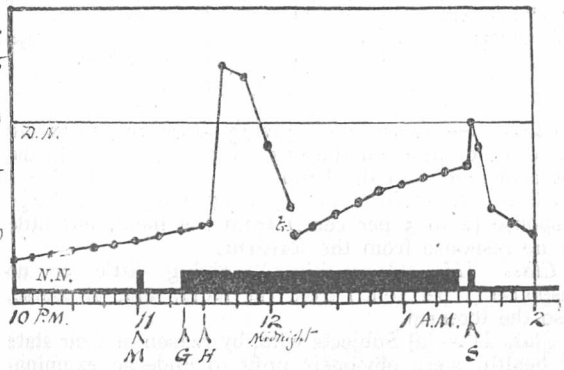

FIG. 2.—Emotivity of A. M. W. during the air-raid on Whitsunday, 1918. (From the *Lancet*.) M indicates the time of the first warning by maroons at 11 p.m. G indicates the commencement of gun-fire. The duration of the disturbance was from 11.20 p.m. to 1.30 a.m. H marks the moment of maximum alarm, when the swelling hum of approaching aeroplanes was most audible. S indicates the second warning by siren at the termination of the disturbance. The electrodes were transferred from the left to the right hand at 12.5. The horizontal lines D.N.–N.N. indicate the average normal day and night conductance of A. M. W., ascertained from other observations.

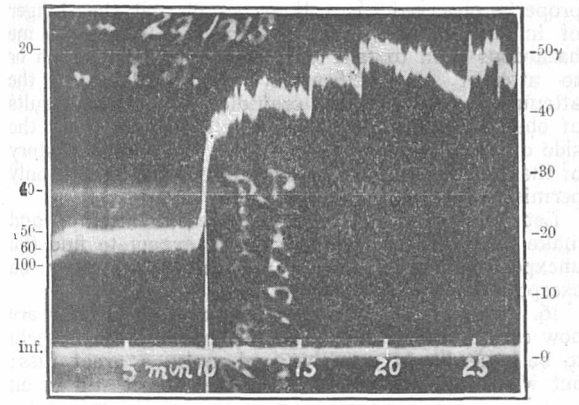

FIG. 3.—Galvanometric record of G de D. during the air-raid of January 29, 1918. (From the *Lancet*.) At the tenth minute of observation the noise of maroons, immediately followed by that of aeroplanes and guns, broke out, and the resistance, which was approximately 60,000 ohms during the first ten minutes before the disturbance, fell to approximately 20,000 ohms during the next 15 minutes. (On the left hand is given the resistance in thousands of ohms, and on the right the conductance in gemmhos.) The measurements are as follows:—

0	8.30 p.m.	.. ...	56 × 1000 ohms	or	18γ
5	8.35 ,,	... ...	53	,,	,,	19γ
10	8.40 ,,	... ...	27	,,	,,	37γ
15	8.45 ,,	... ...	22	,,	,,	45γ
20	8.50 ,,	... ...	20	,,	,,	50γ
25	8.55 ,,	... ...	20	,,	,,	50γ
At 11.30 (all quiet) ...	... ...	44	,,	,,	23γ

who knows what he (or she) is thinking about. And when it is realised that the galvanometer answers to one's thoughts and temper, it becomes quite an absorbing pastime to sit quietly in an armchair and watch oneself think as one watches the galvanometer move.

8. The emotive response is liable to all manner of variations. It varies in different individuals, and in the same individual it varies with different states of mind and body. It varies in magnitude and in its distribution over the limbs with variations in the magnitude of its exciting cause. While it is, in the main, an uncontrollable phenomenon, I call to mind more than one case where to all appearance it has been influenced at will.

9. The *distribution* of the response over the body is especially interesting. In normal persons it is exclusively palmar (and plantar); the rest of the body-surface is silent. But in "sensitives" it extends up the limbs and the trunk. And a border-land person, according to his state of temper, can react normally to-day, but as a "sensitive" to-morrow. The few spiritualistic mediums whom I have examined have (with one doubtful exception) given the reaction proper to "sensitives," *i.e.* in the hand and in the forearm.

10. The *diurnal variations* of the reaction attracted my attention at the very outset of the inquiry. I soon noticed that the same people, when submitted to a standard stimulus at different times of the day, gave responses of very different magnitudes; the responses were at their best about the middle hours of the day, when physiological activity is high, as compared with what was elicited early in the morning and late at night. And the conductivity of the palm of the hand rose and fell during the day (as does the temperature).

I thought it necessary to investigate this diurnal periodicity rather closely to learn how much it might be necessary to take into account the time of day when comparing results obtained on different individuals. So I watched this periodicity on my own hands by means of apparatus set up for the purpose in my dressing-room, so that observations of conductivity could be taken at any convenient time. The observations were recorded to form a graph on squared paper; and it may be remarked, by the way, that throughout the observations the conductivity of my right hand has been found to be higher than that of my left hand.

11. The three weeks over which these observations extended afforded me an admirable opportunity of observing the galvanometric effects of my own normal variations of "temper." Most people are more or less conscious of what may perhaps be called variations of euphoria before breakfast, and of very distinct, if not outwardly evident, variations of euphoria when the morning's letters are read. In order to test this point a photographic recorder was set up in connection with the galvanometer on my dressing-table and I had my letters brought up there and read to me and signalled on the recording plate. Most of the letters made no impression upon me, but I well remember one fortunate morning on which the post included two distinctly effective letters which produced marked effects duly recorded on the photographic plate.

