THURSDAY, DECEMBER 16, 1897.

MENDELÉEFF'S PRINCIPLES OF CHEMISTRY.

The Principles of Chemistry. By D. Mendeléeff. Translated from the Russian (sixth edition) by George Kamensky, A.R.S.M. Edited by T. A. Lawson, B.Sc., Ph.D. Two vols. Pp. xviii + 621 and 518. (London: Longmans, Green, and Co., 1897.)

AN English translation of the earlier (fifth) edition of this remarkable book was prepared by Mr. Kamensky, and edited by Mr. A. J. Greenaway, in 1891. It is therefore familiar to the English chemical world; and that a second edition of the English version should be called for in a comparatively short time, is a proof that the views of the author have a fascination which secures for the book a wide circle of readers. The author speaks of it modestly "as an elementary text-book of chemistry"; but it is probable that the previous edition has been exhausted less by a demand on the part of beginners in the subject, for whom, to say truly it is little adapted, than as a consequence of the interest which has been excited among advanced students and professed chemists by the exposition of the doctrine embodied in the so-called "Periodic Law," which is the principal feature of the work. Enough has already been said in the pages of NATURE (see vol. xlv. p. 529) concerning the characteristics of the book itself—the extraordinary development of the foot-notes, which often expand to such dimensions as almost to drive the text out of the page, and which in many cases contain far more interesting matter; the strange inequality in the materials collected, many processes, especially those connected with manufactures, being quite antiquated; and others which need not be recalled. The confusion of proper names, owing to errors of spelling, is not so conspicuous as in the former editions, though one ludicrous substitution occurs in the chapter on spectrum analysis, where Huggins is three times over transformed into Huyghens! Such defects, however, do very little to impair the real value of the book, or obscure the genius of the author. Turning from the attitude of the literary critic to that of the scientific inquirer, it is much more profitable to see what such a chemist as Mendeléeff has to say about special questions of fundamental or primary importance.

In chemistry the word element is in constant use in the sense originally taught by Boyle, that is, signifying something which has up to the present remained undecompounded. At the present day the majority of chemists have probably settled down to the belief that our seventy or eighty "elements" represent limiting material, and that, so far as terrestrial affairs are concerned, so they will always remain. Others—probably however, a minority—conceive that relations among their atomic weights hint that they may be compounded of finer matter united in various ways, and though they may not expect to rupture the bond which unites the subatomic constituents together by any laboratory process, yet they see in the spectral phenomena of the stars evidence that under other conditions this rupture may actually be accomplished. Mendeléeff seems to believe in the permanence of the terrestrial elements, for not only in the two foot-notes on p. 20, vol. i., but in a long digression upon the subject of Prout's hypothesis (p. 439-441, vol. ii.), he emphatically rejects the idea that the atomic weights of other elements have any definite numerical relation to that of hydrogen, and he points out that attempts at transmutation of one element into another have been hitherto fruitless. "All such ideas and hopes," he says, "must now, thanks more especially to Stas, be placed in a region void of any experimental support whatever, and therefore not subject to the discipline of the positive data of science." Now and again, even at the present day, there is a recrudescence of alchemistic pretensions, but it may be noticed that the discovery for which a claim is put forward always relates to the transmutation of a base metal into silver or silver into gold. If any one suggested that he had succeeded, for example, in extracting lead from thallium, he would be laughed at for his pains, but if he boldly asserts that by a long and secret process he has succeeded in making gold out of silver, he generally finds a few people at least ready to take him seriously.

Chemical affinity is another expression still freely used though with widely different meanings by different chemists; and here again a definite expression of the author's views is fortunately to be found in the pages of his book. He says (p. 27):

> "For a long time, and especially during the first half of this century, chemical attraction and chemical forces were identified with electrical forces. There is certainly an intimate relation between them, for electricity is evolved in chemical reactions, and has also a powerful influence on chemical processes—for instance, compounds are decomposed by the action of an electric current. And the exactly similar relation which exists between chemical phenomena and the phenomena of heat (heat being developed by chemical phenomena, and heat being able to decompose compounds) only proves the unity of the forces of nature, the capability of one force to produce and to be transformed into others. For this reason the identification of chemical force with electricity will not bear experimental proof."

He then goes on in a characteristic foot-note to refer to the facts of substitution or "metalepsy," in which hydrogen, a "positive" element, may be exchanged for chlorine, a "negative" element, without altering the chief chemical characters of the compounds in which the exchange occurs. On a later page, also in a foot-note the author gives an account of the electro-chemical theories of Davy and Berzelius, and their relation to successive hypotheses of the constitution of salts; and here again he seems to reject all modifications of Berzelius' polar doctrine. It must be admitted, however, that the book is not strong in this direction. After much research we have not succeeded in finding a definite statement of such important facts as are embodied in Faraday's laws of electrolysis, the nearest approach to it being found on p. 581, but followed by an apologetic foot-note in which it is stated that the plan and dimensions of the book prevent the author from "entering upon this province of knowledge." This is to be regretted, considering the importance to the chemical student of a good acquaintance with the facts, methods and hypotheses of the now largely-developed province of electro-chemistry.

The preface of the new edition contains a special reference to the author's views concerning solutions—a subject for which he expresses great personal predilection, and to the experimental investigation of which he has devoted some time and labour. A paper by Mendeléeff relating to solutions of alcohol in water was communicated to the Chemical Society of London in 1887. He now states that we have not yet "the right to consider even the most elementary questions respecting solutions as solved." "My own view is that a solution is a homogeneous liquid system of unstable dissociating compounds of the solvent with the substance dissolved." In a foot-note, beginning p. 64, he explains the gas theory as applied to dilute solutions, and expresses the view that the physical and chemical aspects of the question, referring respectively to dilute and strong solutions, must be reconciled. The passage is too long for quotation; but supporters of the so-called hydrate theory may still count the great Russian chemist as on their side, at any rate so far as strong solutions are concerned.

There are, of course, many other subjects which the reader of the book will pursue with much interest, in view of the eminence of the author and the originality with which they are treated; but none of these will equal in attractiveness the subject of the grouping of the elements and the development of the periodic law. It is interesting to remember that, as the author tells us in the preface (p. xii), it was while engaged in writing the first edition of the book in 1869 that he first perceived the scheme and the application of the periodic law in its entirety. But it is only at the opening of the second volume that we come to the exposition of the principles which guided him in the grouping of the elements. This is accompanied by a foot-note which contains a historical *résumé* of the course of events which led ultimately to the recognition of these important principles by all chemists. And here we find a passage (*note* 13, p. 26) which sets forth clearly the depth and solidity of Mendeléeff's conception of the periodic "law," and the superiority of his claim to be regarded as the discoverer of the relation of properties to atomic weight among the elements. Having become convinced that the atomic weights and properties of the elements were mutually related in a certain manner, the Russian chemist did not hesitate to alter accepted atomic weights when required to fall in with the scheme, and to predict the properties of then undiscovered elements; while "neither De Chancourtois, to whom the French ascribe the discovery of the periodic law, nor Newlands, who is put forward by the English, nor L. Meyer, who is now cited by many as its founder, ventured to" do anything of the sort.

As such fortunate and valuable consequences have happily followed the study of the atomic weights by Mendeléeff, it is perhaps hypercritical to complain of his use of the term "law" in the vulgar ambiguous sense.

What after all is a "law of nature"? Is it not a compendium or summary of a series of observed agreements? and the statement so often used by Mendeléeff, that "the laws of nature admit of no exception," by no means proves that exceptions to any and every recognised law of nature may not hereafter be discovered. As such a statement now stands, it merely implies that in most cases the induction is at present incomplete. The question now comes, whether the periodic law itself is a "law of nature"? This is a question which must be troubling very much the discoverer of the law at the present time, now that the individuality of argon and, though less certainly, that of helium have been established. The subject is dealt with in Appendix iii. at the end of the second volume, written by Prof. Mendeléeff in February 1895, and here he clings to the idea that argon is a polymeride of nitrogen, or N_3.

This hypothesis, however, cannot be maintained. All that is known of argon shows that it is a gas having a density lower than 20 (H = 1), and hence that its molecular weight is less than 40, while that of N_3 would be 42. Argon and helium can at present be regarded only as a kind of chemical monsters brought unexpected and unwelcome, like the cuckoo, into the previously happy family of the elements where no place is provided for them. What, then, becomes of the "law of nature" if these two substances are admitted to be exceptions to the law as it now stands? and yet that they are exceptions is the conclusion which seems inevitable. W. A. T.

THE NATURAL HISTORY OF THE ANCIENT WORLD.

Les Choses Naturelles dans Homère. Par le Dr. A. Kums. Pp. 194. (Antwerp: Buschmann. Paris: Alcan, 1897.)

Gleanings from the Natural History of the Ancients. By the Rev. M. G. Watkins, M.A. Pp. xiii + 258. (London: Elliot Stock, 1896.)

The Works of Xenophon. Translated by H. G. Dakyns, M.A. Vol. iii. part ii. Pp. lxx + 130. (London: Macmillan and Co., Ltd., 1897.)

Aristotle on Youth and Old Age, Life and Death and Respiration. Translated, with Introduction and Notes, by W. Ogle, M.A., M.D. Pp. 135. (London: Longmans and Co., 1897.)

THE consideration of the animal world is usually approached from one or other of three points of view. We may be interested in the structure—the morphology and physiology—of animals, and in their place in nature: this is the biological interest. Or we may be especially interested in their habits and doings, and every one has at least observed something of the characters and ways of more than one species of animal. Or we may regard animals as objects of the chase or material for human food. The first of these interests is purely scientific; it must exclude hearsay and fancy; it must be based on the most careful observation and examination with the aid of all the appliances that contemporary art and manufacture can furnish; and it must admit nothing that is unverifiable or supported by doubtful authority. On the other hand, the study of the habits and characters of animals can seldom confine itself to lines so rigidly laid down as these; not only is it extremely difficult for the most scientific investigators to interpret or even to record the actions of the lower creatures without a certain, often unconscious, anthropomorphism or reading-in of motives into them; but we are also confronted by a mass of current beliefs and superstitions, and imperfectly authenticated tales which, in view of their frequent repetition and the widespread evidence accorded to them, it is impossible to dismiss unconsidered, improbable though they may seem at first. Such legends can never be wholly banished from view until we have accounted for their coming into being at all; and the naturalist is thus frequently led into the domain of folk-lore and the study of primitive religious ideas, which from totemistic stages onwards have always in some way or other touched upon the connection of the human and animal worlds. The attitude of the huntsman is different from both those just considered: he makes a very minute study of some of the habits of a few animals, mainly with a view to making himself master of them in a manner gratifying to the sporting instinct.

In the volumes before us all these interests are represented. They all deal with the attitude of the Greeks—in part also of the Romans—to animal nature. Until the time of Aristotle scientific study can hardly be said to have existed, though in him, so far at least as method is concerned, it appears suddenly in almost as systematic a form as any science can boast of at the present day. But hunting and the observation of the ways of animals seem to have been habitual to the Greeks. No one can have failed to notice the unerring accuracy with which Homer, in a few graphic strokes, brings before his readers some familiar scene from nature—the lion and his prey, the jackals surrounding the stag, the tettix, "which in the thickets, sitting on a tree, sendeth forth its thin clear voice," and very many others. Again, the hunting of the boar and of the stag, with all their accompaniments, Homer knew well, and in the works of Dr. Kums and Mr. Watkins all these and kindred topics are treated in some detail. Dr. Kums confines himself to Homer, and it is to students of Homer that his book will be especially interesting. It is an enumeration under classified headings of all that Homer says in different passages about the various departments of nature and human nature, and is a very accurate, complete and well arranged compilation. But it is no disparagement of the book to say that, for the most part, it is not of great general scientific importance. External nature only enters into the poems of Homer as it were by accident, in similes which illustrate human action, or in descriptions of events affecting human agents; and the interest which he arouses is artistic rather than scientific: we are chiefly struck with the perfect description of what the poet saw, with the clearness and truth to life of his pictures. Mr. Watkins, in his "Gleanings," allows himself to range over the whole field of classical literature, and under the title of the "Ancients" he includes not only the Greeks and Romans, but the early Teutonic and Celtic races, and especially our own forefathers; indeed, he deals with much literature that cannot be called "ancient" in the ordinary sense of the word at all, even English literature down to about the sixteenth century. His work is a collection of points which have interested him in the course of his unusually wide reading, in regard to the observation and appreciation of the animal world in periods when science had not become scientific; and we find, not of course a serious or systematic contribution to science or to the history of science, but a delightful mosaic of quotations, anecdotes and folk-lore, very artistically put together, and compared with modern views as expressed in passages from Darwin and other writers. The occasional antiqueness of the author's language, and even the use of the long *s* in the type, which unsympathetic critics would no doubt condemn as affectation, are in keeping with a certain *naïveté* and gracefulness of manner, which add greatly to the pleasure given by the large amount of entertaining information which the book contains. We should not expect in such a book, and we do not find, a complete exposition of the Aristotelian "Systema Naturae"—the only great contribution of the ancient world to natural history and biology; but the author appreciates very fairly indeed the merits of Aristotle and other ancient writers from the naturalist's point of view. Aristotle he recognises as having "sifted much of the popular knowledge, as is his wont"; though even Aristotle is gently censured as uncritical in comparison with modern writers. (To this we shall return.) Pliny, on the other hand,

"though he lived so much later, was an eager listener to all old women's tales. . . . The vastness of his own compilations, and his perpetual industry in noting any circumstances of interest connected with Natural History, smothered his judgment. He had neither time to sift facts nor to weigh the authority to be attached to the statements of other authors; and these defects leave his great 'Natural History' a *rudis indigestaque moles* which compares unfavourably with the more exact and painstaking work of Aristotle."

It is a pity that Virgil is usually quoted in Dryden's translation (of whose defects Mr. Watkins is himself not unaware); for this rendering hopelessly obscures the quite unique power possessed by Virgil of calling up—often by a single word or line—inimitable pictures of external nature, whether scenery or animal life.

The book contains chapters on dogs, cats, owls, pygmies, elephants, horses, gardens, roses, wolves, fish, oysters and pearls. In a chapter on mythical animals there is a neat discrimination of the causes and characteristics of the animal folk-lore of several early peoples. Homeric and Virgilian natural history receive separate treatment; and a specially interesting portion of the work deals with the Romans as introducers into Britain and acclimatisers of a number of well-known animals and plants. We should like to see a fuller account of the influence on our fauna and flora of the periods marked respectively by the Roman occupation, the influx of monks from the continent, and the return of the Crusaders from the East, to all of which our author believes we can trace the introduction of many species. With the mention of a chapter on "Hunting among the Ancients," we may pass to Mr. Dakyns' translation of the *Cynegeticus* of Xenophon. This is hardly the place for a long notice of this work. Suffice it to say that it contains the same kind of matter as we should expect to find in a volume of the Badminton Library dealing with the same subjects—the hunting and tracking of hares with dogs and nets, and the chase and trapping of deer. The habits of the hare, the training, breeding points and management of dogs, and the functions of the keeper, are very fully treated; incidentally, too, precepts of sporting etiquette are introduced, *e.g.* the following:

"Here it should be added that the sportsman, who finds himself on cultivated lands should rigidly keep his hands off the fruits of the season, and leave springs and rivers alone. To meddle with them is ugly and base"

(Mr. Dakyns is responsible for this rather odd translation), "not to speak of the bad example of carelessness to the beholder."

The work is a marvellous display of close and intelligent observation by an enthusiastic sportsman, and will be full of interest to persons of similar taste in the present day. Of course it contains a good deal of "keepers' superstition," very similar to the fancies of the modern keeper, but this, perhaps, adds to the interest; and many more or less brilliant suggestions are made in explanation of facts which seemed to be in need of it. Mr. Dakyns' translation is spirited and, on the whole (to judge from passages chosen at random), accurate; and any sportsman into whose hand the book falls will feel grateful to him for rendering accessible the work of, perhaps, the acutest observer of outdoor life in antiquity.

In turning to Dr. Ogle's translation of some of the minor treatises of Aristotle, we enter the domain of science proper. The translator's name is sufficient guarantee of the excellence alike of introduction, translation, and notes: the work is quite up to the standard of the "Parts of Animals" by the same editor. Shortly, the doctrine contained in the treatises translated rests on the belief that life depends upon heat: the source of this heat was the heart, in which heat was continually being generated by the concoction of food received from the stomach and passed into the heart; and the heat thus generated supplied the place of that which was continually being given off by the body. But life might be destroyed by excess no less than by defect of heat; this excess was provided against by respiration, which cooled the violence of the "fire" in the heart, which always tended to become excessive: in the case of pulmonate animals, the air in the lungs was the means of refrigeration; in the case of branchiates, the water playing upon the gills. Natural death (as distinct from death by disease or violence) was due to the gradual exhaustion of vital heat—an idea at least as clearly defined as the "vital force" of many modern physiologists. The causes of longevity (in these and other treatises) are somewhat vaguely stated, but the correlation of longevity with such characters as large size, high organisation and length of the period of gestation, was observed by Aristotle. These points are, of course, worked out in much greater detail, and the exposition of them by Aristotle cannot here be reproduced at length. The first impression of an ordinary reader will probably be that views so absurd and obsolete are not worth consideration. But on further attention, we find that obsolete though these views may be, yet they were the first step towards a really scientific physiology. The physiology of Plato and Democritus was pure guesswork, or at least only guided by preconceived theories not falling within the range of physiology. It was Aristotle who first saw

"that the study of function must be preceded by the study of structure, or in other words, that physiology must be based upon anatomy. . . . By insisting on the absolute necessity of anatomical observation, he carried biology at one step from the world of dreams into the world of realities; he set the science on a substantial basis, and may indeed be said to have been its founder, for the same imaginings of his predecessors can hardly be dignified with the name of science."

And, to quote a later passage of Dr. Ogle's introduction:

"If we perform the difficult task of excluding from our minds all ideas and facts since acquired, we shall find ourselves constrained to admit that in Aristotle's days no better hypothesis could have been devised with which to colligate the facts or supposed facts then available."