12. One is naturally tempted to ask what relation there may be between the magnitude of the reaction and the mental quality. A first step towards an answer to this question has been taken by Miss Waller, who has made systematic measurements of seventy-three students of medicine, divided according to examination results into an upper and a lower division. The average response was higher in the former than in the latter—*e.g.* to disturbing questions the average value of the response came out about 50 per cent. higher in the upper division.[4]

13. I have often been asked whether pleasant and painful sensations produce similar or opposed galvano-

[4] Mary D. Waller, "The Emotive Response of a Class of Seventy-three Students of Medicine measured in Correlation with the Result of a Written Examination," *Lancet*, April 6, 1918.

metric deflections. The emotive response in its unmistakable form as a sharp movement occurring about two seconds after its exciting cause is always in one direction, *i.e.* in the direction of decreased resistance—increased permeability, poro-dilatation or, if you prefer to think it so, contraction of living matter round pores so as to dilate them. And in many thousands of observations I have never witnessed any similar movement in the opposite direction—*i.e.* in the direction of increased resistance. All that is ever seen in that direction is the gradual remission of a previous deflection in the emotive or excitatory direction. If you regard the question in its psychological aspect, you will soon be satisfied that the matter could not be expected to come out otherwise. Our pleasures and pains are not simple opposites producing opposite physiological effects. Pains are active and exciting states in our conscious life, sharply contrasting with their background. Pleasure is more often merely the subsidence and relief from pain, a gradual recovery of the untroubled state. A pin-prick suddenly excites emotion, and the emotion gradually falls to rest. There is no counterpart pleasure equal and opposite to a pin-prick. Pleasure is of necessity gradual. Too sudden pleasure—joy, as we call it—is exciting, and causes discharge down the nerves that acts precisely like painful excitements and gives rise to electrical effects in the same emotive direction.

14. We distinguished a few moments ago between imaginatives and positives according as threatened pains produced larger or smaller effects than real pains. It is convenient to draw another kind of distinction according to the extent of body-surface over which the response is manifested. The response to "weak" stimuli in the great majority of men and women is exclusively palmar (and plantar). But with "strong" stimuli, and in certain cases with "weak" stimuli as well, the response can also be manifested by the forearm (and by the leg) as well as by the hand (and foot). Such cases may be designated as "sensitives" to distinguish them from the others who are relatively insensitive, but since these others are in a majority, and it would seem inappropriate to designate the majority of mankind as insensitive, it is better to call them "normals." These two labels, "sensitives" and "normals," are not intended to imply any division into two hard-and-fast categories, but rather a scale of differences grading between two extremes. Indeed, I have satisfied myself in at least one case that a subject classified at a first sitting as "normal" was temporarily raised to the degree of "sensitive" in consequence of a rather violent fit of "temper."

It is convenient to reserve the designation "insensitive" for cases low down in the normal scale, giving in response to ordinary stimuli little or no palmar reaction—*i.e.* a doubtful response of the order of 1 per 100 of the initial resistance.

15. Provisionally, then, our observations can be systematised in accordance with the following scheme:

Class.	Emotive Response.		Examples.
	Hand.	Forearm.	
I. Sensitives ... ("Imaginatives")	Yes	Yes	Spiritualistic mediums and others.
II. Normals ...	Yes	No	The majority of men and women.
III. Insensitives ... ("Positives")	No	No	Pythiatics. "Shell shock" cases.
IV. Others	—	—	"Shell shock" cases and others.

Class I.—"Sensitives" giving large responses (10 per cent. or more of the original resistance) from the forearm and from the hand.

Class II.—"Normals" giving moderately large response (2 to 5 per cent.) from the hand, but little or no response from the forearm.

Class III.—"Insensitives" giving little or no response (1 per cent.) from the hand, and, of course, also the forearm.

Class IV.—(*a*) Subjects who, by reason of their state of health, were obviously unfit to undergo examination, and (*b*) subjects who declared themselves as unable to stand it.

Subjects of Class I. and Class II. include those who were characterised a moment ago as "imaginatives." The three spiritualistic mediums to whom I referred just now were included in Class I. Class III. comprises people of duller imagination, or perhaps of firmer fibre, whom we called "positives."

At this early stage indeed, when the number of properly observed cases is so small and the danger of imperfect observation so great, it seems to me hazardous even to talk about rules and exceptions or to attempt a classification. Nevertheless, if the attempt is made without prejudice, and if the results of observation are recorded in physical units by the side of what in medical parlance is the clinical history of the subject, a preliminary classification is not only permissible, but also necessary.

Let me again refer to the present attempt and make good the point that we may expect to find the unexpected, that so-called regular results may be exceptional and *vice versa*.

16. *Pythiatics.*—Hysterical subjects or, as they are now called, "pythiatics," men as well as women, seem to be exceedingly sensitive and make a great fuss; but when they have been persuaded to sit still in an armchair and connected up with the galvanometer and tested by ordinary stimuli—pin-prick, false and real; match-burn, false and real—lo and behold! they exhibit little or no response. They belong to Class III., that of the "insensitives"; and we are reminded of the fact that in exaggerated—*i.e.* pathological—degree the hysterical or pythiatic state is found to include anæsthesia, loss of sensibility, as a leading symptom. But, of course, more observations are necessary, and more observers.

The Modern Londoner and Long Barrow Man.

AT a meeting of the Royal Anthropological Institute held on March 8, Prof. F. G. Parsons read a paper on "The Modern Londoner and Long Barrow Man," in which he discussed a claim made by Dr. Macdonell and Prof. Karl Pearson that the head shape of Londoners of the seventeenth and eighteenth centuries was more like that of the Long Barrow men than of any other race. Prof. Parsons, however, showed, by a detailed comparison of contours obtained from thirty male London skulls of the seventeenth and eighteenth centuries dug up in the Clare Market district, and corresponding with the averages obtained by Dr. Macdonell from his London skulls found at Whitechapel and Moorfields, with those of twenty Long Barrow skulls from Yorkshire, Wiltshire, and Gloucestershire, that in the head measurements, in the depth of the orbital openings, in the length of the face, and in other anatomical details the London

skulls differed markedly from those of the Long Barrow men. On the other hand, in every respect these London skulls corresponded more closely with those of Anglo-Saxons than with those of Long Barrow men. Occasionally a Londoner might reproduce the Long Barrow type, as in the case of the notorious thief Jonathan Wild, but these cases were so rare as not to affect the average contour.

Further, the Londoner of to-day had changed his head shape from that of the seventeenth-century Londoner, but it was in the direction of the short-headed mid-European race, and farther away still from the Mediterranean type, of which the Long Barrow men were such good examples.

When the average contours of the modern London skulls were superimposed upon those of the Long Barrow men, it was at once evident that there were two sets of differences, which Prof. Parsons provisionally described as "masticatory" and "respiratory." The former consisted of increased length of skull in front of the auditory meatus, of a tilting forward of the malar bone and outer margin of the orbit, of a greater splay of the zygomatic arch, of an increased width of the ramus of the jaw, and of a flattening of the side of the head. All these changes were just as evident in an average contour of Eskimo skulls as in that of Long Barrow men, and they were all explicable by assuming an increased development of the great masticatory muscles.

The second set of changes between the Long Barrow and London skulls was the deep face and deep orbital openings of the latter, as in all Nordic skulls. The face of the English child at birth closely agrees with that of the Long Barrow man, and at three and five months the orbits and nose have markedly increased in depth from above downward. This is to be attributed to the narrowing and deepening of the nose to adapt the individual to a cold climate, ensuring that the air shall be more perfectly warmed by contact with the turbinated bones which act as radiators. As the nasion moves up the tops of the orbits have to keep pace with it, and so the characteristic depth of the Nordic orbits is accounted for.

It is interesting to note that though the Eskimo agree with the Long Barrow folk in the first set of masticatory characteristics, they differ from them and agree with the Nordic people in the second set of respiratory changes.

Pendulum Operations in India and Burma.[1]

THE paper referred to below, recently published by the Survey of India, is an opportune contribution to geodetic knowledge. It gives the results of pendulum observations at 108 stations distributed over mountains, plateaux, plains, and coasts. Col. (now Sir) G. P. Lenox Conyngham, Major Cowie, and Capt. Couchman were the observers. The work extended over six years, 1908–13, and it is evident that unremitting care was bestowed upon it throughout.

This is the first attempt made outside the United States of America to apply to pendulum observations the correction for isostasy, first introduced by Mr. Hayford in 1909 when he was reducing the pendulum observations of America. The deduction of the correction for isostasy for any particular pendulum station involves considerable labour; the whole earth has to be divided into circular concentric zones, with the station as their centre; the mean heights of the several zones, above or below sea-level, have then to be determined from maps. This course has to be pursued *de novo* for each successive station. The application of Hayford's system to the pendulum stations of India is thus a most interesting feature of Capt. Couchman's work, and students of modern geodesy will find his explanations helpful and clear. The final results obtained by Couchman furnish strong evidence in support of Hayford's contention that isostatic compensation is complete at a depth of about 113 km.

Geodesy is a science demanding world-wide co-operation; the results obtained in one continent require to be tested in others. The theory of isostasy initiated in America has now been shown by Capt. Couchman to explain anomalies in Asia. But this is not sufficient; geodetic results and theories should be submitted to an international association for scrutiny. The old International Geodetic Association, which had been endeavouring for fifty years to co-ordinate the surveys of all countries, came to an end in 1914, when the war broke out. If geodesy is to progress, a new international association will have to be formed.

The old association, always sympathetic and anxious to help, had an uphill task; it had to contend with jealousies, and to accept results, whether good or bad, without being able to discriminate or criticise. Its authority rested largely on the personal reputation of the late Prof. Helmert, whose right to the position of director was universally recognised, and whose death during the war was lamented in many countries.

In 1914, when the old association came to an end, two questions were awaiting an international decision, namely, the introduction of a new spheroid of reference and the treatment of isostasy. Obsolete spheroids of reference are still employed by various surveys, and their continuance is due, not to any local belief in their correctness, but to an unwillingness to face the laborious complications of a change until a new spheroid has received international approval.

The problem of isostasy is also awaiting international consideration. In America Hayford and Bowie have worked out a complete system of computations, and in India Crosthwait and Couchman have followed Hayford's lead.[2] Will the system be accepted in Europe? When this question comes to be considered by the future international association Capt. Couchman's work on the pendulum operations in India will be found a useful and weighty contribution.

[1] Survey of India. Professional Paper No. 15: "The Pendulum Operations in India and Burma." By Capt. Couchman. (1915.)

[2] In Professional Paper No. 13 (1912) Crosthwait applied Hayford's method to the observations of the plumb-line in India.

University and Educational Intelligence.

NOTICE is given by the University of London that applications for grants from the Dixon Fund for assisting scientific investigations must be made to the Academic Registrar of the University, South Kensington, S.W.7, before May 15 next.

TWO further lectures under the scheme for the exchange of lecturers between Holland and England are announced. Both will be given at the rooms of the Royal Society of Medicine, 1 Wimpole Street; the first, by Prof. W. Einthoven, of Leyden, entitled "The Relation of Mechanical and Electrical Phenomena of Muscular Contraction, with Special Reference to the Cardiac Muscle," will be delivered on May 2 at 5 p.m.; and the second, by Prof. Bolk, of Amsterdam, entitled "The Somatic Changes in Affections of the Endocrine Glands and their Significance in the Evolution of Man," on May 12 at 5 p.m. The lectures, which will be delivered in

English, are addressed to advanced students and others interested in the subject, and admission is free, without ticket.

THE Registrar of the University of Calcutta has submitted an application to the Secretary to the Government of Bengal Education Department (*Pioneer Mail*, March 18) for substantial financial aid for teaching and post-graduate study in accordance with the recommendations of the Calcutta University Commission. For the salaries of the post-graduate staff during the session 1921–22 a sum of 1¼ lakhs of rupees (8333*l.*) is asked. Large grants are also asked for the extension of technological studies in the University College of Science and Technology. It is suggested that part at least of these grants should be recurrent, but for the present year a capital grant of 10 lakhs of rupees (66,666*l.*) would enable the college to carry on its work. The library of the college is also in need of many standard works of reference, and for this purpose a grant of 1¼ lakhs of rupees (8333*l.*) is considered to be necessary.

THE subject proposed for the Adams prize for the period 1921–22 is "The Theory of the Tides." Applications of mathematical and dynamical theory to the observations already available, the rate of dissipation of tidal energy, the characteristics of tides in shallow seas and estuaries, and the general problem of tidal motion as affected by the earth's rotation are among the suggestions which the adjudicators make for the guidance of candidates. The prize is open to any person who has been at any time a graduate of the University of Cambridge, and is worth about 220*l.* Each essay must be accompanied by an abstract indicating which portions are considered to be original, and it may be printed, typewritten, or written by someone other than the author. A motto must be affixed to each essay, and a sealed envelope bearing the same motto and containing the candidate's name, degree, and address should be forwarded with the essay. Essays must reach the Registrary of Cambridge University on or before December 31, 1922.