And when we consider that such ideas and facts include among others those of chemical combination, the circulation of the blood and the existence of nerves, we shall be surprised to find the difference between the Aristotelian and the modern theories so slight as it is. In fact, as Dr. Ogle shows both in the introduction and notes, a very slight alteration of terminology is often all that is required to convert Aristotle's statements into propositions which would still be accepted as true; and even in their crude form, many of his doctrines (or something very like them) were held by the most advanced scientific men of recent centuries, Harvey himself among others. It is further remarkable that Aristotle should, with the extremely inadequate instruments and appliances at his command, have produced results so accurate in the region of anatomy and embryology: his account, *e.g.* of the lung, is a model of careful description so far as it goes, and the work before us will provide many other instances. Aristotle, of course, had his defects, and his editor points these out frankly: he occasionally (though far less than any other ancient author) took mere hearsay for fact; and he was scarcely alive to the importance of experiment. But he had a definite method of investigation; his conclusions were always based on recorded observations of himself and others; the advance he made was almost incredibly great for one man; and the lines he laid down have been (though unconsciously) followed and developed by all great physiologists ever since. To quote Dr. Ogle once more:

"There are minds to which the mistakes and shortcomings of great men apparently present greater attraction than their achievements. To them Bacon is but a man who believed in the spontaneous generation of mistletoe; Cuvier, an upholder of the fixity of species; Kepler, one who thought that the huge volcanoes in the moon were artificial structures built by its inhabitants; Descartes, an asserter of the immediate transmission of light; and Newton himself an advocate of the emission theory. To such persons Aristotle's anatomical statements will doubtless supply much desirable pabulum. But those more genial critics who prefer to dwell upon what a man has done well rather than what he has left undone or done amiss . . . will admit that never has a science been started on its career by its originator with so large an equipment of facts and ideas as that with which Comparative Anatomy left the hands of Aristotle."

THE MEASUREMENT OF RAPIDLY VARYING ELECTRIC PRESSURE.

The Capillary Electrometer: its Theory and Practice. Part i. By G. J. Burch, M.A. Pp. 54. Reprinted from the *Electrician.* (London: G. Tucker.)

MUCH of the present knowledge concerning the capillary electrometer is due to the author of this little book. The instrument was invented in 1875 by Prof. Lippmann, but for twenty years it was hardly used by any people except physiologists, and even by them only in a doubtful sort of way, for they thought that its indication gave merely the period and direction of a sudden change of P.D., and they feared that the magnitude of the variation could not be deduced from the excursion of the meniscus formed at the junction of the threads of mercury and dilute sulphuric acid.

It may be well to mention that we use the letters "P.D.," not merely because they appear to us to be a convenient abbreviation for "potential-difference," but because Mr. Burch, by employing them throughout his book, shows that he has the same opinion.

The book commences with a description of the best methods of constructing a capillary electrometer to which the author's experience has led him, and the reader is warned regarding the faults which he is likely to meet with in the practical use of the instrument, and instructed how to overcome those that can be remedied without making a new instrument.

The first two points that Mr. Burch determined to ascertain experimentally, when he began his work on the capillary electrometer in 1886, were: (1) Does any current pass through the instrument after the meniscus in the capillary tube has reached its stable position for the particular P.D. applied; and (2) does any leakage take place through the instrument if the applied P.D. be withdrawn after the meniscus has been deflected? To each of these questions experiment gave a negative answer, and he was, therefore, led to the conclusion that, although the circuit of a capillary electrometer is composed entirely of conducting substances, and, although there is no visible insulating dielectric, the instrument transmits no current with a P.D. of less than 0·5 volt, but merely receives and maintains a charge as if it were a well-insulated condenser.

The capacity of different capillary electrometers was found by the author to vary between 0·1 and 30 microfarads, but instruments having a capacity of between 0·5 and 2 microfarads gave the best results. When the capacity is unchanged on moving the mercury thread through a considerable portion of the capillary tube the electrometer is found to be equally sensitive throughout that part of the tube.

The author concludes that this instrument is essentially adapted to the poor man, since its cost, including that of the microscope, is less than that of any other electrometer of the same sensibility. It also has the advantage of responding with extreme rapidity to every change of potential.

Various methods are described in detail for obtaining records on photographic plates, having a rapid linear or circular motion, and the author shows how the instantaneous value of a rapidly varying P.D. can be deduced at any point of the photographic curve from the fact, which he proves, viz. that the value of the applied P.D. is measured at any moment by the instantaneous distance of the meniscus from the zero position *plus* the rate of motion of the meniscus at that moment. And in the case of the photographic plate moving circularly, he points out that the second term, depending on the instantaneous value of the velocity of the meniscus, is given by the length of the subnormal to the curve at the particular point.

The book concludes with some interesting examples of curves obtained with telephones, direct and alternate current dynamos, &c., from which the value of the capillary electrometer may be clearly seen.

The reasoning in some parts of the book is not very clear; and, while the figures of the parts of the apparatus itself are in many cases bold and well executed, those illustrating the geometrical reasoning, and the results obtained with the photographic plates, are not as intelligible as one would like. We hope to see Part ii. of this book at an early date; and, for the benefit of those who do not resemble the author in being masters in the use and the theory of the capillary electrometer, we trust that he will not hesitate to sacrifice compression to clearness.

W. E. A.

OUR BOOK SHELF.

A Handbook to the Geology of Cambridgeshire, for the Use of Students. By F. R. Cowper Reed, M.A., F.G.S. 8vo. Pp. x2 + 76. (Cambridge: at the University Press, 1897.)

The geology of Cambridgeshire possesses a special interest for many students. From Cambridge itself there have sprung a greater number of expert British geologists than from any other seat of learning in this country. Though founded by John Woodward, the school was created by Sedgwick; and it has been carried on with signal success by Prof. Hughes. This success, as the present Professor has cordially acknowledged, is partly due to the band of brilliant assistants he has gathered around him. Thus special instruction is given in all branches of geology, and the author of the present work has during recent years rendered aid in the department of stratigraphical palæontology. To a casual visitor the scenery and geology of Cambridgeshire may offer but few attractions, for the country is mostly low-lying, and there is much clay-land and fen. Oxford affords a greater variety of scenery and a more attractive series of fossiliferous formations. Nevertheless, there is much in Cambridgeshire geology to arouse interest when once an enthusiasm for the science has been kindled, and there was need of a concise handbook which should clearly describe and explain the leading facts that have been made known. The excellent "Sketch" by Prof. Bonney dates back to 1875, and the more detailed geological survey memoir on the neighbourhood of Cambridge, by Penning and Jukes-Browne, was issued in 1881. The present work is a model of what a county geology should be. The zones in the Jurassic and Cretaceous rocks, the phosphatic nodules in Lower Greensand and Chalk, the glacial deposits, valley-drifts, and recent accumulations, are all duly described and accompanied by full records of the fossils. If we find fault at all, it is that the author has entered at too great a length into certain contrary views regarding the formation of the Chalky Boulder Clay, for the extraordinary "diluvial theory," as he himself admits, "finds few supporters at the present time." Even the view of S. V. Wood, jun. (noted on p. 168), was modified in that geologist's latest publication.

Our author rightly wanders a little out of the county to give some account of the Red Chalk of Hunstanton, because it is so frequently visited by Cambridge students.

Brief chapters are given on the antiquity of man and on water supply. With regard to the latter subject, we would question the statement (quoted by the author) that "if the Oxford Clay was pierced we might reasonably expect an abundant supply of water." The outcrop of Lower Oolites is some distance away, while at St.

Neots the water that was obtained at a depth below the surface was saline in character. A full and useful bibliography completes this excellent and well-arranged work. H. B. W.

Wild Traits in Tame Animals. By Louis Robinson, M.D. Pp. vii + 329. Illustrated. (Edinburgh and London: Blackwood and Sons, 1897.)

DR. ROBINSON points out in his introduction that the amateur naturalist is a valuable and necessary member of the scientific community. He detects a tendency on the part of the professional naturalist to warn the amateur off the ground. Whether any such mischievous claim of proprietorship is actually set up is not clear to us; the naturalist who pursues his hobby for recreation only is, according to our own experience, welcomed by everybody, if only he is a good fellow, who will bring in his own contributions, great or small, to the general stock, and not spread false information. Dr. Robinson's animated defence of the amateur naturalist may therefore be gladly allowed to prevail; we are only surprised to learn that any defence is needed.

Our author holds that no one in these days can study animals with due profit who is not a Darwinian; he would have his amateur naturalist "an evolutionist down to the tips of his toes." We are not so heartily on his side here. There is risk of spoiling a quick and trustworthy observer by saturating his mind with theories. If natural facts are reported to us, they do not gain in credibility by being expressed in evolutionary phrase. It is good that every naturalist should think upon his facts, but let him think independently, not as an evolutionist, nor as a partisan of any school whatever.

We like the papers which form the bulk of the book much better than the introduction. Dr. Robinson discourses upon dogs, horses, donkeys, cattle, sheep, goats, pigs, cats and poultry. The first two of these seem to us the most interesting, but all possess good points. The author gives us a lively object-lesson upon each animal, trying to explain its structure and habits by the mode of life of its wild progenitors. Very many of his interpretations have been anticipated; that is to be expected; but everything is cast into a new and engaging form; it reads like personal experiences illuminated by the writer's own reflections. No reader who thinks for himself will accept all Dr. Robinson's conclusions, but he will find his interest in the subject heightened, and his sagacity exercised by these amusing dissertations.

L. C. M.

The Psychology of the Emotions. By Th. Ribot. Pp. xix + 455. (London: Walter Scott, Ltd., 1897.)

IN this book Prof. Ribot gives a very complete account of his subject. In the first part he deals with pleasure and pain and the general nature of emotion. He advocates a theory of emotion which he terms "physiological." Feeling is regarded as a primary aspect of mental life, closely connected with biological conditions; and the author seems to think that it is hopeless in this region of psychology, at any rate, to depend wholly on purely psychological methods, the subject only becoming intelligible by going beyond consciousness and treating it in its physiological relations. As part of this general theory Prof. Ribot adopts, with some qualification, the theory illustrated by James in the words, "we feel sorry because we cry, angry because we strike, afraid because we tremble." In the second part, dealing with the special forms of emotion, no attempt is made to give an elaborate classification; but the chief aspects of emotional life are described in the order in which they seem to have developed. In this part, and especially in the chapters on character and temperament, the author brings out the great value of pathology in the study of psychology.

LETTERS TO THE EDITOR

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The Vitality of Refrigerated Seeds.

THE appearance in your last issue of a short paper recently communicated to the Royal Society by myself and Mr. F. Escombe, on the "Influence of very Low Temperatures on the Germinative Power of Seeds," affords me an opportunity of calling attention to two important papers which only became known to us after our own was in print. Both these communications materially strengthen the argument against the necessary existence in resting protoplasts of ordinary respiratory exchanges, or of any metabolic changes resulting in "intra-molecular respiration."

The first paper is by W. Kochs (*Biol. Centralbl.*, 10 (1890), 673), who has shown that dry seeds, placed for many months in the vacuum of a Geissler's tube, do not evolve an amount of carbon dioxide or nitrogen capable of detection by subsequent spectroscopic examination of the contents of the tube, a fact which certainly negatives the idea of any gaseous evolution by "intra-molecular respiration."

Our second omission is one which is much less excusable, since we have overlooked a very important letter communicated to your columns by Prof. Giglioli as recently as October 3, 1895.

In continuation of certain experiments, described in 1878, on the power of resistance of seeds of *Medicago sativa* to the action of certain gaseous and liquid chemical reagents, Prof. Giglioli re-examined the seeds which had been placed under these special conditions continuously for a period of more than *sixteen years*. He found that some of the seeds retained their vitality even when surrounded by atmospheres of nitrogen, chlorine, hydrogen, arseniuretted hydrogen, and nitric oxide; whilst immersion for sixteen years in strong alcohol, and in an alcoholic solution of mercuric chloride, still left a large number of seeds capable of subsequent germination.

That we have been anticipated in some of the conclusions of our paper, based on a totally different method of experiment, will be clearly seen from the following quotations from Prof. Giglioli's letter:—

"My experiments encourage, moreover, the suspicion that latent vitality may last indefinitely when sufficient care is taken to prevent all exchange with the surrounding medium." . . . "It is a common notion that life, or capacity for life, is always connected with continuous chemical and physical change. The very existence of living matter is supposed to imply change. There is now reason for believing that living matter may exist, in a completely passive state, without any chemical change whatever, and may therefore maintain its special properties for an indefinite time, as is the case with mineral and all lifeless matter. Chemical change in living matter means active life, the wear and tear of which necessarily leads to death. Latent life, when completely passive, in a chemical sense, ought to be life without death."

Prof. Giglioli concludes his letter with a reference to the possibility of an extra-terrestrial origin of life on the earth, through the medium of meteorites. HORACE T. BROWN.

52 Nevern Square, Kensington, December 13.

Discovery of a Large Supply of "Natural Gas" at Waldron, Sussex.

THE discovery of this gas occurred accidentally while boring for water in the parish of Waldron, Sussex. The boring was commenced in the lower strata of the "Ashdown sand" (Hastings beds), and was continued to the depth of 377 feet, when the work was stopped. A strong smell of "gas" having been noticed, a light was applied to the top of the lining tube of the bore, and a flame immediately sprang up to the height of 15 or 16 feet, and burned with great fury until it was put out by means of damped cloths being thrown on to the top of the tube (Fig. 1).

It is not quite certain at what level the first release of the gas occurred; and the workmen say that they noticed the smell of it for nearly a month before the testing with a light occurred, during which time boring was carried on.

An iron cap has now been fixed on the top of the tube with a vent. allowing an escape of the gas to take place continuously (see Fig. 2). When lighted this jet flares out about the same size and colour as one of the "naphtha flarers" commonly

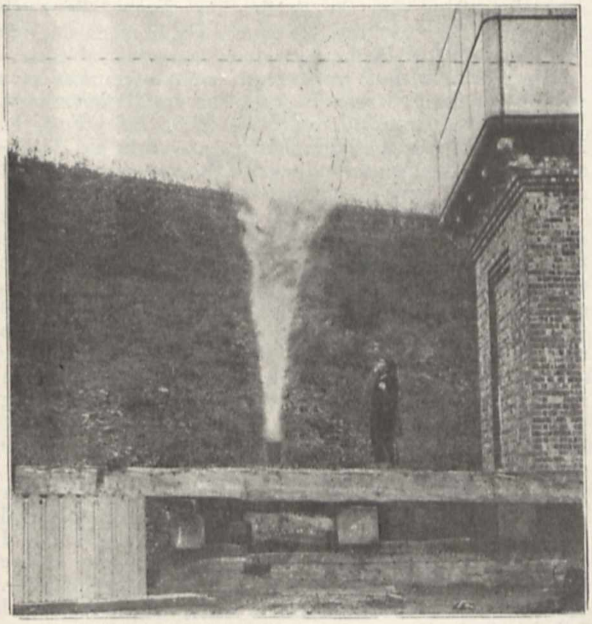

FIG. 1.—Flame of natural gas from bore-hole at Waldron, before the present cap was fixed on the tube. The broken line near the top shows the height of the flame through the six-inch bore-tube.

used for lighting at fairs and markets, viz. about 12-inch flame. This cap and vent have now already been fixed about fifteen months, and the gas from the vent can be lit at any time, and shows no sign of diminution.

FIG. 2.—Bore-tube in well, with cap having a small vent fixed upon the top. The flame of natural gas is shown rising to the left.

I have taken samples of the gas, and submitted it to the county analyst for East Sussex (Mr. S. A. Woodhead), and he informs me, although he has not yet completed his analysis, that the gas is probably derived from petroleum. The presence of certain beds impregnated with petroleum underlying these Wealden beds in East Sussex, has been noticed before while making deep shafts and borings.

Many of the beds in the Purbeck strata (Brightling series) consist of dark leathery shales which emit a strong odour of petroleum, and small traces of it are also occasionally met with in the Gypsum quarries at Netherfield (Sussex). Beds of lignite. and a variety resembling "Cannel coal" (about 2 feet thick) have been met with near the surface in the parish of Waldron (Lower bed of Ashdown sand, Fairlight clays), and several bands of lignite were pierced by the boring at Waldron where the "gas" was found.

The gas is probably derived from these beds of lignite, and perhaps from the petroleum shales of the Purbeck beds; or possibly, but less probably, from the Kimeridge clay underlying these beds (Sub-Wealden boring), which contains a hard, light-coloured bed rich in petroleum.

In reading through the quarterly reports of Mr. Henry Willett, made during the progress of the Sub-Wealden boring (Netherfield, 1875), I find that strange oscillations had been noticed in the depth of the water in the bore-tube. These were attributed to the "accumulation and discharge of carbonic acid, and of inflammable gases derived probably from the petroleum-bearing strata beneath. The discharge of these gases was proved by the extinction of light at various depths, and by an *explosion* at another time."

The discovery of the gas has hitherto been kept a secret among a few. There appears to be at present an ample supply of gas for the lighting of a town if the necessary plant were erected in connection with the tube, and there also seems to be, so far as one can judge, a constant supply. How long it may continue is, of course, a matter of conjecture; but having already run to waste so long without any decrease in force, I think that the supply might be made use of with reasonable prospects of lengthy continuance.

This notice must be regarded as a preliminary one merely, as I am making experiments with the gas, and examining the cores of the boring with a view to ascertain the source of the supply. CHARLES DAWSON.

Uckfield, Sussex.

THE ORIENTATION OF GREEK TEMPLES.[1]

IN giving an account of my second series of observations on the orientations of Greek temples, and the chronological deductions which may be made from them, it seems desirable to recapitulate as briefly as possible the main points which underlie the inquiry.

The subject was introduced to me about eight years ago by Sir Norman Lockyer, who had discovered that there was a very strong probability that in every case the axis of an Egyptian temple, or in other words its orientation, was aligned to that point of the local horizon where at the time of its foundation some conspicuous star rose or set, and that in the case of temples oriented within zodiacal limits, it was also so arranged that on the day of the principal feast of any particular temple, which always took place on a day when the sun at its rising would shine upon the altar or statue of the god, the star should be seen from the sanctuary, through the always narrow eastern opening, shortly before sunrise.