AN interesting event of the present month is the International Conference of Students which has just been held at Prague, an account of which has appeared in the *Westminster Gazette*. Prior to the war a society known as the "Corda Fratres," or International Students' Union, was already in existence. It was dissolved in later years, but is now being restored. In November, 1919, when Strasbourg University was celebrating its newly acquired freedom, La Confédération Internationale des Etudiants was formed by France, Belgium, and Czecko-Slovakia, and most of the other chief countries of Europe have since become affiliated. Apparently a necessary preliminary to admission is the existence of a national students' union in the country concerned. This formerly rendered Great Britain, the United States, and other countries ineligible, but it is stated that steps in the desired direction are already being taken. It is hoped that this country will play a part in the movement —one of great benefit to students and to the future of science, which, it is commonly said, knows no national boundaries. One of the unfortunate results of the war has been the accentuation of barriers to free scientific intercourse and exchange of knowledge, scientific men in Russia, Austria, and other countries being exceptionally unfortunate in this respect. This desire for fraternisation between students in the chief countries of Europe is a hopeful sign for the future of civilisation.

THE Royal Commission on University Finances, appointed in October last to inquire into and report upon a basis for determining the financial obligations of the State of Ontario towards its universities, has presented a report to the Lieutenant-Governor of the State. There are at present five institutions of university standing in Ontario, and the report before us deals with three of them, Toronto, Queen's, and Western Universities. Toronto University is a State institution controlled on its administrative side entirely by the State Government; Queen's and Western Universities are independent, though they have been in receipt of annual grants from the Government which have been determined from year to year. The Commission recognises that higher education can no longer be supported by private individuals, and a definite scheme of State grants for the three universities is recommended. For buildings which are urgently needed it is considered that sums of 1,500,000 dollars, 340,000 dollars, and 800,000 dollars should be given to Toronto, Queen's, and Western Universities respectively. As regards maintenance, it is recommended that for the State University a yearly sum equal to 50 per cent. of the average yearly succession duties should be granted, while for the two independent institutions annual grants, to be adjusted every five years by a Court of Reference, should be made out of consolidated revenue. Should these grants be found insufficient, a direct tax for general educational purposes of one mill per dollar on the value of rateable property of the province is recommended. The question of the control of education in the universities was also discussed, and the Commission concludes that "the State, which gives financial support, has the right (*a*) to determine how this education may be most effectively and economically carried on, and (*b*) to exercise supervision over projected developments involving financial outlay."

WE are glad to see that the Library Association is issuing its Subject-Index to Periodicals for the years 1917–19, in continuation of the Class Lists for 1915 and 1916, and to learn that the association proposes to resume the annual publication of these indexes. It has just published in 87 quarto pages "Section F: Education and Child Welfare." As in former lists, the entries are arranged under subject headings, under each of which papers are placed in chronological order of dates of publication. The difficulty in framing a thoroughly satisfactory classification for papers which discuss education from many different points of view has been met by introducing frequent cross-references. Among the subject headings we find sections for education in general, education in each country taken separately, higher education, education of children, education of women, secondary education, and teachers. There are also sections for technical education, agricultural education, chemistry teaching, the study of engineering, and the study and teaching of science. We notice also sections on universities and colleges and on many universities taken singly. Among sections coming under the head of child welfare we find child study, abnormal and backward children, care and hygiene of children, employment of children, exceptionally gifted children, and milk. The lists of papers on citizenship, rehabilitation of the disabled, and educational aspects of the European war are well worth examining at the present time. There are altogether in this index 2154 titles of papers taken from 242 English and foreign periodicals published during the three years 1917–19. The total number of periodicals examined by the compilers of the Subject-Index to Periodicals for all the subjects catalogued is now nearly six hundred. We hope that the circulation of these useful class-lists will be sufficient to ensure the continuance of their publication.

Calendar of Scientific Pioneers.

April 7, 1823. Jacques Alexandre César Charles died.—The first to substitute hydrogen for the hot air used in Montgolfier's balloons, Charles was originally a clerk, but rose to be professor of physics in the Conservatoire des Arts et Métiers. He is remembered by "Charles's law."

April 7, 1912. Abbott Lawrence Rotch died.—A pioneer in the study of the upper atmosphere, Rotch in 1885 founded the Blue Hill Observatory, which he bequeathed to Harvard University.

April 9, 1626. Francis Bacon, Lord Verulam, Viscount St. Albans, died.—Bacon was the contemporary of Galileo, Kepler, and Napier. He took all knowledge as his province. His "Novum Organum"—which was written and rewritten several times with the most minute care—entitles him to be considered as one of the leaders in the reformation of modern science. He is buried at St. Albans.

April 9, 1889. Michel Eugène Chevreul died.—For many years Chevreul was connected with the Musée d'Histoire Naturelle. His researches related mainly to the chemistry of fats.

April 10, 1813. Joseph Louis Lagrange died.—Though his parents were of French extraction, Lagrange was born at Turin, where he spent the first thirty years of his life. In 1766, on the invitation of Frederick the Great, he went to Berlin. "The greatest king in Europe" wished to have "the greatest mathematician in Europe" at his Court. On Frederick's death Lagrange accepted an offer of Louis XVI. and removed to Paris. Equally great as an investigator in pure mathematics and in applied mathematics, he has never been surpassed as a mathematical writer.

April 11, 1875. Samuel Heinrich Schwabe died.—The name of Schwabe, who lived and died at Dessau, is imperishably connected with the discovery of the periodicity of sun-spots.

April 11, 1884. Jean Baptiste André Dumas died.—Few scientific men in France have been held in higher esteem than Dumas. His success as a chemist was not less marked than his success as a public man, and in 1882 the French Academy struck a gold medal to commemorate his great services to science. His statue stands at Alais, where he was born in 1800.

April 11, 1895. Julius Lothar Meyer died.—The fellow-student of Roscoe in the laboratory of Bunsen at Heidelberg, Meyer afterwards held chairs of chemistry at Breslau, Neustadt, Karlsruhe, and Tübingen. His name is best known for the share he had in the periodic classification of the elements.

April 11, 1902. Marie Alfred Cornu died.—A brilliant experimentalist, Cornu in 1867 became professor of physics at the Ecole Polytechnique, and in 1896 was elected president of the Paris Academy of Sciences. His original work related mainly to optics. He also made a re-determination of the velocity of light.

April 12, 1897. Edward Drinker Cope died.—Curator to the Academy of Natural Sciences, and later professor of geology and palæontology at Philadelphia, Cope greatly extended the knowledge of fossil vertebrates.