There is plenty of evidence from various sources that *heliacal* stars, as they are called; that is, stars when just visible at their rising before their light is overpowered by the rays of the rising sun, or setting whilst still distinguishable, were very much observed by the ancients. And the use of an heliacal star so observed in connection with temple worship was to give warning to the priests to enable them to be ready for the sacrifice or other function at the exact moment of sunrise. Roughly speaking, a bright heliacal star would in Greece give nearly an hour's warning of the sun's approach, though somewhat less in Egypt.

If in almost every case a connection, such as I have indicated, between the orientation of a temple and the

[1] Abstract of a paper read before the Royal Society, March 11, 1897. On the Orientation of certain Greek Temples, and the Dates of their Foundation, derived from Astronomical Considerations—being a supplement to a paper on the same subject published in the *Transactions* of the Royal Society in 1893—by F. C. Penrose, F.R.S

sunrise effect in the sanctuary, preceded by an heliacal star, can be established, it carries an amount of probability of the truth of the theory which it is very hard to gainsay.

To us the practical use of such theory is, that it gives the means of determining very approximately the date of the foundation of any temple, namely the time when the sunrise and the heliacal star were so connected.

As seen from a given point at its rising or setting, the amplitude of a star (that is, its bearing from true east or west) is subject, as time goes on, to a slow alteration resulting from the displacement of the star, in consequence of the celestial movement called the precession of the equinoxes, and this can be calculated with great precision so as to show the date at which it would have been visible as the forerunner of the sun from the sanctuary of a temple. There is architectural evidence in Egypt that attempts had been made to retain the use of such stars, and in two ways: one by a structural alteration in the eastern opening, so as still to allow of its being seen; and the other as evidenced by finding that a temple, architecturally of later date, but of the same cult, had been built alongside of an older temple which had lost the star which had at one time served as its morning clock.

Sir Norman Lockyer having been satisfied that the principles of temple building, as above mentioned, had prevailed in Egypt, and being led by a cursory examination of Greek examples to suspect that the same would be found to prevail in that country also, invited me to take up this inquiry with respect to Greek temples, which led to my making a preliminary communication to the Society of Antiquaries in 1891, and a more detailed report to the Royal Society in 1893, of which an abstract appeared in NATURE, May 11, of that year. The paper itself was published in the *Transactions* of the Royal Society (vol. 184, pp. 805 *et sqq.*) to which the supplement, already referred to, was published in vol. 190, pp. 43 *et sqq.* The first series contains more than thirty examples, the second nearly as many, and both collections entirely confirm the view of the matter already made highly probable from Egyptian sources. Indeed the second series, chiefly drawn from colonial Greece, is in one respect more satisfactory than the previous one.

The architectural remains of the greater number of the temples in Greece proper, comprised in the first list, do not accord with the early dates derived by calculation from their orientations; and it is necessary to assume that in the majority of cases a temple, of which we find the ruins, was built parallel to the lines of an earlier structure which had conformed to the orientation postulate, and the date arrived at is that of the first foundation on the site. Traces of such earlier foundation can, however, be actually found or inferred in a sufficiently large proportion of the whole to justify the assumption; but in more than half the cases they have either disappeared or not yet been found. In the colonial examples of the last series, however, quite two-thirds of the orientation dates are consistent with the architectural remains now standing, without need of any hypothesis respecting foundations as yet undiscovered.

All the temples I have met with in Magna Grecia or Sicily are what may be named solar temples; namely, those which admit of being lighted through an eastern door by the sun when rising in the line of the axis. Three of them, indeed, lie on the solstitial limits; of this I did not find any examples in Greece. The nature of the inquiry in a solar temple is of this kind, viz.: given the angle of orientation, and the apparent height of the eastern horizon, we calculate the declination which the sun would have required to illuminate the sanctuary at its rising (allowance being made for the variation of the obliquity of the ecliptic many years ago, an allowance which may require a small correction when an approximate date has been arrived at). From this the sun's right ascension is computed, giving generally two values—one vernal, the other autumnal. The next search is made for a suitable star. It must be remembered that in the case of a rising star the declination cannot differ much from that of the sun, or else it could not be seen through the same narrow opening, and to be serviceable as a warning star, it must precede in right ascension by a suitable interval; if too short the star could not be seen, if too long its warning would be inconveniently early. Thus the data for the preliminary search are: for declination, that already ascertained for the sun, and for right ascension, one hour less may be taken.

It would occupy too much space to enter into the details of the calculation which involves the change due to the movement of the star from *precession*; but if the result shows that a conspicuous star or constellation, either in the spring or autumn (and within the limits of possible archæology), occupied approximately the position required by the hypothesis, the discovery will justify a more exact computation. Should it, however, fail for a rising star, there still remains the search for a setting star which would fulfil the proper conditions. The search is conducted on analogous principles, but with difference in detail.

In more than fifty cases which I have tried by the four lines of investigation indicated above, I have succeeded in finding in each one solution, and one only. In two I have obtained an alternative possible star; the choice between the two requiring to be settled archæologically. In not one case of which I had full particulars have I failed to find an answer.

An objection has been made that, as there are so many stars in the heavens, some solution of the problem is inevitable, without there having originally been any intentional correspondence. The answer is not difficult.

Firstly, there are very few available stars. They must be of sufficient brightness: a third magnitude star is the very minimum, and could only be resorted to (unless in a close constellation like the Pleïades or Aquarius) if situated very much by itself, so as not to be mistaken for any other. They must also be near enough to the ecliptic to be seen through the narrow eastern opening. A list of fourteen single stars and two star groups exhausts the whole possible number. Moreover, they must be so placed in the firmament as to satisfy the condition required for warning stars. Again, in the two hundred trials made for the fifty temples, as mentioned above, would there (in the case of the assumed multitude of stars) have been one hundred and fifty misses to the fifty hits which were wanted; and if there had been no arrangement, and the orientations had been fortuitous, would the most ancient sites have always secured the oldest orientation dates, and those of which the recent foundation is historically known have taken their proper rank?

It is true that the sequence might have been acceptable, but not so the exactness of the dates. These must depend upon the correctness of certain assumptions with regard to the elements of the problem, especially as to the altitude of the star and the depression of the sun at the heliacal phase, if it may be so called.

From a good deal of attention which I paid to the visibility of stars in twilight I derived the following rules, from which all the calculations have been made, except in a very few cases where local circumstances required some modification. The rules are made for the case of rising stars. When setting in the morning twilight they may be seen nearer to actual sunrise; but it is probable that the same rule would have been applied, as the same time would have been required for warning, whether a rising or setting star was used. It may be observed that rising stars seem to have been the favourites, in proportion of about three to two.

In ordinary fair weather in Greece or in South Italy I found that a first magnitude star can be seen at an altitude of 3° when the sun is 10° below the true horizon. A second magnitude should require an altitude of 3° 30′, with the sun depressed 11°; whilst a third magnitude star, of the use of which there are very few examples, would require a depression of 13°. A general confirmation of these elements may be drawn from Biot's "Recherches sur l'Année Vague des Égyptiens," in which he derives from Ptolemy that in Egypt a solar depression of 11° was considered proper for the observation of heliacal stars. This seems a very reasonable mean for the rules of solar depression applying to stars of different magnitudes as given above.

Following these rules, I obtained orientation dates for the temples I examined last year as below.

agree in style with the dates assigned to them by the theory. Mention is made by Diodorus of the temple of Jupiter strongly confirmatory of the orientation date 430 B.C. At Segesta the date arrived at is too early by about 100 years to agree with the character of the architecture. It may have been that the Segestans, who seem always to have been a struggling community, may have taken a very long time to have brought their temple to the state of finish at which at last it arrived, for it appears never to have been quite completed.

Selinus offers the example of one temple—a temple remarkable for the archaic character both of its masonry and its sculpture—of which the orientation date anticipates the arrival of the Hellenic colony which occupied the place in 628 B.C., but in the other examples in that

—	—	—	Orientation date	—	—
			B.C.		
	Athens	A small temple near Jupiter Olympius ...	780	September 23	Spica setting
	,, ...	The ancient Asclepieium	560	April 5 ...	α Arietis rising
Greece ...	Delphi	First foundation of Temple of Apollo ...	970	March 1 ...	β Lupi setting
	,, ...	Rebuilt so as to follow the star	630		,, ,,
	Argos	The ancient Heræum	1830	October 24 ...	Antares rising
	Taranto	A Doric Temple	640	November 10	,, ,,
	Metapontum ...	Foundations of a temple near San Sansoni...	610	December 21	β Geminorum setting
Calabria ...	,, ...	Doric Temple	580	March 6 ...	γ Pegasi rising
	Near Cotrone ...	Temple of Juno Lacinia on Cape Colonna ...	1000	March 28 ...	α Arietis rising
	Near Gerace ...	Ionic Temple of the Locrians	610	December 21	β Geminorum rising
	,, ,, ...	Ditto rebuilt on same site	430	November 23	β Tauri setting
	Girgenti	Temple of (attributed to) Juno Lacinia ...	690	April 1 ...	α Arietis rising
	,, ...	,, ,, Hercules	470	March 20 ...	Spica setting
Sicily ...	,, ...	,, ,, Concord	450	,, ...	,, ,,
	,, ...	,, ,, Jupiter	430	April 14 ...	α Arietis rising
	,, ...	,, ,, Castor	400	September 13	Spica setting
	Segeste	Temple (perhaps) of Jupiter	550	April 5 ...	α Arietis rising
	Selinus	The Archaic Temple called Temple C ...	795	September 30	α Arietis setting
	,, ...	Temple D (adjoining and following the star)	610	October 4 ...	,, ,,
	,, ...	Temple A	550	March 5 ...	γ Pegasi rising
	Syracuse	Temple forming part of Duomo	815	September 20	Spica rising
	,, ...	,, of Jupiter	610	October 3 ...	α Arietis setting
	,, ...	,, ,, Diana	450	September 26	Spica rising
	Pœstum	,, ,, Neptune	535	March 22 ...	Spica setting
South Italy..	Pompeii	Doric Temple in triangular Forum	640	November 12	Antares rising
	,, ...	Temple of Isis	750	June 19 ...	β Geminorum rising

For the sake of comparing the above with dates that are archæologically probable, and confining the inquiry to the Greek colonies, we may observe:

The Doric capital at Taranto is of an extremely ponderous type, and may well be assigned to the seventh century. A Lacedemonian colony under Phalanthus is reported to have taken possession of Tarentum about 700 B.C.

At Metapontum, at the temple near San Sansoni, nothing but foundations remain; the architectural character of the other is quite in accordance with the orientation date. The city was one of the most ancient in South Italy. One column only remains of the temple on Cape Colonna near Cotrone, and its character is that of the fifth century. In the case of this celebrated temple we clearly have the case of a rebuilding on the old lines.

The foundations of the older temple of the Locrians near Gerace were discovered under the substructions of the later temple. Its orientation date, 610, is quite consistent both with the early Ionic architecture which was found, and that of the Hellenic colonisation, 683 B.C. That of the later temple is also in accordance with the architecture of the fifth century. Girgenti was occupied by a Greek colony B.C. 582, but a city with so commanding a site had, no doubt, an earlier foundation; and we may feel confident that the temple of Juno Lacinia, though the present structure is Hellenic, was founded by the earlier inhabitants. The remains of the other temples

city the orientation dates are quite consistent both with the architecture and with Hellenic citizenship. Syracuse was colonised in 734 B.C. The orientation date of the "Duomo" temple is eighty years too early for agreement with that epoch. The architecture is indeed very rude, but perhaps some small variation in the elements of the calculation should be made, which would bring it within the Hellenic period. The dates of the other two temples at Syracuse are extremely probable. The date, 535 B.C., assigned to the Temple of Neptune at Pœstum, appears to be thoroughly suitable to its massive but advanced style, and is confirmed by a passage in Herodotus, in which, although he does not make any allusion to the temple, yet speaks of a Posidonian architect of great celebrity at that very date. The temple of Isis at Pompeii is remarkable from there being evidence of a large window having been formed in the temenos wall centrally placed with regard to the eastern axis of the temple, doubtless for the admission of the rising sun and its warning star. The window had been filled up with brickwork at some subsequent date. The last point touched upon in the paper has reference to a group of ten temples of late foundation, of most of which the dates are accurately known. At first these temples seemed to be exceptions to the rules which connect the orientation with heliacal stars, but by allowing a few more degrees of solar depression than what is absolutely necessary for distinct vision, they are found to conform in all other respects. The explanation of this change seems to be that the temple service had become more complicated, and more time was required by the priests for their preparations. Every additional degree of sun depression would add about five minutes for that purpose. The maximum extra allowance in this group of temples is thirty-five minutes.

F. C. PENROSE.

NATURE AND A CAMERA.[1]

THE remarkably favourable reception accorded by the public and the press to the earlier effort of the Messrs. Kearton has naturally tempted them to another venture; and the volume before us shows no falling off in the matter of interest and the exquisite execution of the illustrations from its predecessor. Only too frequently authors, having scored one success, are apt to think their hold on the public will permit of a very inferior second effort obtaining the same share of patronage as the first, and any odd scraps of new information they may possess are, with the aid of abundant "padding," worked up to form a volume of the required dimensions. The present work displays in an equally marked degree the freshness and brightness so conspicuous in "British Birds' Nests"; and as covering a wider area is calculated to attract an even larger circle of readers. One of the best tests of a work of this nature is its capability of arousing the interest of young persons, and this, from practical experience, we find to be the case with the volume before us.

FIG. 1.—Nightingale on Nest. (From "With Nature and a Camera.")

Photography in the hands of artists of the capacity and perseverance of Mr. Cherry Kearton is undoubtedly the only real method of portraying animals in their native haunts, and more especially birds on their nests; and in the truthful representations of objects of the latter class the present volume can fear few rivals. Nothing can be more exquisite than the illustration of a nightingale on her nest, which the publishers have permitted us to reproduce (Fig. 1); but this is only one among many of the same excellence and interest, those of the whitethroat and the chiffchaff being, if possible, even more beautiful. The only thing we miss in illustrations of this nature is colour, which would be of especial value in photographs, like the upper one on page 253, dealing with the protective resemblances of animals to their surroundings. Possibly even this want may be supplied in the near future.

But it is by no means the beauty of the illustrations alone that calls for commendation in the work; many of the observations in the text claim recognition from all interested in the habits of British animals, while some have a bearing on considerations of a higher nature. For instance, in regard to protective resemblance, Mr. Kearton says he is puzzled by the circumstance that while young terns instinctively recognise its value, some of their parents apparently do not and others do. This is exemplified as follows: "As a rule, Sandwich terns' eggs harmonise closely with their surroundings, and even the experienced field naturalist has to exercise a great deal of care to avoid treading upon a clutch when visiting a breeding station. A friend of mine told me a few years back that he had once visited a colony of these birds on an island where the natural breeding accommodation was so limited that many of them had conveyed patches of pebbles on to the grass, and laid their eggs thereon. We both recognised this as a wonderful instance of the knowledge of the value of protective coloration; but I must confess that last summer at the Farne Islands my faith in the wisdom of these birds received a rude shock when I met with five or six clutches of eggs lying most conspicuously on small circular patches of broken mussel-shells, the dark blue of which contrasted violently with the golden grey of the sand." From this it would almost seem that the birds are unable to distinguish between a mussel-shell and a pebble, and that any cluster of small smooth objects looks to them equally suitable as a nesting site.

Although the greater portion of the work is devoted to birds in their haunts, the subjects treated of are diverse. To the general reader and tourist the chapters on the people and birds of St. Kilda will, perhaps, be the most interesting; while the sportsman will find much to attract him in those on gamekeepers and duck-decoying. To the amateur photographer the volume will appeal not only as a standard of excellence at which to aim as regards his own efforts, but more especially from the account given in the final chapter of Mr. Kearton's method of photographing. From this latter it will be apparent that the task of portraying many kinds of birds—especially when they inhabit lakes or beetling sea-cliffs—in their native haunts, is no easy one, but rather one beset with numerous dangers to life and limb. In the preface the author deprecates the charge of foolhardiness, and the results obtained go far to justify the risks necessarily incurred.

In the chapter on sea-birds and their haunts will be found some of the matter most interesting to the ornithologist, and it is here that some of the most successful of the photographs occur. As an example, we select, partly on account of its small size, the figure of a solitary razorbill mounting guard over its egg reposing lower down on the side of a pinnacle of rock (Fig. 2). But for beauty of detail and execution we may refer to the gull's nest with egg and young, and the group of puffins on p. 269, and also to the nest of the black-headed gull on the following page. To obtain the photograph of gannets nesting on the Bass Rock, Mr. Cherry Kearton ran risks

[1] "With Nature and a Camera, being the Adventures and Observations of a Field-Naturalist and an Animal Photographer." By R. Kearton, with Photographs by C. Kearton. 8vo. Pp. xvi + 368, illustrated. (London: Cassell and Co., Ltd., 1897.)

which evoked the fear of even the adventurous natives of the district. When once their haunts are gained, gannets with young are however, according to our author, very easy birds to photograph, as they will permit the observer to walk among them with no more protest than an occasional peck at his legs. Much has of late years been written on the destruction by human agency of our sea-birds; and it is, therefore, of interest to note that other causes likewise aid to no inconsiderable extent in the diminution of their numbers. "The mortality among sea-birds of all kinds," writes our author, "reckoning the loss of eggs and young ones, from purely natural causes alone, must be very great in the course of a season. We saw a great number of young terns lying dead everywhere upon these islands, and Watcher Darling told us that two years ago very few Arctic or common terns got away. He picked up several dead

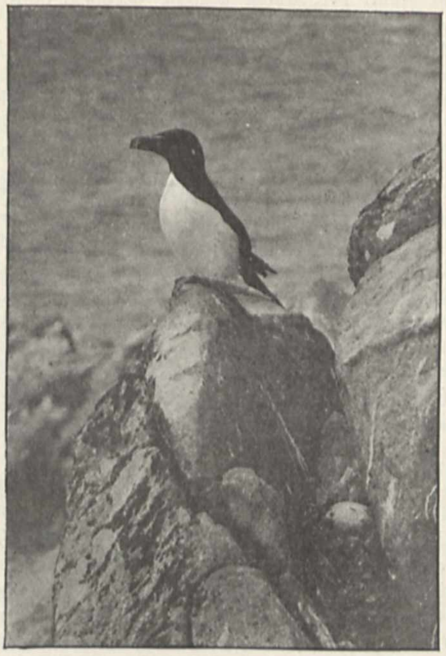

FIG. 2.—Razorbill and Egg. (From "With Nature and a Camera.")

ones with sand-eels in their bills, and concluded that there was no small fry for them, and that the eels, although the natural diet of Sandwich terns, were too large for the young of the smaller species to swallow."

Most of us suppose that the eider is pre-eminent for the quantity of down she employs for lining her nest; but in this, according to our author, she is beaten by the common wild duck. Did space allow, many other observations of equal interest might be quoted, but for these we must refer the reader to the work itself, which will form a welcome Christmas gift to all, whether young or old, interested in wild nature. R. L.

DR. FRIEDRICH A. T. WINNECKE.

IT is always a painful duty to review the life work of those who have recently passed away, to estimate the position their names will occupy in the history of a science, and to survey the grounds on which their reputation will finally rest. But in the case of Dr. Winnecke, whose death was recorded last week, the task becomes both painful and difficult. Thirty years ago he occupied a prominent position among continental astronomers, and was intimately connected with the onward growth and development of the science in many important directions. His enterprise and ability were everywhere acknowledged, and a long career of work and usefulness seemed before him. But while he was still a comparatively young man, the state of his health prevented him from adding to the reputation he had established, and to-day his name is perhaps little more than a memory to many, who, interested in newer problems and more sensational inquiries, may possibly undervalue the work of an older school, which occupied itself mainly in the astronomy of position. But wherever a just and comprehensive view of astronomy as a whole is taken, Winnecke's work will be remembered with gratitude and admiration.

Dr. Winnecke enjoyed the advantage of admirable mathematical training under competent teachers. The school of Bessel was then in the ascendant, and the reputations of Encke and of Argelander were at their zenith; while in the district of Hanover, where Winnecke passed his early years, the memory of Herschel was still treasured, and helped to give direction to his astronomical tastes. He received his training in practical astronomy mainly at Bonn, under Argelander, where he became a proficient in the use of the heliometer, and with this instrument effected a complete triangulation of the stars in the Præsepe cluster, together with a thorough examination of the necessary constants of reduction. This latter part of the work he prepared himself for publication, but never printed, and it forms a painful commentary on his enfeebled energies to remember that this work never saw the light till many years after, when Dr. Schur proved himself an able and sympathetic coadjutor, and arranged the numerical portion of the research for general use. In 1858, Winnecke left Bonn for Pulkova, where he still interested himself in extra-meridional work. The fine series of observations of the great comet of 1861, which he followed until May 1862, long after it had ceased to be observed in other telescopes, and on which the final orbit rests, is a proof of both his energy and his observational skill. Cometary astronomy always had for him great attractions, and besides the periodic comet which bears his name, he found several others, receiving the prize of the Vienna Academy of Sciences for his cometary discoveries. At Pulkova, too, he took some part in the geodetic work arranged between Dr. Otto Struve, Argelander, and the late Astronomer Royal, for determining the differences of longitude between places on the great European arc of parallel, and, in conjunction with Colonel Forsch and Captain Zylinski, carried through that portion of the scheme which connects Haverford West with Nieuport and Bonn.

Winnecke also bestowed some attention on the problem of the sun's distance, which forty years ago was a burning question. Hansen and Le Verrier were contending for the rejection of Encke's value of the parallax as the outcome of mathematical investigations based on the lunar and planetary theories, and were supported by the result of Foucault's mechanical operations arranged to determine the velocity of light. Winnecke was among the first to perceive the importance of obtaining evidence from independent sources, and fully appreciated the value of utilising the observations of Mars as a new element in the discussion. The result of his investigation of the observations made at the 1862 opposition was to assign to the Solar Parallax a value of 8″·964, confirmed by Stone's result of 8″·932.

After leaving Pulkova, Winnecke settled for some years in Karlsruhe, where he was an industrious observer of comets and variable stars. On the conclusion of the Franco-German war, he was invited to take charge of the new observatory at Strassburg. The equipment of this observatory and the details of its arrangement are due to his superintendence, and it certainly ranks among the best arranged of continental observatories. While in the position of Director, Winnecke's health finally broke down, and for a great many years he has been unable to take any part in the management of the establishment he had so admirably fitted and equipped. W. E. P.

NOTES.

THE Physico-Chemical Institute of the University of Leipzig, of which Prof. W. Ostwald is director, will be formally opened by a ceremony to be held in the large lecture theatre of the Institute on January 3.

DR. HUGH GALT, acting Professor of Forensic Medicine and Public Health at Glasgow University, has for some time back been engaged in a research upon the starches, which is likely to prove of value to the Department of Public Health.

MR. JOHN MILNE writes that arrangements have been made for the establishment of horizontal pendulums, with photographic apparatus to record unfelt movements, at Toronto, Harvard, Philadelphia, Victoria, B.C., New Zealand (two), Batavia, Madras, Calcutta, Bombay, Mauritius, the Cape, Argentina, San Fernando, and Kew, whilst a number of other stations are under consideration. Seismograms have already been received from Toronto. At his station on the Isle of Wight, for purposes of comparison, Mr. Milne has also two horizontal pendulums writing on smoked paper, and very shortly a Darwin bifilar pendulum is to be established. To this will be added later a von Rebeur-Paschwitz apparatus, with which type of apparatus Mr. Milne worked for many years in Japan.

DR. CHARRIN has been appointed to succeed Prof. d'Arsonval in the chair of Medicine of the Collège de France.

A NEW branch of the Russian Geographical Society has just been opened at Tashkend, for Turkestan.

ON December 4 the friends and pupils of Dr. C. Cramer, the professor of botany at Zürich, celebrated the fortieth anniversary of his connection as teacher with the Polytechnic in that town.

PROF. DR. WILLI ULE has just taken over the editorship of the weekly scientific periodical *Die Natur*, which was founded by Dr. Otto Ule and Dr. Karl Müller, and is now in its forty-sixth year of publication.

WE regret to see the announcement of the death of Mr. Gardiner G. Hubbard, President of the National Geographic Society, Washington. The death is also announced of Dr. Campbell Morfit, formerly professor of applied chemistry in the University of Maryland, and one of the scientific advisers of the United States Government.

AT the close of a lecture delivered by Lieut. Peary in Edinburgh on Friday last, under the auspices of the Royal Scottish Geographical Society, Dr. J. N. Murray, on behalf of the Council of the Society, presented him with the medal of the Society in recognition of his work in the Arctic regions.

A BROOKLYN correspondent sends this item of news:—"Prof. Langley and Prof. Elfreth Watkins have constructed flying machine designed to draw a railroad car. This has been tested for several days on the Medford branch of the Pennsylvania Railroad, near Mount Holly, N.J., and has drawn the car at the rate of six miles an hour. The machine is actuated by a gasoline engine, the power being applied to two propellers, about four feet long, which make 800 revolutions per minute. It is expected that machines can be constructed on this principle, which can draw cars at the usual railroad speed."

WE learn from *Science* that Dr. George H. Horn, the eminent entomologist, died at Philadelphia on November 25. He was one of the Secretaries of the Philosophical Society, and was formerly Corresponding Secretary of the Academy of Natural Sciences. He had been until recently professor in the University of Pennsylvania, though his connection with that institution was chiefly honorary. Dr. Horn was only fifty-eight years of age, and his death, following those of Cope and Allen, is a further severe loss to the city of Philadelphia and to science in America.

La Nature announces the death of Prof. A. Joly, director of the chemical laboratory of the École normale Supérieure, and professor in the Paris Faculty of Sciences. Born at Fontenay-sous-Bois in 1846, M. Joly entered the Normal School in 1866. When he left this school he became attached to Saint-Claire Deville's laboratory, and afterwards was professor of physics at the lycée Henri IV., which post he occupied until he was nominated sub-director of the laboratory of the Normal School. The titular director of the laboratory at that time was M. Debray. M. Joly next became instructor (maître de conférences) in chemistry at the Sorbonne, and then professor attached to the Faculty of Sciences of Paris. His works refer principally to the rare metals (niobium among others) and acids of phosphorus.

THE first ordinary meeting of the Röntgen Society was held on December 7, Dr. Gladstone, F.R.S., being in the chair. Mr. A. A. Campbell Swinton read a paper on "Adjustable X-ray Tubes," in which various methods were discussed for regulating the penetrative and other qualities of X-rays, and for compensating the unavoidable and troublesome variations in vacuum that are found to occur in practice. The paper was illustrated by numerous experiments, and several adjustable tubes of Mr. Swinton's design, embodying the improvements and principles enunciated, were shown in operation.

THE ninth Congress of Archæological Societies was held at Burlington House on December 1, the Right Hon. Viscount Dillon in the chair. The Hon. Secretary reported that the Committee had authorised the completion of Mr. Gomme's Index of Papers from 1682, with a view to immediate publication. It was reported that a wish had been expressed to have an index of the archæological articles in certain journals and publications, other than the *Transactions* of Societies. The Standing Committee had considered the subject, and recommended that if anything were done it should be by adding a supplement to the Index as now published. After discussion the question was referred to the Committee with power to act, if they found they could do so to advantage and at reasonable expense. It was resolved, on the motion of Sir John Evans, K.C.B.: "That a memorandum be sent to the various local Archæological Societies, suggesting the desirability of placing themselves in communication with the Ordnance Survey officers for their districts so as to promote the record on the surveys of the earthworks within their districts, and where possible to determine their age by excavations." Mr. C. Hercules Read, the Secretary of the Society of Antiquaries, made a statement as to the steps that had been taken by Government in response to the request of the Society of Antiquaries for information as to what is done in foreign countries for the protection of ancient and historical monuments. Full information had been obtained and would shortly be published in a Blue Book. It appears that in no country in Europe is so little protection given as in England. Mr. Hope read a draft report on the best mode of indexing the *Transactions* of Societies; this had been prepared by the Committee consisting of himself and Mr. J. H. Round and Mr. Gomme. As it appeared that several Societies were anxiously waiting for the recommendations, it was agreed that the report should be referred back to the Committee for final consideration, and that as soon as complete it should be issued to the Societies. The Hon. Secretary reported that a National Photographic Record Association had been formed under the presidency of Sir J. Benjamin Stone, M.P., who had been at the head of the original Warwickshire Survey. He was directed to communicate to the Association that "The Congress hears with great satisfaction of the formation of a National Photographic Record Society, and expresses its desire to assist the work in any way it can."

MR. W. A. KNIGHT, writing from Bruton, Somerset, informs us that on November 30, at 10.20 p.m., he was fortunate enough to observe there a splendid lunar rainbow. The moon was sufficiently near the horizon to give a large arc, and although it was scarcely quarter-full, the black clouds looming in the north-east made the bow appear quite bright. There appears to be no doubt that what Mr. Knight saw was a lunar rainbow and not a halo, for it was opposite the moon.

PROF. A. RIGGENBACH has sent us the results of seven years' rainfall observations at Basle, deduced from a self-recording gauge. Of course the period is very short, and in dealing with monthly and annual means the author combines the values with those of an ordinary gauge, giving altogether a series of thirty-three years. But the principal object of the paper is to bring out some interesting details, which cannot well be obtained from an ordinary gauge. Among these we may mention the frequency and duration of very heavy showers, the great majority of which last only about twenty minutes. Sixty per cent. of these occur between 1h. and 7h. p.m., and 87 per cent. occur between June and September. In the yearly range the rainfall probability reaches a maximum in the early summer and in the late autumn, while the minima fall in mid-summer and in the first months of the year. In the daily range the duration of rainfall reaches a maximum between 6h. and 8h. a.m., and falls to a shallow minimum at 7h. to 8h. p.m., after which it rises uniformly to the maximum again. The various phases are shown both in tabular and graphical form. Dr. Riggenbach is perhaps best known to English meteorologists by the success with which he has prosecuted cloud photography.

HERR OTTO BASCHIN contributes to the *Verhandlungen der Gesellschaft für Erdkunde zu Berlin* an account of the fitting out and departure of Andrée's balloon expedition. The different possibilities as to the fate of the explorers are discussed, and the conclusion reached that there is as yet no reason to give up hope of their return. Under the most favourable circumstances the balloon might easily deposit its passengers on a part of Northern Siberia, from which it would take months to reach the nearest telegraph station.

THE new number of the *Mittheilungen von Forschungsreisenden und Gelehrten aus den deutschen Schutzgebieten* contains some items of geographical interest. Dr. F. Stuhlmann contributes a paper on the German-Portuguese frontier in East Africa, with a new map of the mouth of the Ravuma. In the same region Lieut. Stadlbaur gives a short account of the Turu district and its people; whilst First Lieutenant Freiherr von Stein describes the Ossa or Lungasi lake, on a tributary of the Savaga in the Kameruns.

DIFFERENT minds place different estimates on the intellectual accomplishments of the past half-century. In ordinary conversation the men of the mart will point to an Eiffel tower, a suspension bridge, a continental express train, a man-of-war, or an Atlantic cable. But in a discourse recently delivered in commemoration of the jubilee of the Sheffield Scientific School of Yale University, President Gilman remarked that perhaps the greatest triumphs of the intellect during the last half-century are these five contributions to human knowledge: the establishment of the principles of evolution; the establishment of the principle of the conservation of energy; the development of mathematical science and its application to physics, mechanics, electricity and astronomy; the development of spectrum analysis and the consequent discoveries respecting light and electricity; and the discovery of the nature and functions of bacteria, and of their influence, for weal or woe, upon living organisms.

As the result of an investigation of the red spectrum of argon, Dr. J. R. Rydberg comes to the conclusion (*Astrophysical Journal*, November) that it belongs to one single element. Moreover, there seems to him to be no reason to doubt that the blue spectrum belongs to the same element, but corresponds to a higher temperature. As to the supposed displacement of a great number of the lines of the white spectrum towards the red end of the spectrum, it is remarked, "nothing seems to indicate that we have to do with a *continuous* displacement, but rather with the appearance of new lines on the red side of those of the other spectra, with which they ought to be closely related. In such a case it seems most probable that the interesting observation of Eder and Valenta depends on a change in the relative intensity of two sets of connected lines."

IN the *Philosophical Magazine* for December, Mr. J. D. Hamilton Dickson examines the relation between the electric resistance of a metallic wire and the temperature. Although it has been demonstrated that platinum is a suitable substance for determining temperatures over a very wide range, not much different probably from 2000° C., nevertheless, seeing that each platinum thermometer needs at least to have its constant specially and carefully determined, not by three, but by a series of observations, it cannot be too strongly urged that this work should in each case accompany the record of results when expressed in platinum temperatures; and no one will deny that to have these results expressed at once in terms of the normal air-thermometer will permanently enhance the value of the work in such a manner as to amply recompense the extra labour. With the view of helping towards this desirable end, Mr. Dickson proposes a formula of the form $(R+a)^2=p(t+b)$, where a, p, b are constants, and gives reasons for considering it as more representative of the connection between temperature and resistance than any formula hitherto proposed, and just as simple as any.

AN interesting extension to space of n dimensions of Euler's and Meunier's theorems on the curvature of surfaces has been given by Signor Luigi Berzolari in the *Atti dei Lincei*, vi. 10. The author proves the following propositions:—Given in S_n a form of $n-1$ dimensions, the curvature (of Kronecker) at any point of any hyperplane section is equal to the curvature of the hyperplane section having the same trace on the tangent hyperplane at that point divided by the $n-2$th power of the cosine of the angle between the hyperplanes. The curvature of the normal hyperplane section at O is a maximum when the trace of the cutting hyperplane on the tangent hyperplane at O is one of the principal sections $S_n - 2$ of the indicatrix, and the sum of the curvatures of any $n-1$ hyperplane normal sections mutually at right angles is constant.

DETERMINATIONS of the thermal conductivity of ice by different observers have hitherto exhibited a remarkable discrepancy of results, the values of this coefficient being, according to F. Neumann, 0·34; De la Rive, 0·14; Forbes, 0·134 and 0·128, according to direction; and, according to Mittchel, 0·30, the centimetre, gramme, minute and degree Centigrade being taken as units. In the *Atti dei Lincei*, vi. 9, Signor Paolo Straneo describes a simple method of determining this coefficient. From observations on two different kinds of ice, taking two different cubes of each, the values obtained are 0·307, 0·309 for one kind, 0·312 and 0·313 for the other. A further determination gives 0·304 for the first kind; hence, generally, *k* lies between 0·30 and 0·31. Noticing that certain kinds of ice are anistropic, the properties being different along the vertical and horizontal directions referred to the position when frozen, Signor Straneo, in a subsequent paper, investigates the question as to whether the thermal conductivity varies with the direction. In homogeneous amorphous ice the values for the vertical and horizontal directions were found to be practically equal (0·312 and 0·308), but homogeneous non-amorphous ice gave for the same directions 0·328 and 0·301 respectively in one experiment, and 0·325 and 0·308 in another, showing that only ice which is not perfectly amorphous presents small differences in the coefficient of conductivity in different directions.