April 13, 1855. Sir Henry Thomas de la Beche died.—Like Murchison, de la Beche left the Army at the end of the Napoleonic wars and devoted himself to geology. He became the first director of the Geological Survey of Great Britain, and founded the Museum of Practical Geology. E. C. S.

Societies and Academies.

LONDON.

Linnean Society, March 17.—Dr. A. Smith Woodward, president, in the chair.—W. B. **Alexander**: The vertebrate fauna of Houtman Abrolhos Islands, West Australia. Prof. P. **Fauvel**: "Annélides Polychètes de l'Archipel Houtman Abrolhos, recueillies par M. le Prof. Dakin."—F. **Chapman**: Sherbornina, a new genus of fossil Foraminifera from Table Cape, Tasmania.—Miss E. L. **Turner**: Some birds from Texel. The author devoted most of her attention whilst on the Island of Texel to the avocets, ruff and reeve, godwit, and two species of tern, describing the habits of the birds observed, especially during the nesting period.

Mineralogical Society, March 22.—Dr. A. E. H. Tutton in the chair.—Prof. H. **Hilton**: The vibrations of a crystalline medium. The paper attempts to give an indication of the kind of vibrations which the molecules of a crystal may be expected to make about their positions of equilibrium. The case of an orthorhombic crystal in the form of a rectangular parallelepiped is considered in detail, and the normal modes of the molecular motion are completely determined.—Prof. R. **Ohashi**: Augite from Nishigatake, Japan. The crystals have been detached from basalt by natural weathering; the specific gravity is 3·338 at 4° C. The prism angle agrees with that of diopside, but that of the pyramid does not. Etched figures show that the crystal belongs to the holosymmetric class. Both the optical properties and chemical composition show that in this augite the diopside molecule predominates.—Dr. G. T. **Prior**: The chemical composition of the Adare and Ensisheim meteorites. The results of the analyses supported the idea that in meteoric stones the ratio of MgO to FeO in the magnesium silicates varies directly with the ratio of Fe to Ni in the nickel-iron. For Adare these ratios were respectively $4\frac{1}{2}$ and 11, and for Ensisheim 3 and $3\frac{1}{2}$.—W. **Barlow**: Models representing the atomic structure of calcite and aragonite.

CAMBRIDGE.

Philosophical Society, March 7.—Prof. A. C. Seward, president, in the chair.—Prof. R. C. **Punnett**: A peculiar case of heredity in the sweet pea.—C. G. **Lamb**: (1) Insect oases. Certain species of Diptera occur for several consecutive years in extremely localised patches in a certain locality which was characterised by extreme uniformity in respect to its flora, etc. Several of the species are so far only known from that locality, and are of South European distribution. The suggestion was made that the species is putting up its last fight against extinction. (2) Venational abnormalities in Diptera. The great rarity of teratological conditions in the wings of flies other than the Nematocera was illustrated. An exception exists in the Ortalid, *Ptilonota guttata*. The instability of the species is confirmed by the commonness of great diversity in the acrostichal bristles, and by its having afforded the only known dipterous case of Batesonian teratology in an antenna.—Prof. S. J. **Hickson**: Some Alcyonaria in the Cambridge Museum. Two specimens collected by Darwin in the *Beagle* in the Galapagos Islands in 1835. One is clearly a representative of a species that has not hitherto been described, and the author proposes to name it *Cavernularia Darwinii*. The character which distinguishes it from all other species that have been described is seen in the spicules, which are short rods with two, three, or four knobs at each end. The other specimen preserved by Darwin in the Galapagos Islands is a frag-

ment of a Gorgonid, probably belonging to the genus Septogorgia. There are two other species of the genus Cavernularia in the collection, one *C. Chuni*, from the coast of Borneo, and the other *C. analabarica*, from the Bay of Bengal. They are the only sea-pens that have been described by the collectors as "washed ashore," and must therefore have either a floating habit or a very feeble attachment to the bottom. Specimens of the genus Pseudocladochonus from the coast of Japan have been hitherto recorded only from the Malay Archipelago. They show a remarkable resemblance to the extinct Carboniferous fossil Cladochonus of the family Auloporidæ, but, as pointed out by Versluys, the resemblance is probably due to convergence. A re-examination of some specimens of the genus Vergularia from the coast of Victoria, Australia, shows that they cannot satisfactorily be separated from the British and North Atlantic species *Vergularia mirabilis*. An Alcyonarian belonging to the genus Sarcodictyon came from the coast of South Australia, and is difficult to separate from the species *S. catenata*, which has hitherto been recorded only from the British area. These two species offer examples of geographical discontinuity.—J. **Gray**: The mechanism of ciliary movement. The movement of the cilia on the gills of *Mytilus edulis* was described. The effects of acids and of certain metallic ions seem to indicate that the mechanism of ciliary and muscular activity is essentially the same.—A. B. **Appleton**: The influence of function on the conformation of bones. A summary was presented of the effects produced on the mammalian femur of those muscular specialisations characteristic of cursorial, jumping, and arboreal types respectively. Consideration of the maximum effective leverage attainable by the adductor and femorococcygeus muscles in different positions of the thigh was shown to harmonise with some variations in their attachment in various mammalian groups.—J. T. **Saunders**: A note on the hydrogen-ion concentration of some natural waters. The hydrogen-ion concentration of waters occurring naturally in those districts where chalk, gault, or lime is present in the soil or subsoil is remarkably constant. Divergences are caused by the presence of large masses of vegetation, by débris stirred up from the bottoms by currents, or by the presence of sewage or other decaying organic matter.—P. A. **Buxton**: Animal ecology in deserts. The paper recorded some incomplete observations on desert life, the majority made in Mesopotamia under war conditions. Heat, dryness, terrific winds, low relative humidity, great diurnal range of temperature, the heat of the surfaces on which many of the desert animals crouch, and the brilliant direct sunshine are characteristic of the region. Protective coloration is a well-known characteristic of desert animals; it is difficult to see of what advantage it can be to purely nocturnal animals. The coloration of the courser is not efficient, because the bird's legs are long and it casts a sharp black shadow. The animals which are not protectively coloured are black. These are all probably protected by characters other than colour. The development of certain insects is inhibited in summer; probably the inhibitory factor is high temperature or low relative humidity; it is certainly not due to a drying up of the food-plant.—J. **Line**: The biology of the crown gall fungus of lucerne. The thallus of this fungus, *Urophlyctis alfalfae* (Lagerh.), P. Magnus, is described. Resting spores are developed as simple terminal proliferations from the swollen hyphal ends, no conjugation process taking place. They produce a large number of zoospores on germination, which normally infect only the young adventitious buds of *Medicago sativa* and possibly *M. falcata*, causing the formation of galls.

EDINBURGH.

Royal Society, March 21.—Prof. F. O. Bower in the chair.—Prof. H. **Briggs**: An experimental analysis of the losses due to evaporation of liquid air contained in vacuum flasks. Liquid air and liquid oxygen are now being employed not only in the laboratory, but also to serve the airman in high flying, for mine rescue apparatus and blasting in mines and quarries, for evacuation plant, and for medical purposes. If a European war were ever to break out again, oxygen would, owing to the probable use of poison gases in enormous quantities, become the chief remedial measure, and would be required on a colossal scale. The experiments described in the paper gave a quantitative measure of the proportion of heat entering a vacuum flask containing liquid air (*a*) by conduction through the vacuum, (*b*) by radiation across the vacuum, and (*c*) by conduction along the neck; they further provided data for calculating the pressure in the vacuum space and the emissivity of the reflected surfaces bounding that space. The purpose of the investigation was to get information to assist in the design of metallic vacuum vessels.—Dr. J. **Marshall**: A generalisation of Lagrange's equations of motion and their Hamiltonian forms.—Sir T. **Muir**: Note on a continuant of Cayley's of the year 1874.

PARIS.

Academy of Sciences, March 14.—M. Georges Lemoine in the chair.—E. **Picard**: The determination of the axis of rotation and velocity of rotation of a solid body.—H. **Douvillé**: A brackish-water fauna at the top of the Lower Cretaceous near Bayonne.—G. **Gouy**: Imperfect aplanetism.—L. E. **Dickson**: The composition of polynomials.—A. **Witz**: An aviation motor admitting of a constant mass, with constant compression at all altitudes.—Sir George Greenhill was elected a correspondant for the section of mechanics in succession to the late M. Voigt.—G. J. **Rémoundos**: Couples of algebroid functions of one variable corresponding to the points of an algebraic curve of higher order than unity.—C. E. **Traynard**: Singular hyperelliptic functions.—N. **Abramesco**: Developments in series according to the inverse of given polynomials.—T. **Varopoulos**: Some points in the theory of functions and the theory of numbers.—A. **Denjoy**: A calculation of totalisation.—T. **Carleman**: A class of integral equations with asymmetrical nucleus.—H. **Mellin**: Solution of the general algebraical equation with the aid of the Γ function.—J. L. **Walsh**: The position of the roots of the derived functions of a polynomial.—P. **Le Rolland**: The deviations from the law of isochronism produced by the suspension strip of the pendulum. The suspension of a pendulum by an elastic strip of metal partially compensates the circular error for large amplitudes, but compensation is not possible at all amplitudes.—A. **Véronnet**: Hypotheses on the formation of new stars.—J. B. **Charcot**: The Island of Jan Mayen. This island was supposed to have been first discovered in 1611 by the Dutch sailor whose name it bears. The descriptions in the "Légende Latine" (ninth century) of the voyages of the Irish monk, Brennain Mac Finlonga (St. Brandan), include such an exact account of this island that the author agrees with E. Beauvois that the Irish monk must have been the first discoverer.—F. **Schrader**: The new universal atlas of Vivien de Saint-Martin and Schrader.—M. **Pariselle**: The hydrates of pyridine. Nine different hydrates of pyridine have been described. From a critical discussion of the data it is concluded that in no case is the evidence sufficient to prove the existence of a definite combination of pyridine and water.—R. **Audubert**: The elementary quantity of energy concerned in solu-

tion. An attempt to discover for the dissolved state a law equivalent to Trouton's law for the gaseous state. Calling ρ the molecular latent heat of solution and T the temperature which corresponds for the state of saturation to an osmotic pressure of one atmosphere, ρ/T should be constant if an analogous relation holds. For various salts in solution this ratio has a value of about 32.—J. **Meunier**: The principles of analysis by means of reducing flames; the detection of traces of manganese in the presence of iron or other substances. The material in the form of powder is carried away as dust in a stream of hydrogen which is ignited and the flame examined spectroscopically.—L. **Forsén**: The constitution and systematic representation of the complex derivatives of the molybdic acids.—R. **Fosse** and G. **Laude**: Syntheses of cyanic acid and urea by the oxidation in alcoholic ammoniacal solution of phenols and aldehydes. The production of ammonium cyanate and urea by the oxidation of ammonia and alcohols is favoured by the presence of copper. Thus with ethyl alcohol the yield of urea is increased from 0·85 to 8·32 grams per 100 c.c. of alcohol by the addition of copper salts. Details of the amounts of urea obtained are given for various alcohols, phenols, and aldehydes.—M. **Godchot**: Some derivatives of thuyamenthone.—O. **Bailly**: The action of epichlorohydrin on disodium hydrogen phosphate in aqueous solution and the stability of a monoglyceromonophosphoric ester.—A. **Mailhe**: The preparation of the amines of secondary alcohols. The method of reduction of ketazines by hydrogen in presence of reduced nickel described in an earlier communication has been extended to ketazines of the formula R·CO·R′. Several new primary and secondary amines have been prepared.—P. **Gaubert**: The interference colours produced by thin crystalline plates.—A. **Briquet**: The low country of Picardy north of the Somme: the existing shore-line.—R. **Dongier**: The simultaneous oscillations of temperature and wind at the top of the Eiffel Tower and their relation with the Bjerknes steering surface of a depression. Two temperature charts on different days are given, showing the variations of temperature at the summit of the tower and at three lowel levels; the variations of the velocities of the wind at the summit are also shown. The diagrams prove the existence of a current of warm air set in motion above the colder layers by forces always present in a depression. This is in good agreement with the views of Bjerknes on the structure of cyclones in movement.—M. **Delcambre**: A case of sudden filling of an atmospheric depression.—R. **Souèges**: The embryogeny of the Scrofulariaceæ: development of the embryo in *Veronica arvensis*.—P. **Nobécourt**: The action of some alkaloids on *Botrytis cinerea*.—Mlle. D. **Kohler**: The variation of organic acids in the course of anthocyanic pigmentation. Details of experiments proving that anthocyanic pigmentation is not accompanied by an increase in the amount of organic acids.—E. **Couvreur** and X. **Chahovitch**: A natural mode of defence against microbe infections in the invertebrates. Micro-organisms (pyocyanic and coli bacilli) are destroyed by the blood and digestive fluids of certain invertebrates.—A. **Thooris**: The morphological classification of fifty champion athletes. Metric verification by radioscopy.—L. **Mercier**: *Apterina pedestris*. The flight muscles in certain Diptera, wingless or with rudimentary wings.—A. **Lécaillon**: The action exerted by concentrated sulphuric acid on the eggs of *Bombyx mori*.—H. **Drouin**: Changes in the absorption by skin and muscular tissue brought about by the addition of lipoids to stannous solutions.—W. **Kopaczewski**: A simple apparatus for measuring surface tension.—G. **Blanc**: Experimental researches on the virus of herpes.