THE physical aspect of the reversal of the photographic image is the subject of a suggestive paper by Captain Abney in the *Journal* of the Camera Club. To investigate the matter, a series of photo-micrographs of sections of films which had been given known exposures was taken. From these sections it is seen that the part of the films in which reversal has taken place are markedly different at the upper and lower surfaces. Near the upper surface the section shows comparatively fine grains of silver, whilst at the bottom surface it shows coarser grains. At the top part of the film, where the light has acted strongly, the reversal has taken place. At the bottom the light has not acted much more than usual, owing to the shielding action of the top part. When given areas of the film are examined, the numbers of separate silver particles are found to be very much the same in both cases, showing that there is a sort of normal number per volume which is subject to reduction, and that the main difference is in the *size* of the reduced particles. In the course of a discussion upon the subject of the paper, Dr. Armstrong, referring to the sections of the unreversed image, considered that Captain Abney had shown that to be the case which must be the case, and that so long as there was no reversal the particles must be practically as large as the bromide particles, and all of the same dimensions. By showing that the particles in the reversed image were so very much smaller, Captain Abney had contributed in an important degree to the solution of the character of the change that took place; it appeared to him that it had been shown that there was in some way a re-conversion of the surface of the particle into soluble matter—that evidence had been adduced to prove that there must be a re-transference of the bromine back into the silver at the surface, leaving untouched the silver lower down in the particle, and consequently that when the fixing solution was applied, the particle became reduced in size.

AN article of perhaps no little interest to many persons in this country, and of some substantial importance to Spanish industries, is the so-called gut from silkworms. This is useful for fishing purposes, partly on account of its great tenacity and partly owing to its transparent quality, the line attaching the hook when in the water not being visible. The manner of obtaining this threadlike gut is described in the *Journal* of the Society of Arts as follows:—After the grub has eaten enough mulberry leaves and before it begins to spin, which is during the months of May and June, it is thrown into vinegar for several hours. The insect is killed, and the substance which the grub, if alive, would have spun into a cocoon, is forcibly drawn out from the dead body into a much thicker and shorter silken thread. Two thick threads (from each grub) are placed for about four hours in clear cold water, after which they are dipped for ten or fifteen minutes in a solution of some caustic, for which purpose soft soap dissolved in water is used. This serves to loosen a fine outer skin, which is next removed by the hands while the workman holds the thread between his teeth. The silk is then hung up to dry, care being taken to choose a shady place, as the sun has the effect of making them too brittle afterwards. In some parts of the country these silk guts are bleached with sulphur vapour, which makes them look beautifully glossy and snow-white, like spun glass, while those naturally dried retain always a yellowish tint.

THE current number of the *Annali d'Igiene Sperimentale* contains a note by Dr. Casagrandi on a yeast producing a red pigment which, in many respects, resembles the one described by Demme some years ago, and isolated by him from a cheese. Demme stated that his variety was not endowed with any fermentative properties; that isolated by Casagrandi, on the contrary, ferments glucose very readily. This fermentative power is not, however, a trustworthy one for establishing differences between very similar varieties of bacteria, for, as in other cases so in this, Casagrandi has found that Demme's yeast can be induced to ferment glucose if particular precautions are adopted. Both Demme's and Casagrandi's specimens are pathogenic to guinea-pigs, rabbits and rats, when subcutaneously introduced into these animals; whilst of much interest is the fact that when grown in milk they are both capable of so modifying the character of this liquid that dogs and rabbits fed with such milk develop diarrhœa, and the same symptoms have been observed in babies which had partaken of milk in which this red yeast had been growing. This yeast appears to be present in our surroundings, and may, therefore, at any time make its presence felt by obtaining access to milk if the latter is left unduly exposed. We already have one well-recognised red yeast, the so-called *Rosa hefe*, but Casagrandi does not claim that his variety is anything more than an offshoot from the second red yeast, known to us as the *Saccharomyces ruber* discovered by Demme some seven years ago.

NO. 11, vol. iii., of *Spelunca* contains, among much other cavern-lore, an illustrated account of M. Martel's explorations in the British Isles in 1895.

IN the November number of the *Irish Naturalist*, Mr. G. H. Kinahan urges the importance of a careful study of quartz-rocks, when not metamorphosed, with a view to the recognition of structures that may prove some of them to be of organic origin, like the modern sinter produced by the algæ of hot springs.

MR. W. JEROME HARRISON has reprinted, from the *Glacialists' Magazine*, "A Bibliography of Norfolk Glaciology," on the lines of his similar work on the Midlands. Over four hundred papers are catalogued, in approximate order of publication, and short abstracts of the most important are given. There is also a list of the Geological Survey maps, and an author-index. A reproduction of a photograph of one of the great chalk-masses in the drift of Runton forms a frontispiece to this useful reprint.

To commemorate the incorporation of the University College of Sheffield, a number of scientific papers by members of the College have been brought together and printed in a volume for private distribution. The subjects of physical papers included in the volume are:—The influence of carbon on iron, by Prof. J. O. Arnold; the preparation of pure iron by electrolysis, by Prof. W. M. Hicks, F.R.S., and Mr. L. T. O'Shea; vortex aggregates with gyrostatic quality, by Prof. Hicks; functions connected with tesseral harmonics, by Prof. A. H. Leahy; superheated steam-engine trials, by Prof. W. Ripper; the amount of carbonic anhydride in the atmosphere, by Prof. W. Carleton Williams; and contributions to the knowledge of the Triazole series, by Dr. George Young. In biological science there are papers on the comparative intellectual value of the anterior and posterior cerebral lobes, by Dr. C. Clapham; the development of the ovipositor in *Periplaneta orientalis*, by Prof. A. Denny;

the preparation of marine animals and plants as transparent lantern slides, by Prof. H. C. Sorby, F.R.S.; and the shape and position of the pancreas and the adjoining viscera, by Prof. C. Addison. The editing committee state that the volume "is presented as an earnest that the new College may in the future be distinguished, not only for the number of students it has trained, but also as a place for the advancement of knowledge." We accept the token, and from its character we are sure that the University College of Sheffield will not be behind in valuable contributions to science.

THE number of cuprous salts at present known is very small in comparison with the large number of stable cupric salts that can exist. The isolation of cuprous sulphate, in particular, has not yet been effected. In the current number of the *Comptes rendus* of the Paris Academy of Sciences there is an interesting account, by M. A. Joannis, of some attempts to isolate this salt, which, although unsuccessful, tend to prove that cuprous sulphate can be formed under certain conditions. Finely divided metallic copper digested with a solution of cupric sulphate, as is well known, undergoes no change. If, however, carbon monoxide is led in, a slow absorption takes place, the copper dissolving, and the solution becoming decolorised. These facts can be accounted for by assuming that cuprous sulphate is formed which combines with the carbon monoxide to form a compound analogous to that obtained from cuprous chloride. The decomposition of this solution when the gas is removed by the mercury pump is somewhat remarkable, for as soon as the pressure is reduced to about 2 mm. a pellicle of metallic copper forms on the surface, and the solution becomes blue, the reaction between cupric sulphate, copper, and carbonic oxide being in fact a reversible one and a function of the pressure of the gas.

FROM the December *Journal* of the Chemical Society, we derive the following particulars of a paper on the production of sugars in beetroot, by Friedrich Strohmer:—The opinion expressed thirty years ago by H. Schacht, that the quality of beetroots depends on the number of developed leaves and the length of life of the plant, is now shown to be free from objections. Sugar is produced in the leaves, either directly as reducing sugar, or from starch or other carbohydrate, and migrates through the leaf stems to the root. The production of sugar depends on the amount of light, and the form and position of the leaves are of importance. When the sunlight passed through white or yellow glass, leaf production was vigorous, but with blue or red glass feeble; and the weight of roots under the influence of yellow light was nearly twice as great as when blue and red light were employed. The percentage of sugar under the different conditions was 7·4–8·1 with yellow, 6·4–7·4 with red, and 8·0–8·4 with blue light. For producing total organic substance in beetroot, rays of medium wave-length are the most favourable, but for converting the products of assimilation into sugar, the so-called chemical rays seem to have a prominent *rôle*. The results of field experiments showed that sugar production begins at an early stage in the leaves, but is greatest from the beginning of August to the middle of September. Under favourable conditions, there may be a not inconsiderable accumulation of sugar even later. From the beginning of July, the sum of the percentages of water and sugar in the roots is constant. This, and the fact that the percentage of sugar in the roots increases until the leaves die, indicates that the sugar, once stored in the roots, remains there. It is only when the roots are taken out of the soil and the leaves cut off, that the sugar begins to be used up in maintaining the life of the plant and in preparation for second year's growth.

THE additions to the Zoological Society's Gardens during the past week include an Ocelet (*Felis pardalis*) from Para, presented by Mr. William Wethered; an Arctic Fox (*Canis lagopus*) from the Arctic Regions, presented by Mr. H. E. Wood; a Dominican's Cat (*Felis dominicanorum*), two White-legged Falconets (*Microhierax melanoleucus*), a White-browed Laughing Thrush (*Dryonastes sannoi*), a Collared Jay Thrush (*Garrulax picticollis*) from the province of Foochoo, China, presented by Messrs. C. B. Rickett and J. De la Touche; four Burrowing Owls (*Speotyto cunicularia*) from Argentina, presented by Miss Sandys Lumsdaine; a Common Chameleon (*Chamæleon vulgaris*) from North Africa, presented by Miss M. L. Peake; a Golden Eagle (*Aquila chrysætus*) from Newfoundland, two Black-necked Swans (*Cygnus nigricollis*, ♂ ♀) from Antarctic America, purchased; a Crested Porcupine (*Hystrix cristata*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

OPPOSITIONS OF TWO MINOR PLANETS.—The minor planet Ceres will be in opposition to the sun on the 25th of this month. (For elements and coordinates see pages 2 and 3 of Appendix to Nautical Almanac 1897.) Although Ceres is the largest of the asteroids, it is interesting as having to give precedence to Vesta for brightness; the stellar magnitude at this opposition will be 7·1. Ceres is now describing a retrograde path on the borders of Auriga and Gemini, near ϵ Geminorum, and has therefore a considerable altitude.

There is also an opposition, on the 26th inst., of one of the fainter and less well-known minor planets, viz. Gerda, the elements and coordinates for which, as given by M. A. Iwanow, of Pulkova, will be found in *Astr. Nach.*, 3458. At the time of opposition the asteroid will be near to ν Geminorum.

THE TOTAL SOLAR ECLIPSE OF 1900.—Prevision is always a desirable attribute, and to an astronomer it is essential. We are reminded of this by an account given by Prof. Frank H. Bigelow, in the *Monthly Weather Review*, of the probable meteorological conditions along the path of the total eclipse of the sun, in the United States, on May 28, 1900. Beginning with May 15, of this year, and continuing until June 15, so as to include May 28 centrally, meteorological observations were made at sixty-six stations distributed uniformly over the portions of the States of Virginia, North Carolina, South Carolina, Georgia, Alabama, Mississippi, and Louisiana, crossed by the eclipse track. Observations were made of the general state of the sky at 8 a.m., 8.30 a.m. and 9 a.m., and also of the state of the sky near the sun. The results show that the conditions in the interior of Georgia and Alabama were better than in North Carolina, South Carolina, or Louisiana. Apparently it would be safer to establish eclipse stations in central Georgia or Alabama, upon the southern end of the Appalachian mountains, where the track crosses the elevated areas, than nearer the coast line in either direction, north-eastward towards the Atlantic coast or south-westward towards the Gulf coast.

It is intended to repeat the observations during the years 1898 and 1899, so as to obtain as good information as possible with regard to suitable eclipse stations for the year 1900.

CORRECTED POSITION OF THE MOON.—It will be remembered that the Pleïades have been quite recently occulted twice by the moon, once in July and again in October. These occultations were specially observed at Lyons, and in No. 22 *Comptes rendus*, vol. cxxv., M. Lagrula shows that in a series of occultations of stars by the moon, observed at epochs sufficiently near together, it can be supposed that the corrections to apply to the tables of our satellite vary proportionally with the times. It is then possible from these to combine the equations of condition supplied by the different phenomena observed. Thus we can obtain with great precision the semi-diameter and the coordinates of the moon at the mean epoch, and even in certain cases her parallax. The two important occultations discussed are those which took place on July 23 and October 13, 1897. The results are given in the following table, where D and π represents the semi-diameter and the parallax of the moon at her mean distance; Δx and $\Delta\delta$ the corrections in R.A. and declination, which ought to be applied to the coordinates in Hansen's tables, corrected from Newcomb's numbers.

Paris Mean Time 1897	D	π	$\Delta\alpha$	$\Delta\delta$	No. of Obs.
d. h. m.	′ ″ ″		s. s.	″ ″	
July 23 13 9	15 32·87±0·14	indeterminate	+ 0·30±0·01.	− 0·1±0·2	36
Oct. 13 14 5	15 32·86±0·24	57′ 3″·2±1″·0	+ 0·31±0·02.	+ 0·5±0·4	29

A NEW FORM OF MIRROR FOR A REFLECTING TELESCOPE.—During the dedication exercises held in connection with the Yerkes Observatory, Dr. C. L. Poor advocated and exhibited a reflecting telescope in which the mirror is a portion of a paraboloid of revolution cut from the surface near the extremity of the latus rectum. The reflected rays then being at right angles to the incident rays, no dome would be required for such a telescope, and there would be no secondary mirror. This form of telescope was, however, recommended by Prof. Pickering more than sixteen years ago (NATURE, 1881, August 25); moreover, Prof. Schaeberle shows in the *Astronomical Journal*, No. 419, the inefficiency of such an instrument, from the following considerations. Let L denote the distance from the focus to the centre of the mirror, which is evidently inclined about 45° to the line of sight. If D denotes the minimum diameter of this elliptical mirror, the maximum diameter must be D sec 45° if a circular cone of rays is to be used. The linear distance from the focus to the nearest and most distant points of the mirror will then be approximately—

$$\text{Least distance} = L - \tfrac{1}{2} D \sec 45^\circ.$$
$$\text{Greatest distance} = L + \tfrac{1}{2} D \sec 45^\circ.$$

If we assume $\frac{L}{D} = \frac{7}{1}$, the greatest distance divided by the least distance becomes 1·22.

This quantity is approximately the *blurring factor* for the given ratio of focal length to aperture for this form of instrument. For a star which is only 5′ from the optical axis of the telescope, and in a place containing the longer axis of the mirror, the image will, therefore, be a line no less than 66″, or more than a minute of arc.

Exactly at the focal point this star image will be a point, but for all other positions of the image the definition will be unworkable.

RECENT RESEARCHES ON TERRESTRIAL MAGNETISM.[1]

THE science of terrestrial magnetism has on one previous occasion formed the topic of a Rede Lecture. Twenty-five years ago Sir E. Sabine delivered a discourse on this subject, with which his name will always be honourably connected. The length of time which has elapsed may perhaps justify a return to the same theme, though it must be admitted that now, as then, the study of the magnetic properties of the earth is in an early stage of development. It is true that considerable advances have been made in the theory of the nature of magnetism itself, and of its connection with electricity; but when we attempt to apply theory to explain the actual condition of the earth progress is at once checked by difficulties, many of which have hitherto proved insuperable. We have no real knowledge of why the earth is a magnet, no real knowledge as to why its magnetic state is continually changing, and thus we are compelled to spend long periods of time in collecting facts, which, though their number and complication oppress us, are still insufficient to answer some of the simplest questions that an inquirer, approaching the subject for the first time, would be sure to ask. Terrestrial magnetism is in this respect in the same stage as that occupied by astronomy during the centuries in which the data were accumulated on which Kepler and Newton worked. We have a certain grasp of the facts, but have not yet found the thread of theory which binds them together.

And in one respect the magnetician is less favourably situated than was the astronomer. The rapid repetition of the principal astronomical events made it comparatively easy to discover the laws which those events obey; but, though some magnetic phenomena run through their courses in a day, a year, or a short period of years, the greatest change of all, that which causes the magnet to point now to the east and now to the west of the geographical north, has been studied for three hundred years and is still unfinished. It is a secular variation, of which the period, if definite period there be, must be measured by ages, and centuries may yet elapse before the first cycle which man has watched will be complete.

In spite of these difficulties attempts are continually being made to draw from the facts at our disposal some more definite information as to the causes of terrestrial magnetism; to foretell the future from the present; to trace the connection between the magnetic state of the earth and the constitution of the sun or of the earth itself; and I propose, therefore, to bring before you some of the theories and speculations which are now attracting the attention of those who take special interest in this science.

The fundamental fact, or rather series of facts, from which we have to begin our investigation is a knowledge of the magnetic state of the surface of the earth. To determine this, observations have for many years past been made at many different places, at sea and on land. The general result is a matter of common knowledge. The compass needle points approximately north and south, and dips from the horizontal towards the magnetic poles of the earth.

The first and simplest hypothesis that will serve as a rough approximate explanation of these facts, is that the earth itself is uniformly magnetised, or that there is at the centre of the earth a small but very powerful magnet by which the compass and the dipping needle are controlled.

If this suggestion were adequate, we should be compelled to assume that the axis of the magnet was inclined to the axis of the earth, for the magnetic and geographical poles do not coincide. It would further follow that at the magnetic poles, where the dipping needle is vertical, the magnetic force, which determines the position of the needle, would be of maximum intensity.

But here the simple hypothesis breaks down. The distribution of terrestrial magnetism is more complex than that which can be thus explained. It is true that there are two magnetic poles, but the directive force is not greatest where the needle is vertical. On the contrary there are in each hemisphere two other points, generally called magnetic foci, at which the force is a maximum.

It is thus evident that the magnetic system of the earth might be better represented by supposing that there are within it two magnets inclined both to each other and to the geographical axis, that the foci indicate the directions of these axes, and that the magnetic pole or point where the needle stands vertical is determined by their joint action. Mr. H. Wilde attempted to imitate the magnetic state of the earth by the aid of a duplex arrangement of this kind, but even this was insufficient. He was compelled to supplement it by covering with thin sheets of iron those portions of the globe which correspond to the oceans, and with this modification he succeeded in making a capital magnetic model of the earth.

For the moment, however, I will not follow up the line of inquiry thus suggested, but will only draw attention to the fact that, in spite of all these complications, mathematical analysis supplies us with the means of answering certain questions as to the magnetic constitution of the earth, without the aid of a clear mental picture of the causes to which that magnetic state is due. Whether there be one or more independent magnetic systems within the globe, whether some portions are more magnetic than others, are points upon which at present we have but little information, but there are a few facts from which we can argue with the knowledge that the foundations of our investigation are secure.