Books Received.

Artificial Light: Its Influence upon Civilization. By M. Luckiesh. (Century Books of Useful Science.) Pp. xiv+366. (London: University of London Press, Ltd.) 12*s*. 6*d*. net.

Creative Chemistry: Descriptive of Recent Achievements in the Chemical Industries. By Dr. Edwin C. Slosson. (Century Books of Useful Science.) Pp. xvi+311. (London: University of London Press, Ltd.) 12*s*. 6*d*. net.

Field Methods in Petroleum Geology. By Dr. G. H. Cox and others. Pp. xiv+305+xi plates. (New York and London: McGraw-Hill Book Co., Inc.) 24*s*. net.

The Chemistry of Plant Life. By Dr. Roscoe W. Thatcher. (Agricultural and Biological Publications.) Pp. xvi+268. (New York and London: McGraw-Hill Book Co., Inc.) 18*s*. net.

The Fauna of British India, including Ceylon and Burma. Mollusca, iii.: Land Operculates (Cyclophoridæ, Truncatellidæ, Assimineidæ, Helicinidæ). By G. K. Gude. Pp. xiv+386. (London: Taylor and Francis; Calcutta: Thacker, Spink and Co.; Bombay: Thacker and Co., Ltd.) 35*s*.

Thoughts of a Nature Lover. By Kenneth Rogers. Pp. 125. (London: Holden and Hardingham, Ltd.) 5*s*. net.

Municipal Engineering: Surveying the Scope of Municipal Engineering and the Statutory Position, the Appointment, the Training, and the Duties of a Municipal Engineer. By H. Percy Boulnois. (Pitman's Technical Primers.) Pp. vii+103. (London: Sir I. Pitman and Sons, Ltd.) 2*s*. 6*d*. net.

The Essentials of Mental Measurement. By Dr. William Brown and Prof. Godfrey H. Thomson. (Cambridge Psychological Library.) Pp. x+216. (Cambridge: At the University Press.) 21*s*. net.

A Short Manual of Forest Management. By H. Jackson. Pp. x+70. (Cambridge: At the University Press.) 7*s*. net.

Board of Education. Illustrated Catalogue of the Collections in the Science Museum, South Kensington, with Descriptive and Historical Notes: Machine Tools. Pp. 61+iii plates. (London: H.M. Stationery Office.) 1*s*. net.

Transactions of the Royal Society of Edinburgh. Vol. lii., part iv., No. 29. Isle of Wight Disease in Hive Bees. Pp. 737–79. (Edinburgh: R. Grant and Son; London: Williams and Norgate.) 9*s*.

Geological Survey of Nigeria. Bulletin No. 1: The Geology of the Plateau Tin Fields. By Dr. J. D. Falconer. Pp. 55+x plates. (Nigeria.) 10*s*. net.

Medical Research Council and Department of Scientific and Industrial Research. Reports of the Industrial Fatigue Research Board, No. 11. Preliminary Notes on Atmospheric Conditions in Boot and Shoe Factories. (Boot and Shoe Series, No. 2.) Pp. 69. (London: H.M. Stationery Office.) 3*s*. net.

A New British Flora: British Wild Flowers in their Natural Haunts. Described by A. R. Horwood. Vol. iii. Pp. xi+251+xviii–xxxi plates. Vol. iv. Pp. xi+257+xxxii–xlix plates. (London: Gresham Publishing Co., Ltd.) 12*s*. 6*d*. net each vol.

Bibliographie des Livres Français de Médecine et de Sciences. Publiée par la Section de Médecine du Syndicat des Editeurs. 1908–20. Pp. xiii+146. (Paris.)

Legislative Assembly, New South Wales. Report of the Director-General of Public Health, New South Wales, for the year 1919, including a Report on the Influenza Epidemic, 1919. Pp. v+272+x plates. (Sydney: W. A. Gullick.) 6*s*. 9*d*.

Universities and their Freedom. By W. M. Childs. Pp. 56. (London: A. L. Humphreys.) 2*s*. net.

Joseph Glanvill and Psychical Research in the Seventeenth Century. By H. Stanley Redgrove and I. M. L. Redgrove. Pp. 94. (London: W. Rider and Son, Ltd.) 2s. 6d. net.

Report of the Ninth Annual Conference of Educational Associations held at the University College, London, 1921. Pp. viii+470. (London: Conference Committee, 9 Brunswick Square, W.C.1.) 5s.

The Electro-Deposition of Copper and its Industrial Applications. By Claude W. Denny. (Pitman's Technical Primers.) Pp. xii+108. (London: Sir I. Pitman and Sons, Ltd.) 2s. 6d. net.

Diary of Societies.

THURSDAY, APRIL 7.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. T. R. Wilson: Thunderstorms (Tyndall Lectures).

LINNEAN SOCIETY, at 5.—Reginald A. Malby: A Miniature Alpine Garden from January to December.—H. W. Monckton: Exhibition of Various Forms of *Taraxacum erythrospermum*, Andrz.

CHILD-STUDY SOCIETY (at Royal Sanitary Institute), at 6.—M. Dainow: Original Research in Vocational Tests.

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—K. Baumann: Some Recent Developments in Steam Turbine Practice.

CHEMICAL SOCIETY (at Institution of Mechanical Engineers), at 8.—Dr. F. W. Aston: Mass Spectra and Atomic Weights.

FRIDAY, APRIL 8.

ROYAL ASTRONOMICAL SOCIETY, at 5.—E. A. Milne: Radiative Equilibrium and Spectral Distribution.—E. A. Milne: Radiative Equilibrium in the Outer Layers of a Star: The Temperature Distribution and the Law of Darkening.—Prof. H. H. Turner: Note on Barnard's Observations of Nova Ophiuchi No. 2 (Hind, 1848) and of Nova Persei No. 2 (Anderson, 1901).—Guido Horn d'Arturo: A Spiral Nebula in the Northern Hemisphere of the Milky Way.—Major W. J. S. Lockyer and D. L. Edwards: The Spectrum of ϕ Cassiopeiæ in Relation to those of α Cygni and γ Cygni.—Rev. A. L. Cortie: The Ultra-violet Spectrum of Nova Aquilæ 1918 June 10.—Sir W. H. M. Christie: Observations of the Moon, Saturn, etc., made at Prof. W. H. Pickering's Observatory in Jamaica.

PHYSICAL SOCIETY OF LONDON (at Imperial College of Science), at 5.—Dr. W. J. H. Moll: A New Registering Microphotometer.—Sir William Bragg: The Examination of the Structure of Crystals in the Form of Powder by Means of the Ionisation Spectrometer.—H. Parry: A Balance Method of Using the Quadrant Electrometer for the Measurement of Power.

ROYAL SOCIETY OF MEDICINE (Clinical Section), at 5.30.—Dr. Ivor Davies: Hair Ball or Hair Cast of the Stomach and Gastro-Intestinal Tract. A Report of Two Cases with Specimens, and an Abstract of 108 Cases from the Literature.—Dr. M. Cassidy: Report *re* Case of Neoplasm of Lung.

ROYAL INSTITUTION OF GREAT BRITAIN, at 9.—Dr. R. H. A. Plimmer: Quality of Protein in Nutrition.

SATURDAY, APRIL 9.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. H. H. Dale: Poisons and Antidotes.

MONDAY, APRIL 11.

ROYAL GEOGRAPHICAL SOCIETY (at Lowther Lodge), at 5.—E. Heawood: The World-Map before and after Magellan's Voyage.

INSTITUTION OF ELECTRICAL ENGINEERS (Informal Meeting) (at Chartered Institute of Patent Agents), at 7.—F. Creedy and Others: Some Characteristics and Applications of Multispeed A.C. Motors.

INSTITUTION OF MECHANICAL ENGINEERS (Graduates' Meeting), at 7.—L. H. Bedford: Electrolysis as Applied to Engineering.

SURVEYORS' INSTITUTION, at 8.—L. S. Wood: The Forestry Directorate in France.

ROYAL SOCIETY OF ARTS, at 8.—Dr. S. J. Lewis: Recent Applications of the Spectroscope and the Spectrophotometer to Science and Industry.

TUESDAY, APRIL 12.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Prof. R. A. Sampson: The Measurement of Starlight.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. T. Lewis: Observations upon the Nature of Auricular Flutter and Fibrillation (Oliver-Sharpey Lecture).

ROYAL PHOTOGRAPHIC SOCIETY OF GREAT BRITAIN, at 7.—H. M. Lomas: Problems of Kinematography.—R. J. Trump: A Shutterless Continuous Feed Kinematograph.

QUEKETT MICROSCOPICAL CLUB, at 7.30.

ROYAL AERONAUTICAL SOCIETY (at Royal Society of Arts), at 8.—Major G. I. Taylor: Annual Wilbur Wright Lecture.

ROYAL ANTHROPOLOGICAL INSTITUTE, at 8.15.—L. H. Dudley Buxton: The Ancient and Modern Inhabitants of Malta.

WEDNESDAY, APRIL 13.

ROYAL SOCIETY OF MEDICINE, at 5.—Sir Thomas Horder, Mr. Clayton-Greene, Sir Berkeley Moynihan, Dr. D. Pennington, A. Evans, and Others: The Problems For and Against Team Work in this Country.

ROYAL SOCIETY OF MEDICINE (Proctology Sub-section), at 5.—Mr. Lockhart-Mummery, Sir Charles Gordon-Watson, and Others: Pruritus Ani.

ROYAL SOCIETY OF ARTS, at 8.—Prof. H. E. Armstrong: Low Temperature Carbonisation and Smokeless Fuel.

INSTITUTION OF AUTOMOBILE ENGINEERS (at Institution of Mechanical Engineers), at 8.—G. Watson: A Suggested Programme for Automobile Research.

THURSDAY, APRIL 14.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—C. T. R. Wilson: Thunderstorms (Tyndall Lectures).

ROYAL SOCIETY, at 4.30.—*Probable Papers.*—Prof. K. Onnes, Sir Robert Hadfield, and Dr. H. R. Woltjer: The Influence of Low Temperatures on the Magnetic Properties of Alloys of Iron with Nickel and Manganese.—C. N. Hinshelwood and E. J. Bowen: The Influence of Physical Conditions on the Velocity of Decomposition of Certain Crystalline Solids.—N. K. Adam: The Properties and Molecular Structure of Thin Films of Palmitic Acid on Water. Part I.—E. P. Metcalfe and B. Venkatesachar: The Absorption of Light by Electrically Luminescent Mercury Vapour.

ROYAL COLLEGE OF PHYSICIANS OF LONDON, at 5.—Dr. T. Lewis: Observations upon the Nature of Auricular Flutter and Fibrillation (Oliver-Sharpey Lecture).

INSTITUTION OF ELECTRICAL ENGINEERS (at Institution of Civil Engineers), at 6.—E. A. Watson: Magnetos for Ignition Purposes in Internal Combustion Engines.

OIL AND COLOUR CHEMISTS' ASSOCIATION (at 2 Furnival Street), at 7.30.—F. H. Barry: Indian Products of Interest to the Oil and Colour Chemist.

OPTICAL SOCIETY (at Imperial College of Science), at 7.30.—F. Twyman: An Interferometer for the Testing of Camera Lenses.—W. Shackleton: The Testing of Heliograph Mirrors.

RÖNTGEN SOCIETY (at University College), at 8.15.

FRIDAY, APRIL 15.

ROYAL COLLEGE OF SURGEONS OF ENGLAND, at 5.—Prof. A. Keith: Demonstration of the Contents of the Museum.

SATURDAY, APRIL 16.

ROYAL INSTITUTION OF GREAT BRITAIN, at 3.—Dr. H. H. Dale: Poisons and Antidotes.

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