Magnetic forces can be produced only by magnetised matter, or by electric currents, and these may either exist within the globe or be external to its surface. Some of the currents, however, may be both internal and external in the sense that their circuits pass partly through the rocks and partly through the air, and that at certain points they traverse the surface from earth to air or from air to earth. Thus the first important question with which the investigator is confronted is: Are the forces which act upon the compass produced within or without the globe? and, if the magnetic forces are in part due to electric currents, are all these currents wholly internal or wholly external, or do some of them flow in part within and in part without the earth?

With regard to the first inquiry, the great mathematician Gauss furnished us with a method by which, if our knowledge of the magnetic state of the surface of the earth is sufficiently

[1] The "Rede Lecture" delivered in the Senate House, Cambridge, on June 9, by Prof. A. W. Rücker, F.R.S.

accurate and extensive, we can determine the relative proportions of those parts of the force which are due to causes wholly external or internal respectively. It is only lately that a further attempt has been made to discover whether, in addition to these, currents from earth to air and from air to earth also exist. The credit of this attempt is due to Dr. A. Schmidt, who, taking the most recent and the most accurate facts at his disposal, deduced from them the conclusion that about one-fortieth part of the magnetic force is due to causes wholly external to the earth, and that a slightly larger fraction is produced by vertical currents; the origin of the remaining thirty-eight fortieths being traced to internal causes only.

And now it becomes necessary to say a few words as to the method by which the vertical earth-air currents may be detected. If we could perform the impossible operation of severing the north pole of a magnet from the remainder without immediately producing poles of the opposite kind in the broken fragments, the isolated pole thus manufactured would be urged northwards by the magnetic forces which are in play near the surface of the earth. If therefore a traveller were to carry such a pole with him, he would be assisted when going northwards, retarded when returning to the south. If the tour ended at the starting-point, the advantage gained when moving in one direction would in general be exactly compensated by the disadvantage of being compelled to oppose the magnetic forces during the remainder of the journey.

To this rule there is one exception. If the migrations of the magnetic pole carried it round an electrical current, so that its course passed through the circuit in which the current flows, as a thread might pass through a ring, and if the route finally led back to the starting-point without again passing through the circuit of the current, the exact equilibrium of loss and gain would be destroyed, and when the journey was over the wandering pole would either have added to or drawn upon any store of energy which it might at first have possessed.

Whether the result would be a loss or a gain would depend upon the direction in which the journey was performed relatively to the direction of the current. On this point it is unnecessary to dwell. Suffice it to say that if the amount of the loss or gain experienced by a given pole is known, the magnitude and direction of the current, whose circuit had been traversed, can be calculated. The result would not be affected by whether the current flowed from all parts of the district which the path of the pole had encircled, or was confined to a few points only; the total flow would be registered without reference to how it was distributed. If some of the currents flowed in opposite directions the excess of one set over the other would be measured.

If now a current passes at a certain point from earth to air it must return from air to earth elsewhere, completing the circuit through the soil. The course of the unburied portion may be regarded as an aerial arch, and from what has been said it will be evident that if a magnetic pole were carried round a leg of this arch the circuit of the current would be pierced, and the total upward or downward flow would be determined. The experiment, as thus described, is impossible, but, by an appropriate method, we can determine the force which would be exerted at any point on the detached north pole of a magnet of given strength, and, if this be known for a sufficient number of points on the path, we can calculate what the result would be if the imaginary conditions of the journey could be realised.

The calculations of Dr. Schmidt as to the existence of earth-air currents were based upon this principle, and were applied to the earth as a whole. Their general accuracy has been confirmed by Dr. Bauer, who supposed the hypothetical isolated magnetic pole to be carried along lines of latitude right round the earth. If, for instance, the journey were made along latitude 51½°, beginning and ending at London, the resulting work would show the total amount of the currents which traverse the northern portions of the Northern Hemisphere between that latitude and the geographical pole. If the same operation were repeated, say on latitude 45°, a similar result would be obtained, and the difference between the two would give the average flow of the currents which traverse the surface of the earth between these two latitudes.

Of course, it must be remembered that by such a calculation we can only arrive at a mean result. If, for instance, we had proved that between these latitudes there was, on the whole, an upward current, it would by no means follow that at all points on the vast surface included between the selected boundaries the currents were flowing from below to above. The meaning of the result would be that, within the region considered, the upward were stronger than the downward currents, and that, if the excess were uniformly distributed over the whole of the surface to which the calculation applied, an average current of such and such a magnitude would be produced.

Turning from the method of detecting the vertical currents to the question as to whether they exist, there are, apart from the calculations of Schmidt and Bauer, some experimental and theoretical reasons which support an affirmative answer. We know that earth currents traverse the soil beneath us. The Aurora is evidence of electrical discharge in the atmosphere. It is conceivable that there are cross connections between these two systems. Again, if the immediate surroundings of the earth are electrically conducting, the mere rotation of the huge magnetic mass of the earth itself would cause the production of currents which at some points would flow out of, and at others would flow into the surface. The late Prof. Hertz calculated the forms of the paths of such currents for the case of a uniformly magnetised sphere rotating about its magnetic axis, and, though the fact that the magnetism of the earth is irregularly distributed forbids us to apply his calculation directly to the globe, yet the principle holds good, though the distribution of the currents would be more complex. Dr. Bauer has deduced from the calculations already referred to the average direction of flow between different latitudes.

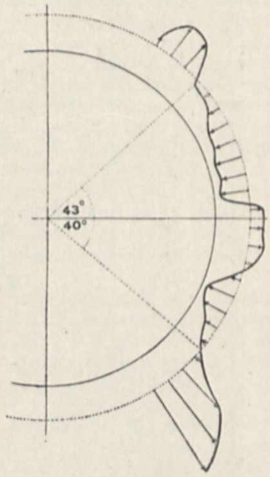

FIG. 1.

The result is shown in Fig. 1. The directions and magnitudes of the supposed vertical currents are indicated by arrows, and points at which there are no such currents occur at lat. 43° N. and 40° S.

Up to this point, therefore, the argument seems all in favour of the actual existence of currents from earth to air, but the results of calculations such as these must be accepted with very great caution. Our knowledge of the magnetic state of the earth is very imperfect; we know but little of the oceans as compared with the land, and of the land but little of the less civilised regions. Whatever be the lines of latitude chosen they must pass over sea, or desert, or both; and if the assumptions made as to the magnetic conditions of these regions are incorrect, it may be that the results are due not to the physical existence of the currents, but to the inaccuracy of the data to which the formulæ were applied.

It therefore becomes important to check such large scale calculations by others which depend only on the comparatively small areas which have been minutely studied.

In 1895, Dr. Carlheim-Gyllenskiöld applied the test for the existence of vertical currents to Sweden, for which comparatively numerous observations could be utilised. The conclusion at which he arrived was that there was no evidence for the existence of the currents, except in those parts of the country where the data were so untrustworthy as to make any conclusion valueless.

In 1896 similar calculations were made for this country. Dr. Thorpe and I have recently completed a magnetic survey of the United Kingdom which is, I believe, the most complete of any which has hitherto been made of an equally large area. All our observations were made within a few years, and, therefore, the corrections for secular change were comparatively unimportant.

The survey was divided into two parts, in one of which we depicted the magnetic state of the kingdom in 1886; while the other part was devoted to a similar investigation for the epoch 1891. We were thus able to compare the results obtained at two periods, separated by a few years only, and by their concordance or disagreement to judge of the value of our conclusions. As these appear to be of some importance with regard to the question we are now discussing, I have recently repeated the calculations in a somewhat different way, and have determined the average value of the currents flowing through all the districts in the United Kingdom which are bounded by lines of latitude and longitude corresponding to whole degrees.

Thus, if starting on the meridian of Greenwich a traveller were to go due north from lat. 51° to 52°, that is from mid-Sussex to the north of Hertfordshire, then were to go due west until long. 1° W. was reached near Buckingham, thence due south along long. 1°, until when near Petersfield he turned homewards due east along lat. 51°, his route would include an area of, in round numbers, 2800 square miles, or of about 7000 square kilometres. In each such circuit the average current expressed in hundredths of an ampere per square kilometre has been determined, and the results are shown on maps both for 1886 and for 1891.

These maps are given in Fig. 2, A and B. The numbers indicate the average flow in hundredths of an ampere per square

north, in the west and south, while in the midlands and the east the general tendency is from above to below.

But in spite of this apparent agreement, I am very doubtful whether these conclusions can be trusted. In the first place the currents are very minute. The whole flow of electricity passing through an area of 2800 square miles is less than that concentrated by Prof. Moissan in a few square inches within an electric furnace. The forces to be measured are so small that they must be seriously affected by the inevitable errors of observation and reduction.

Again, the observations which were made at nearly 900 places scattered all over the kingdom, are affected by local disturbances, due to quite other causes than those we are now discussing, and the magnetic state of the whole area, such as it would be if these disturbances were removed, can only be deduced by an

FIG. 2, A.

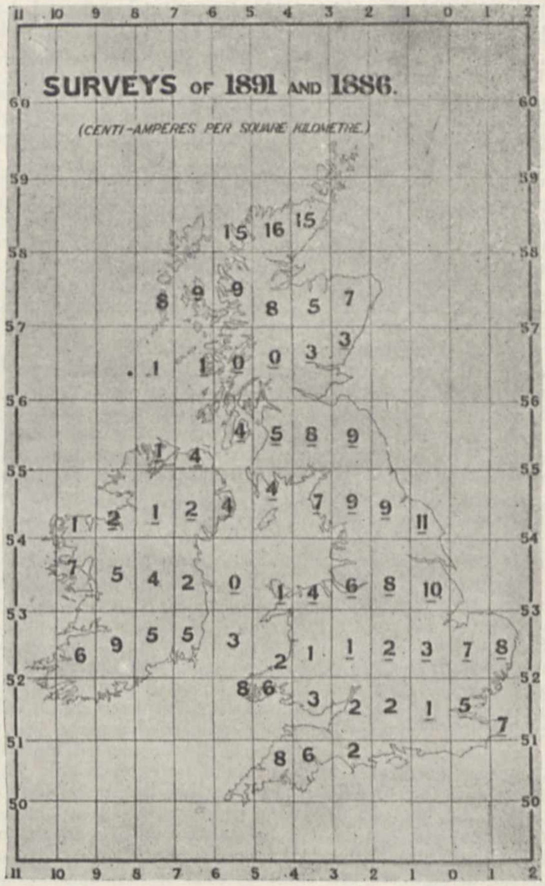

FIG. 2, B.

kilometre. The figures are underlined where the flow of the current is from above to below. In other cases the direction is upwards.

Fig. 2, A, shows the result for January 1, 1886, deduced from the 200 stations which were then available. In Fig. 2, B, all the facts obtained in the two surveys are worked up to a final result for the date January 1, 1891.

If we compare the two maps thus obtained from the two surveys, the conclusions arrived at are, in some respects, not very different. In both the larger currents occur near the boundaries of the land area to which the observations were necessarily confined. If the maps are to be trusted, the largest currents exist in the extreme north of Scotland, in the east of England, and in the far west of Ireland. It is also in favour of the trustworthiness of the results that in both cases the upward currents occur in the same parts of the kingdom. The figures indicate that the currents flow upwards in the far

elaborate system of averaging the results obtained at different places. This process of taking means is least accurate near the boundaries of the survey, and thus the larger currents which are indicated near the shores of our islands have probably no real physical existence, but are due only to the relative uncertainty of our knowledge of the magnetic state of the particular localities in which they appear to flow. From this point of view, therefore, it appears to be unsafe to trust to any particular figure, and that a better result will be obtained if we deal with larger areas and content ourselves with taking the mean of all the currents which appear to flow within them through the surface of the earth.

Adopting this plan, the general conclusions to be drawn from the two maps are very nearly identical. If for the moment we neglect the question as to whether the currents are flowing up or down, their average magnitude in any considerable area in the United Kingdom is about five-hundredths of an ampere per square kilometre. If, however, we take account, as we are bound to do, of the difference of direction, treating those which flow upwards as positive and those which flow down as negative, the result would show that the mean current in the United Kingdom is about five-thousandths of an ampere per square kilometre. Of course, if we deal with considerable but smaller areas, the precise value obtained depends upon the district chosen, but this does not affect the conclusion to any important extent. Thus, for the reason I have already given, it is probable that our knowledge of the magnetic state of the central districts is better than our information as to the borders, and if we confine ourselves to the centre of the kingdom, we find that the average current is downwards in both cases, and that in 1886 it was apparently a little larger, and in 1891 a little less than one-hundredth of an ampere per square kilometre.

Even these concordant conclusions are rendered more doubtful if the two completely independent sets of results obtained by means of the two surveys for 1886 to 1891, respectively, are reduced to the same date. It is true that the magnitudes of the calculated currents are larger than those shown in the map given above, but on the whole they are so opposed in direction that the comparison compels us to reject the hypothesis of their physical reality.

I therefore feel justified in asserting that no evidence that can be relied upon points to the existence of any flow of electric currents through the surface of the British Isles, whether from below to above or from above to below. The quantities are so minute that if they existed they could barely be measured, and the results are too discordant to command assent.

Since the survey of the United Kingdom was completed, my friend Dr. Van Rijckevorsel has made a minute magnetic survey of Holland. In the case of so small a district it is more difficult to eliminate the effects of local disturbances than when the area to be dealt with is larger, and thus I doubt whether conclusions as to the flow of electrical currents drawn from Holland alone could be regarded as trustworthy. Taking them, however, for what they are worth, they indicate an upward current of about one-tenth of an ampere per square kilometre for that country. All these quantities are less than the currents which Dr. Schmidt's calculations demand. In the neighbourhood of the United Kingdom the flow should, according to his calculations, be upwards and the magnitude about fifteen-hundredths of an ampere per square kilometre. This is approached by the flow in Holland, but is from ten to twenty times greater than the average obtained over large areas in the United Kingdom.

So far, then, the question as to whether such currents really exist appears to be doubtful. The calculations of Schmidt and Bauer lead to the conclusion that when the world as a whole is investigated the answer is affirmative, but all the more accurate investigations which have hitherto been made in small areas combine to prove either that the currents do not exist, or that they are less than Dr. Schmidt's theory demands. This fact, taken by itself, is not conclusive, as Sweden, the United Kingdom, and Holland are all in the west of Europe, and it might well be that this happened to be a district in which the currents were exceptionally small; but, on the other hand, the doubt thus raised is formidable. Dr. von Bezold has recently stated to the Berlin Academy that Dr. Schmidt himself must now be added to the list of doubters; and von Bezold confirms this caution by figures which lead him to the conclusion that in all probability the results obtained from calculations which embrace the whole globe are due rather to the want of accuracy of our knowledge than of the physical reality of currents from earth to air. I should myself be sorry to pronounce a final opinion, but I must confess that I seriously doubt whether the horizontal magnetic force has been determined with adequate accuracy at a sufficient number of places in the vast regions which are covered with the sea to enable us to draw any final conclusion from areas which include them, and I certainly consider that the balance of evidence is at present opposed to the physical reality of the currents. Before we can accept the opposite proposition some evidence must be produced based on surveys as complete as those of England and Holland. Before long we shall probably have full information as to France and Maryland, and it is possible that one or other of these may furnish positive evidence sufficient to outweigh the negative results which have hitherto been obtained.

(*To be continued.*)

A PROPOSED SWEDISH EXPEDITION TO THE ARCTIC REGIONS.

A YEAR since, Dr. A. G. Nathorst, of Stockholm, read a paper before the Swedish Society for Anthropology and Geology, entitled "Återblick på Polarforskningens närvarende Ställning samt Förslag till en Svensk Polarexpedition" (a review of the present position of Polar investigation, with a project for a Swedish Polar expedition), which has since been published in *Ymer* (Årgång 1896, Heft 4, pp. 267–286), the journal of the Society. At the time of reading the paper, there seemed but little probability of a near realisation of the projected scheme; but, during the present year, the King of Sweden and certain wealthy merchants of Stockholm and Gothenburg have generously come forward and provided the funds necessary for carrying it out, and Dr. Nathorst, who will act as the scientific leader of the expedition, is now engaged in preparations for a start next year (1898).

As the result of Nansen's voyage, Dr. Nathorst thinks that there is but little probability of the discovery of fresh land areas in the vicinity of the Pole, and that the aim of future expeditions to the Arctic regions should be a thorough scientific investigation of those lands, of which at present but little is known beyond the fact of their existence. Under this head may be mentioned the west coast of Ellesmere Land and Grinnell Land and the neighbouring islands; also the shores of Jones Sound, in Arctic America. Further, large tracts of the north-eastern and north-western coasts of Greenland remain to be examined, in spite of the admirable work of the Danish, Austrian, and other exploring expeditions. But it is with Spitsbergen and the region east of it that previous Polar explorations on the part of Sweden have been most closely connected; and though no fewer than twelve different Swedish expeditions, led by such men as Torell, Nordenskiöld, Nathorst, de Geer, and others, have visited this region since 1858, and that it has been the field of work for expeditions from other countries as well, the most recent being that under Sir Martin Conway in 1896, it yet offers, in Nathorst's opinion, a rich harvest for scientific investigation.

The west coast of Spitsbergen is now fairly well known, but owing to the ice coming from the east and blockading the eastern coasts of the island, nothing has as as yet been ascertained of their geological structure. The same obstacle has also prevented observations on Stans Foreland (Edge Island), Barentz Land, North East Land, Kung Karls Land, and Ny Island; but it is probable, that given favourable conditions of the ice, a steam vessel would be able to approach sufficiently near these islands to allow of their geology at least to be made out. The exploration of these lands between Spitsbergen and Franz Josef Land is the main object of the expedition; but should this be frustrated by the prevalence of the ice, the research work would be carried on in Spitsbergen itself, and more particularly a study would be made of the raised shell-banks and terraces, evidencing a comparatively recent elevation of the land, and of the remarkable quaternary deposits which show that the climate of the island, for a certain interval after the Ice age, was warmer than at the present time. Promising botanical results might be also expected from an examination of the valleys extending from the heads of the fiords, as, for example, those in Sassen Bay, Kol Bay, and Van Mijens Bay.

A stout vessel of from 350 to 400 tons, and a crew of thirteen men, would, in Nathorst's opinion, be most suitable for the undertaking; and the scientific staff would consist of a geologist, a botanist, two zoologists, one hydrographer and meteorologist, and one for cartography and photography. It is not intended to over-winter in the Arctic regions, but the vessel would be provisioned for a year, in case of accidents. The estimated cost of the expedition is about 4000*l*. It is proposed to reach Spitsbergen in the beginning of June, and work there until the middle of August, when it is hoped the ice will allow Kung Karls Land and the other islands near it to be examined.

THE USE OF KITES IN WEATHER PREDICTION.

THE systematic exploration of the upper air by means of kites is referred to by Prof. Cleveland Abbe in the *Monthly Weather Review*, at the end of a long article upon the experiments made previous to 1893. It is pointed out that at that time the Malay kite and the free balloon were merely looked upon as the means for occasionally obtaining isolated items of information from the upper regions; the world had not then awakened to the possibility of the work inaugurated by Prof. Moore in July 1895, which looks to the compilation of a daily map of simultaneous observations high above the earth's surface and over a large portion of the United States, for study in connection with the map of surface conditions. Observations of the air at a single station can have but little value compared with the international balloon work of Europe, or the extended national kite work of the U.S. Weather Bureau.

In an address at Toronto, before the British Association, Prof. Moore is reported by the *Review* to have said:

"For twenty-seven years the forecasters of the Weather Bureau have studied the inception, development, and progression of these different classes of atmospheric disturbances. From a knowledge personally gained by many years' service as an official forecaster, I do not hesitate to express the opinion that we have long since reached the highest degree of accuracy in the making of forecasts possible to be attained with surface readings. It is patent that we are extremely ignorant of the mechanics of the storm; of the operations of those vast yet subtle forces in free air which give inception to the disturbance, and which supply the energy necessary to continue the same. Long having realised this, I determined at once, on coming to the control of the United States Weather Bureau, to systematically attack the problem of upper-air exploration, with the hope ultimately of being able to construct a daily synoptic weather chart from simultaneous readings taken in free air at an altitude of not less than one mile above the earth. It appeared to me that all previous plans for investigating the upper air, by means of free and uncontrollable balloons, by observers in balloons, or by isolated kite stations or mountain observatories, were of little value in getting the information absolutely necessary to the improvement of our methods of forecasting. Simultaneous observations, at a uniform high level, from many co-operating kite stations, was the fundamental feature of the plan that I inaugurated for the prosecution of this important investigation.

"Prof. Marvin was assigned to the difficult task of devising appliances and making instruments, and I am pleased to say that we have improved on kite flying to such an extent that apparatus is now easily sent up to a height of one mile in only a moderate wind. We have made an automatic instrument that, while weighing less than two pounds, will record temperature, pressure, humidity, and wind velocity. By January next we expect to have not less than twenty stations placed between the Rocky Mountains and the Atlantic Ocean taking daily readings at an elevation of one mile or more.

"We shall then construct a chart from the high-level readings obtained at these twenty stations, and study the same in connection with the surface chart made at the same moment. As we shall thus be able to map out not only, as now, the horizontal gradients for the lower surface conditions, but in addition the simultaneous gradients for the upper level, and, what is of still more importance, shall be able to deduce from these, for any section of the atmosphere, the simultaneous vertical gradients of temperature, humidity, pressure, and wind velocity, we may confidently hope to better understand the development of storms and cold waves, and eventually improve the forecasts of their future course, extent, and rate of movement. It will be a fascinating study to note the progress of cold waves at the upper and lower levels, and to determine whether the changes in temperature do not first begin above. I am anxious to know the difference in temperature between the surface and the upper stratum in the four quadrants of the cyclone, and also of the anti-cyclone, especially when the storm or cold-wave conditions are intense. The vertical distribution of temperature in the several quadrants may give a clue to the future direction of movement of the disturbance."

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

MISS EMILY PENROSE, principal of Bedford College, London, has been appointed principal of the Royal Holloway College, Egham.

MR. WM. H. SAGE and Dean Sage have presented to Cornell University the large residence of the late Mr. Henry W. Sage, at Ithaca, for a students' hospital, and will equip it and endow it with 100,000 dols. The residence is valued at 80,000 dols.

THE following resolution has been unanimously passed by the lecturers and teachers in the medical school of Guy's Hospital: "That the medical school of Guy's Hospital earnestly request Her Majesty's Government to reintroduce into Parliament the London University Commission Bill of 1897, and to pass it into law during the ensuing Session."

AMONG the institutions created during the last half-century for the promotion of scientific research and education, the Sheffield Scientific School of Yale College, New Haven, holds an honourable place. A review of the foundation of the School, and of the work of the distinguished investigators who have been connected with it, was given in a discourse delivered by President Gilman at the semi-centennial anniversary recently held. It was in 1847 that Profs. Silliman and Norton opened a laboratory on the College grounds for the purpose of practical instruction in the applications of science to the arts and agriculture. Thus was born the Sheffield Scientific School of Yale University. At first chemistry was alone; engineering soon found a place; mathematics, physics and astronomy joined the oligarchy; in due time, mineralogy, geology, physical geography, zoology, botany and physiology found a welcome; modern languages and literature, history and economics, became strong allies. While this evolution was going on, not a word was spoken in disparagement of classical culture, nor a word of religious controversy. From the beginning onwards the institution has been the department of a University which never suffered its love of letters to blind its eyes to the value of science. The School largely owes its success to its association with the fame, the fortune, and the followers of a great *alma mater*. Substantial advantages were bestowed by the mother upon her offspring; and the present high position which the School occupies shows that the child has deserved the encouragement it has received.

A MEETING was held at the University of London on Tuesday afternoon, the Chancellor (Lord Herschell) presiding, to discuss the proposed legislation on the University of London question. The *Times* reports that there were present, besides the Vice-Chancellor (Sir Henry Roscoe), representatives of the Corporation of the City, the Technical Education Board of the London County Council, the Royal Colleges of Physicians and Surgeons, the various medical schools, University College, King's College, Bedford College, the Royal College of Science, and the City and Guilds of London Institute. The Chancellor invited expression of opinion on the London University Commission Bill which the Government propose to reintroduce early in the Session. He said that the Bill embodied the compromise between the various parties hitherto in conflict, and that it was to receive the support of the Senate, as also of both parties in Convocation. The Chancellor further explained why no proposal for any new charter was within the range of practical politics, reconstitution at the hands of a statutory commission being the only remaining course. He therefore urged the acceptance of the compromise. Many of those present spoke in favour of the scheme, and urged that a deputation should wait upon the Vice-President of Council at an early date. The only objection came from one of the smaller medical schools, which declared its preference for the creation of a second University in London. The feeling of the conference was, however, entirely in favour of the reconstruction of the existing University. A deputation to the Government will be appointed as suggested to urge the passing of the Bill.

SCIENTIFIC SERIALS.

Bulletin of the American Mathematical Society, November 1897.—The number opens with an account, by Prof. Osgood, of the proceedings at the International Congress of Mathematicians held at Zürich in August last. The transactions of the Congress, which was attended by about two hundred mathematicians, together with the papers read, or presented, are to be published in full.—Prof. J. McMahon performs a like work for the Detroit meeting of the American Association for the Advancement of Science. An analysis of the twenty-one papers presented to the Section is given. One of these communications was an account of stereoscopic views of spherical catenaries and gyroscopic curves by Prof. Greenhill, who was present at the meeting, and to whom the Section "is also indebted for instructive remarks made in connection with many of the other papers." Then follow five papers read before the American Mathematical

Society, viz. before the Chicago Section (April 24, 1897): Quaternions as members of four-dimensional space, by Prof. A. S. Hathaway. Note on the invariants of n points, by Dr. E. O. Lovett, is another communication which was made at the same meeting.—Dr. Lovett contributes also a note on the fundamental theorems of Lie's theory of Continuous Groups (October 30). The object of the note is to call attention to a misapprehension, if not an error, in a paper, by J. E. Campbell, on a law of combination of operators bearing on the theory of continuous transformation groups, read at the March 11 meeting of the London Mathematical Society (*Proc.*, vol. xxviii. pp. 381-390). The fourth paper is one read at the Toronto meeting, August 16. It is an interesting short note by Prof. T. F Holgate, and is entitled, "A geometrical locus connected with a system of coaxial circles." The writer's object is to find the locus of points through which three lines can be drawn tangential to three circles of a coaxial system in pairs.—Condition that the line common to $n-1$ planes in an n space may pierce a given quadric surface in the same space, by Dr. V. Snyder, was read at the Detroit meeting mentioned above. The note is a generalisation of a proof recently given by the author (criteria for nodes in Dupin's cyclides) of the geometric significance of a certain determinant.—Dr. E. W. Brown gives a valuable analysis of Prof. H. Lamb's Hydrodynamics. Of this the reviewer writes: "The author is to be congratulated on the completion of a task which will earn him the gratitude of all those who are now, or may in the future be, interested in Hydrodynamics.—In the Notes are particulars of the British Association meeting at Toronto, in so far as it concerned mathematicians. —Other matters are a list of the mathematical courses for the winter semester (1897-98) in the Universities of Göttingen, Leipzig, Munich, Vienna and Strassburg.

IN the *Meteorologische Zeitschrift* for November, Dr. J. Hann gives the daily range of the meteorological elements at Cairo, deduced from the observations of the five years 1891-5, as published in the *Résumé Mensuel* of the observatory at Abbassieh. These values are of some interest, as Dr. Hann states that the monthly means contained in the tables give for the first time the true daily means for Cairo. The barometric range exhibits the small amplitudes for the latitude that have been noticed in other parts of the Mediterranean. The night minimum does not appear to fall below the daily mean throughout the year. The range of temperature shows no special peculiarities; it is greatest in June, and is greater in the dry spring than in the damp autumn. The daily range of wind force is noteworthy, especially during spring and autumn; during the year there is only a very slight variation at night-time, but in the afternoon there is a great increase in the force from winter to spring, and from summer to autumn. During the winter half-year the nights are clear, while cloud prevails at the middle part of the day; in the summer the morning hours are cloudiest, but from about noon the sky is almost cloudless. The influence of the overflow of the Nile in the autumn naturally affects the range of humidity.

IN the *Journal of Botany* for November and December, Mr. F. Townsend completes his monograph of the British forms of *Euphrasia*, of which he makes fourteen "species" founded on von Wettstein's monograph of the genus. It is accompanied by seven plates illustrating the habit of each "species," and details of the form of the flowers and leaves.—In a paper on "New and Critical Marine Algæ," Mr. E. A. L. Batters describes a number of species new to science, together with a new genus, of Florideæ, *Porphyrodiscus*, from Berwick, with the crustaceous habit of *Hildenbrandtia*.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, November 25.—"On certain Media for the Cultivation of the Bacillus of Tubercle." [1] By Dr. Arthur Ransome, F.R.S.

The following conclusions had been drawn from previous experiments:—

(1) That finely divided tuberculous matter, such as pure cultures of the bacillus, or tuberculous matter derived from sputum, in daylight and in free currents of air is rapidly deprived of virulence;

(2) That even in the dark, although the action is retarded, fresh air has still some disinfecting influence; and

(3) That in the absence of air, or in confined air, the bacillus retains its power for long periods of time.

These observations afforded an explanation of the immunity of certain places, and the danger of infection in others. They show that where tuberculous sputum is exposed to sufficient light and air, to deprive it of virulence before it can be dried up and powdered into dust, no danger of infection need be dreaded. It would appear further, from this research and others, that it is only when there is sufficient organic material in the air, derived from impure ground air, or from the reek of human bodies, that the tubercle bacillus can retain its existence and its virulent power.

But, in addition to the above-mentioned researches, it seemed desirable that an attempt should be made to ascertain what part was played respectively by the several forms of organic impurity that are present in insanitary dwellings. It was determined, therefore, to collect the aqueous vapours arising from the ground, or from human bodies, and to submit these products to the test of trying whether they would serve as cultivating media for the bacillus of tubercle.

By means of a simple freezing mixture of ice and salt it was easy to condense the aqueous vapour, both of the breath and that coming from ground air.

Some evidence was obtained with simple glycerine agar that the organic fluids facilitated cultivation to some extent. With the organic fluids there were only two failures, and growth was fairly rapid.

In the next series of trials, it was decided to use as the material bases some non-nitrogenous substance, and at length it was determined to use a particularly pure "filter-paper."

Some degree of success was attained in twelve out of fifteen specimens of the organic fluids.

The degree of growth was also much the same as in the previous series, though perhaps slightly less vigorous.

It was now determined to try to do without the help of the glycerine, which, as is well known, so greatly assists the ordinary cultivations of the bacillus. Accordingly, four tubes with simple filter-paper as the supporting medium, and condensed fluids, from the breath of a healthy person, and from that of a phthisical patient, as nutrient fluids, were inoculated, and no glycerine was added. In these tubes the same cultivation was used as in the previous experiments.

Shortly afterwards, two similar tubes with fluid from healthy breath alone, but with 5 per cent. of glycerine, were sown with the same cultivation, and were left at the ordinary temperature of the laboratory, about 21° C.

All of the former group took on active growth within four weeks, and one of the latter. In other words, it was proved that pure filter-paper, moistened with these condensed fluids, alone would suffice to nourish and promote the growth of the bacillus, and, further, that this growth would take place at ordinary temperatures. It may hence be concluded that when this organic fluid is present in ordinary dwellings, the bacillus may grow at the temperature of living rooms as well as at the temperature of 35° C.

Two sets of tubes were then prepared of condensed vapour from breath, and from ground air from a pure sandy soil. No glycerine was added; but for the solid medium, in some instances, the pure filter-paper was employed; in others, an ordinary lining paper, containing a little size, but carefully sterilised, was used.

Some of these were placed in the incubator at a temperature of 37° C., others were left in the dark at the ordinary temperature of the laboratory.

In many of the tubes a free growth was observed as early as the end of the first fortnight.

Out of the total number in this series of 37, in thirty six instances there was free growth on the medium employed, on both kinds of paper, and all kinds of condensed fluid. Eleven of them were grown at a temperature of about 20° C. In only one instance was there complete failure (vapour from healthy breath).

The bearing of these researches upon the subject of the prophylaxis against tuberculosis seems to be of some importance.

They prove that any one of the various organically charged vapours, whether coming from healthy or from diseased lungs,

[1] By permission of the Royal College of Physicians, this research, which forms a portion of the Weber-Parkes prize essay, is communicated to the Royal Society before publication. The cost of the inquiry is defrayed by the Thrustan prize, presented to the author this year by Gonville and Caius College, Cambridge.

from the air of cellars, or from comparatively pure ground, forms an excellent cultivating medium for the bacillus of tubercle when kept away from the disinfecting influence of air and light.

This power of promoting its growth is particularly manifest when the supporting substance is common wall-paper, though it is quite apparent when very pure filter-paper is used.

It is further proved that, on these substances, the growth of the bacillus may take place at the ordinary temperatures of dwelling-rooms; and, hence, that there is no safety against the increase of the organism in ordinary living-rooms in which active tuberculous dust is present, and in which the natural disinfectants of the bacillus, fresh air and light, are not present in sufficient amount to destroy their virulence.

Physical Society, December 10.—Mr. Shelford Bidwell, President, in the chair.—Mr. Albert Campbell exhibited: (1) An experiment to illustrate alternate exchange of kinetic energy. Two brass spheres, each about one inch diameter, are suspended from the same point by equal wires. One of them is then thrown so as to describe a circular orbit. The second sphere, starting from rest, gradually takes up motion from the first sphere, and in turn describes a circular orbit. The first now comes to rest, and the reverse process takes place. This alternating action repeats itself until all the energy is lost in the wires. (2) An experiment to illustrate the low heat-conductivity of glass, and the expansion of glass by heat. A long tube is clamped at the lower end, in a vertical position. One side of it is then heated with the flame of a Bunsen burner, and the glass is observed to bend, moving over a fixed mark near the top of the tube. When the flame is withdrawn, the first position is quickly regained. Mr. Campbell then read a paper on "Temperature compensators for standard cells." Some account of the methods adopted by the author has already been published, he now describes the apparatus. The first compensating arrangement (3) can be used for keeping the potential-difference between two points of a conducting system constant at all room-temperatures. Or it can be adapted to modify the voltage of a standard cell to some convenient whole number. This arrangement (3) resembles a Wheatstone's bridge with the galvanometer-branch removed. One pair of opposite arms is of copper, the other pair is of manganin. The bridge-battery is a Leclanché cell; this supplies the auxiliary voltage, which is utilised at the two galvanometer-points of the bridge, and is there applied in series with the standard cell. In an alternative method, suggested by Mr. C. Crawley, only one of the four arms is made of copper. The second compensating arrangement (4) is intended to maintain constant potential between two points, at all room-temperatures. For this purpose, two wires, *a* and *b*, are connected in parallel. One of them, *a*, is all of manganin, the other, *b*, is partly copper and partly manganin. Constant *current* is applied at the ends of *a* and *b*. The various resistances are chosen so as to give constant difference of potential between the ends of the manganin portion of *b*. By this method the potential-difference can be maintained to within 1 in 2000. Mr. Swinburne said that twelve or thirteen years ago he had given a good deal of thought to compensation by wires of different temperature-coefficients. The first thing he tried was a Wheatstone's bridge. This was compensated by making the bridge-arms of wires whose temperature-coefficients differed—as, for instance, platinoid and copper. He then applied the same principle to the compensation of standard cells, using a potentiometer method that gave direct readings, and to the compensation of voltmeters and watt-meters. These results were published between 1885 and 1890, in the electrical journals. He believed that Mr. Evershed had also developed this idea, by putting "back" turns on voltmeters, and by other differential devices. The details of Mr. Campbell's apparatus had a few points of special interest. The way in which he connected up the bridge (3) seemed particularly worthy of notice. Prof. Ayrton asked whether thermo-electric effects produced difficulty in the compounded arrangement. Mr. Campbell said the system was symmetrical, and the thermal currents were consequently neutralised. Mr. Appleyard, referring to experiment (2), said it was identical with one that had been shown for the past eight years at lectures at Cooper's Hill College. It was specially of interest as illustrating the deflection that occurs with girders and bridges when exposed on one side to sunshine.—Mr. J. Rose-Innes read a mathematical paper on Lord Kelvin's absolute method of graduating a thermometer. Lord Kelvin has investigated the cooling effects exhibited by various gases in passing through a porous plug. He found that for any gas, kept at the same initial temperature, the cooling effects were proportional to the difference of pressure on the two sides of the plug. He also found that, for any one gas, the cooling effect per unit difference of pressure varies approximately as the inverse square of the absolute temperature. This rule holds very well in the case of air; it is not so satisfactory for carbonic acid; it fails for hydrogen. With hydrogen there is a *heating* effect that increases, if anything, when the temperature rises. Mr. Rose-Innes proposes an empirical formula, containing two disposable constants, α and β, characteristic of the gas in question. Denoting by T the absolute temperature, he finds that, very approximately, the cooling effect is given by the expression $(\alpha/T - \beta)$ This relation includes the three cases—air, hydrogen, carbonic acid—under one form, and thus enables them to be treated in one common investigation. Moreover, the differential equation concerned in the thermo-dynamic scale is thereby rendered more manageable; it leads to simpler algebraic results after integration. The paper discusses the thermo-dynamic correction for a constant-pressure gas-thermometer, and the correction for a constant-volume gas-thermometer; also an estimate of the absolute value of the freezing-point of water; the results obtained take, for the most part, a very simple shape, using the above expression for the cooling. Dr. S. P. Thompson said the empirical expression, $(\alpha/T - \beta)$, indicated that at some particular temperature the cooling effect vanished; that was a point suggestive of useful results if investigated by experiment. Mr. J. Walker read a communication from Mr. Baynes on the paper, and remarked upon the desirability of adopting two constants. He thought that further experiments should be made to discover how specific heat at constant temperature depends on temperature. The calculated values for hydrogen were too few to be taken as evidence of the validity of the rule. Mr. Rose-Innes, in reply, said that from what was known of hydrogen, it might be expected to behave at ordinary temperatures as air behaves at higher temperatures. His object was, if possible, to include in one formula the case of the three investigated gases. This was better than having a separate formula for each gas. Whether or not hydrogen was confirmatory with air and carbonic acid, might be considered as *sub judice*; it required further experimental data to test the formula in that case.—The President proposed a vote of thanks to the authors, and the meeting was adjourned until January 21, 1898.

Chemical Society, November 18.—Prof. Dewar, President, in the chair.—The following papers were read:—On the decomposition of camphoric acid by fusion with potash or soda, by A. W. Crossley and W. H. Perkin, jun. Camphoric acid, when fused with alkali, gives a mixture of a number of fatty acids with dihydrocamphoric acid, $C_{10}H_{18}O_4$, pseudocamphoric acid, $C_{10}H_{16}O_4$, and an acid of the composition $C_9H_{16}O_4$; the results are explained and constitutions assigned on the assumption that camphoric acid has the constitution,

$$\left.\begin{array}{l} CH_2.CH(COOH) \\ | \\ CMe_2.CMe(COOH) \end{array}\right\rangle CH_2.$$

—Experiments on the synthesis of camphoric acid, by W. H. Bentley and W. H. Perkin, jun. The authors have prepared isobutylmethylhydroxyglutaric acid, $CHMe_2.CH_2.CH(COOH).CH_2.CMe(COOH)OH$, hoping that by loss of water it would give an acid of the constitution assigned in the previous paper to camphoric acid; by loss of water, however, a lactonic acid or its derivatives were usually obtained.—Synthesis of an isomeride of camphoronic acid, by S. B. Schryver.—The action of magnesium on cupric sulphate solution, by F. Clowes and R. M. Caven. When magnesium acts on copper sulphate solution, hydrogen, cuprous oxide, and copper are produced.—Properties and relationships of dihydroxytartaric acid, by H. J. H. Fenton. Dihydroxytartaric acid is readily prepared by oxidising dihydroxymaleic acid in aqueous solution; it gives a quantitative yield of tartronic acid on heating.—The molecular association of liquids and its influence on the osmotic pressure, by H. Crompton. The author shows that Planck and van Laar's demonstrations that association can have no effect on osmotic pressure are invalid owing to faulty reasoning.

Geological Society, December 1.—Dr. Henry Hicks, F.R.S., President, in the chair.—A revindication of the Llanberis unconformity, by the Rev. J. F. Blake. In a paper published in the *Quarterly Journal* of the Society for 1893, the author of the present paper maintained that certain conglomerates and associated rocks occurring for some distance north east and south-west of Llanberis, which had hitherto been considered to lie below the workable slates of the Cambrian rocks of that area, were in reality unconformable deposits of later date than those slates. In the year 1894 a paper appeared in the same journal, in which the authors maintained that in no case which had been examined could any valid evidence be found in favour of the alleged unconformity, and that in one (on the north-east side of Llyn Padarn) which they supposed to afford the most satisfactory proof of it, the facts were wholly opposed to the notion. The present paper was a reply to these authors, in which their objections, founded on general considerations, on field observations, and on microscopic examination of rock-specimens, were discussed, and the author gave the results of further observations on the rocks of the district.—The geology of Lambay Island, Co. Dublin, by Messrs. C. I. Gardiner and S. H. Reynolds. The authors, who have previously described the neighbouring district of Portraine (*Quart. Journ.* Geol. Soc., December 1897), undertook an examination of this island, with the intention of comparing the rocks with those of Portraine, and of investigating the nature of the rock familiar to geologists under the name of "Lambay porphyry." The sedimentary rocks are similar to some of those of Portraine, and are of Middle or Upper Bala age. Associated with them are pyroclastic rocks and andesitic lava-flows, some of the lavas having flowed beneath the sea. The sediments and volcanic rocks were exposed to denudation, and a conglomerate composed of their fragments was accumulated round the volcano. The "Lambay porphyry," which has been determined as a diabase-porphyry by Dr. von Lasaulx, is partly intrusive in the other rocks, but has in places come to the surface as a lava-flow Petrographical descriptions of the various rocks were given by the authors.

Mathematical Society, December 9.—Prof. Elliott, F.R.S., President, in the chair.—Miss F. Hardcastle communicated a theorem concerning the special systems of point groups on a particular type of base curve.—Mr. Love, F.R.S., gave a sketch of a paper, by Prof. W. Burnside, F.R.S., on the straight line joining two given points.—Impromptu communications were made by Messrs. F. S. Macaulay, A. Berry, and E. T. Whittaker.

Entomological Society, December 1.—Mr. R. Trimen, F.R.S., President, in the chair.—Mr. Dudley Wright exhibited an aberration of *Argynnis euphrosyne*, in which the upperside was suffused with black, and the silver spots of the underside of the hindwings converted into streaks.—On behalf of Mr. W. H. Tuck, Mr. Tutt showed examples of *Metœcus paradoxus*, L., taken in nests of *Vespa vulgaris* near Bury St. Edmunds, together with some of the cells in which they were found. About a fifth of the nests examined were affected, some containing as many as twenty-four, twelve and eight examples of the beetle; the more usual number present was from two to four. The dates between which examples were taken in 1897 were from August 2 to October 1. According to Dr. Chapman the eggs were laid in the cracks of posts, &c., from which the wasps got the pulp to make their cells.—Combs were also exhibited from nests of *Vespa crabro* and *Vespa germanica*, in which Mr. Tuck had found larvæ of *Velleius dilatatus*, Fabr., which, however, he had been unable to rear.—The Rev. A. E. Eaton exhibited a specimen of the singular *Myodites subdipterus*, Fabr., taken by himself at Biskra, Algeria, and a near ally of *Metœcus*.—Mr. Blandford called attention to a new instance of the destructive propensities of *Dermestes vulpinus*, Fabr. He had received examples found at Hong-Kong among flags made of bunting, which were presumably injured, although no details had been forwarded. This form of injury was analogous with the damage to woodwork recorded by himself and others; it had nothing to do with the feeding-habits of the insect, but was committed by the larvæ in their search for shelter in which to pupate. Probably the flags had been stored at some period in the neighbourhood of infested leather goods, or dried provisions. The only other case of damage to textile fabrics by *Dermestes vulpinus* which he knew of occurred in connection with the case recorded by him (*Proc. Ent. Soc. Lond.*, 1890, p. xxxi); a blue handkerchief spotted with white, left in the infested building, was found next day to have all the white spots eaten out.—Mr. Champion communicated papers entitled "Notes on American and other Tingitidæ, with descriptions of two new genera and four species," and "A list of the Staphylinidæ collected by Mr. J. J. Walker, R.N., in the Straits of Gibraltar."

PARIS.

Academy of Sciences, December 6.—M. A. Chatin in the chair.—On the stability of the Eiffel tower, by M. Bassot. The paper is accompanied by four diagrams, showing the motion ot the summit of the tower. The conclusion is drawn from these curves, that to verify by periodic observations any permanent displacement undergone by the summit, the measurements should be taken in the evening, two or three hours before sunset, as at that time the irregular movements are at a minimum.—On double integrals of the second species in the theory of algebraic surfaces, by M. Émile Picard.—The first modifications which occur in the fixed cells of the cornea, in the neighbourhood of wounds of that membrane, by M. L. Ranvier. A section is cut perpendicularly to the incisions made in the living animal, and gold staining applied until the fixed cells are nearly black. Those cells which have been cut by the knife at the end of twenty-four hours show budding prolongations by the edges of the wound. These phenomena exhibited by the cells of the cornea of the rabbit are of the same order as the extension by budding of the cylinder axes of cut nerve cells.—On the contamination of wells, by M. Duclaux. By an analytical study of the waters from the shallow wells of a village lately subject to a slight typhoid epidemic, it is shown that a comparatively simple chemical analysis suffices to distinguish between polluted and unpolluted wells, provided that the composition of the water of the district in a pure state is known. The bacteriological method of examination is looked upon as less trustworthy than the chemical method.—Actinometric observations made upon Mont Blanc, by MM. Crova and Hansky. The measurements were carried out in August and September, and were much interfered with by rain. At the summit the maximum value of the solar constant was 3·4, and it is suggested that under more favourable conditions this magnitude might be increased to 4·0.—Observations on the planet (DL) Charlois (1897, November 23) made at the Observatory of Toulouse (Brunner equatorial), by M. F. Rossard.—Application of the method of least squares to the detection of systematic errors, by M. Jean Mascart. A discussion of the conditions under which the application of the method of least squares becomes illusory.—On the approximation of functions of large numbers, by M. Maurice Hamy.—On associated pencils, by M. C. Guichard.—On the focal planes of a curve plane to one or several axes of symmetry, by M. P. H. Schoute.—On the existence of integrals in certain differential systems, by M. Riquier. Elliptical vibrations in fluids, by M. V. Crémieu.—The interference in air of two sound waves of different phases has been studied by observing the motion of a quartz fibre placed at the point of intersection of the waves.—On the dissociation and polymerisation of gases and vapours. Supposed dissociation of chlorine at high temperatures, by M. A. Leduc. The only evidence in favour of the dissociation of chlorine is one isolated observation of M. Crafts at 1400° C.—On the electric conductivity of discontinuous conducting substances, in relation to telegraphy without wires, by M. Édouard Branly.—On the transformation of the X-rays by metals, by M. G. Sagnac. If a bundle of X-rays is allowed to impinge upon a polished metallic surface, such as steel, or a mercury bath, there is no appreciable regular reflexion, but rays, termed by the author secondary rays, can be shown photographically or electrically to be diffused from the surfaces. These radiations show generally all the properties of the original X-rays, but the nature of the metal is not without influence, as the secondary rays from different metals can be distinguished by their unequal transmission by the same substance.—Some new facts observed in Crookes' tubes, by M. Virgilio Machado.—On the accidental causes of irreversibility in chemical reactions, by M. A. Colson. Two reactions are described in detail: the decomposition of normal phosphates by hydrochloric acid, and that of silver sulphate by hydrogen sulphide. In both cases secondary reactions intervene, which render the reversibility of the phenomena impossible.—On the existence of a cuprous sulphate, by M. A. Joannis (see p. 159).—On the elementary unity of the body called cerium, by MM. Wyrouboff and A. Verneuil. A criticism of the results of M. Boudouard, whose atomic weight determinations are stated to be affected both by impurities in his material, and inaccuracy in experimental work.—On aldehyde ammonia, by M. Marcel Delépine. Aldehyde ammonia, when left for three days in a vacuum over sulphuric acid, loses water, giving brilliant white crystals of a new base, ethylidene-imine, which analysis and cryoscopic estimations show to have the formula $(CH_3-CH=NH)_3$. A solution of aldehyde-ammonia in absolute alcohol gives a crystallised picrate of the same base.—On a reaction peculiar to orthophenols, and on the derivatives of antimonylpyrocatechol, by M. H. Causse.—On the nature of the combinations of antipyrine with aldehydes, by M. G. Patein.—Physiological and therapeutic effects of spermine, by M. Alexander Pœhl. The effects of the alkaloid are uniform, and consist in accelerating the phenomena of oxidation, thus favouring the elimination in the form of harmless products of several poisonous organic secretions.—Disappearance of lead poisoning by the partial substitution of metastannic acid in the putty used in glass polishing, by M. L. Guéroult. The original putty contained 62 per cent. of lead; by the addition of metastannic acid the lead was reduced to 20 per cent. During the six years in which this modified powder has been used, there have been no symptoms of lead poisoning in any form, although, with the original putty, saturnine paralysis was frequent.—On some new colloidal substances, analogous to albuminoids, derived from a nucleo-albumin, by M. J. W. Pickering.—On the development of *Trombidion holosericeum*, by M. S. Jourdain.—Observations on the *Rougets*, by M. P. Mégnin.—Researches on red granules, by MM. J. Kunstler and P. Busquet.—The formations included under the name of red granules appear to be due to a diffraction phenomenon, and have no morphological value.—On a ferment of cellulose, by M. V. Oméliansky.—On the decomposition of chloroform in the organism, by MM. A. Desgrez and M. Nicloux. Experiments are described tending to show that during anæsthesia by chloroform some carbon monoxide is produced by the action of the latter upon blood.—On some comparative results of ordinary clinical methods and fluoroscopic examination in pleuretic effusions, by MM. Bergonié and Carrière. The examination by means of the Röntgen rays is valuable in many ways as a supplement to the ordinary clinical methods.—Antagonism between the venom of the *Vespidæ* and that of the viper; the first vaccinates against the second, by M. C. Phisalix.—Permeability of the trunks of trees to atmospheric air, by M. Henri Devaux.—On the disease of chestnuts, by M. E. Roze.—Characteristics of a gas coal found in the northern coal field of New South Wales, by M. C. Eg. Bertrand.—On the fauna of the siderolithic Eocene beds of Lissieu (Rhône), by MM. Ernest Chantre and C. Gaillard.—Mechanical determination of the mean direction of the wind, by M. Louis Besson.

DIARY OF SOCIETIES.

THURSDAY, DECEMBER 16.

ROYAL SOCIETY, at 4.30.—On a Method of Determining the Reactions at the Points of Support of Continuous Beams: G. Wilson.—The Comparative Chemistry of the Suprarenal Capsules: B. Moore and Swale Vincent.—Memoir on the Integration of Partial Differential Equations of the Second Order in Three Independent Variables: Prof. Forsyth, F.R.S.—On the Biology of *Stereum hirsutum*, Fr.: Prof. H. Marshall Ward, F.R.S.—An Examination into the Registered Speeds of American Trotting Horses, with Remarks on their Value as Hereditary Data: F. Galton, F.R.S.—On the Thermal Conductivities of Pure and Mixed Solids and Liquids, and their Variation with Temperature: Dr. C. H. Lees.—Cloudiness: Note on a Novel Case of Frequency: Prof. Pearson, F.R.S.—On the Occlusion of Hydrogen and Oxygen by Palladium: Dr. Mond, F.R.S., Prof. Ramsay, F.R.S., and Dr. J. Shields.—The Relations between Marine, Animal, and Vegetable Life: H. M. Vernon.

LINNEAN SOCIETY, at 8.—On the Affinities of the Madreporarian Genus Alveopora: H. M Bernard.—On West Indian Characeæ collected by T. B. Blow: H and J. Groves.

CHEMICAL SOCIETY, at 8.—Stereo-Chemistry of Unsaturated Compounds. Part I. Esterification of Substituted Acrylic Acids: Dr. J. J. Sudborough and Lorenzo Lloyd.—Formation and Hydrolysis of Esters: Dr. J. J. Sudborough and M. E. Feilmann.—A New Method of Determining Freezing Points of very Dilute Solutions: Dr. M. Wilderman.

FRIDAY, DECEMBER 17.

INSTITUTION OF ELECTRICAL ENGINEERS (Chemical Society's Rooms), at 8.—Accumulator Traction on Rails and Ordinary Roads: L. Epstein.

INSTITUTION OF CIVIL ENGINEERS, at 8.—The Elastic Properties of Steel Wire: Archer D. Keigwin.—The Elasticity of Portland Cement: W. L. Brown.

EPIDEMIOLOGICAL SOCIETY, at 8.30.—The Physical and Ethnological Conditions under which Leprosy occurs in China, the East Indian Archipelago, and Oceania: Dr. James Cantlie.

SUNDAY, DECEMBER 19.

SUNDAY LECTURE SOCIETY, at 4.—Some Animal Co-operative Societies: Dr. Andrew Wilson.

MONDAY, DECEMBER 20.

ROYAL GEOGRAPHICAL SOCIETY, at 8.30.

IMPERIAL INSTITUTE, at 8.30.—Petroleum Sources of the British Empire: Boverton Redwood.

TUESDAY, DECEMBER 21.

INSTITUTION OF CIVIL ENGINEERS, at 8.—A New Transmission Dynamometer: Prof. W. E. Dalby.

ROYAL PHOTOGRAPHIC SOCIETY, at 8.—Photomechanical Printing in Connection with the Survey of India: Colonel Waterhouse.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

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