THURSDAY, APRIL 9, 1903.

THE CORRESPONDENCE OF CHARLES DARWIN.

More Letters of Charles Darwin. A Record of his Work in a Series of hitherto Unpublished Letters. Edited by Francis Darwin, Fellow of Christ's College, and A. L. Seward, Fellow of Emmanuel College, Cambridge. In two volumes, illustrated. Vol. i., pp. xxiv+494; vol. ii., pp. viii+508. (London: J. Murray, 1903.) Price 32*s.* net.

WE close most biographies with the exclamation "too long and far too many letters," but the three volumes of the "Life and Letters of Charles Darwin," published in 1887, left their readers, like young Oliver Twist, "asking for more." At that time considerations of space and other reasons prevented the editors from publishing numerous letters in their possession, and since then many of great interest have been received. From this unused material they have compiled, with only a few slight repetitions, "an almost complete record of Darwin's work," which will be welcomed, we are sure, not only by students of science, but also by all interested in the history of the Earth and Man. It is now nearly forty-four years since the "Origin of Species" was first published. The book was received with objurgation by the many, with praise by the few, yet in about half that time it had forced its way to a front place among the classics of scientific literature, and though opinions still differ about the prime factor in producing a species, a place is assured to Charles Darwin among naturalists similar to that of Isaac Newton among physical mathematicians. The former, indeed, has effected, outside his own field, an even more rapid and extensive transformation of thought. The idea of evolution has acted like a solvent in subjects to which it might have been supposed alien, for it has even won recognition from theology, by the partisans of which it was at first so vociferously and ignorantly assailed. It has, in short, succeeded in revealing the "How" of the natural order, though making no pretence of fathoming the mystery of the "Why."

The "Life and Letters" contained an autobiographical sketch written in Darwin's later years for the information of his children. When the family removed from the old home at Down, they discovered a fragment of another—dated so long ago as 1838—which is included in the present work. This has a special value as containing fuller and clearer reminiscences of his childhood—information which is always welcome to the students of human nature, for the child in so many respects is the father of the man. From his earliest days Darwin was a collector of curiosities—seeking for minerals and stones before he was nine years old—and was always anxious to understand their structures and significance. He was not, however, quite a pattern good boy, for he confesses to flying into passions and often telling fibs. These, however, were not to get him out of scrapes, but simply results of indulging a too vivid imagination, with the desire to astonish the hearers. The tenor of his letters and the devotion of his family circle prove beyond question how effectively he overcame the former fault, and his writings would almost lead us to think the latter incredible, for they show conscientious accuracy to have been one of his most marked characteristics. But it proved him to possess the imaginative faculty, without which perhaps no great generalisation has ever been made. Pegasus, indeed, must be ridden with a curb, but that steed alone can carry its rider across the bounds of space and time.

The present volumes pass briefly over school days at Shrewsbury, the short residence at Edinburgh, and the undergraduate life at Cambridge, where a friendship with Prof. Henslow proved the turning point of his career. Some half-dozen letters, written during his voyage on the *Beagle*—every one well worth preservation—are now printed for the first time, and two or three relating to his marriage and settling at Down. One, addressed to his *fiancée*, shows what the wives of scientific men have often to endure, for he confesses that Charles Lyell and he had been talking "unsophisticated geology" for half an hour, with "poor Mrs. Lyell sitting by a monument of patience," adding that he wants practice in ill-treating the female sex, for he did not observe Lyell had any compunction; "I hope to harden my conscience in time; few husbands seem to find it difficult to do this." But what he owed to this marriage we learn by an extract from his autobiography, which, now that Mrs. Darwin has passed away, is very rightly printed in the present work, for it shows what true and deep feeling lay beneath that calm exterior.

The period between his settling at Down and writing the "Origin of Species" is covered by fifty-eight letters, addressed chiefly to Huxley and Hooker, his most intimate friends. They form a very interesting addition to those already published in the second volume of the "Life and Letters," and throw further light upon the incubation of the idea which was to bring order out of a scientific chaos. Its publication was accelerated, as is well known, by the receipt of a manuscript from Dr. A. R. Wallace, proving that the conception which Darwin had been laboriously working out for some years had dawned upon the former during his researches in the Malay Archipelago. No circumstances could have offered a more favourable opportunity for a wrangle about priority; they proved the nobility of both men's natures by cementing their friendship, and a correspondence discussing topics arising from the "Origin of Species" is not the least interesting part of the present work. With the appearance of the "Origin," the letters become more varied and the writers more numerous; points had to be defended or developed, and new facts sought in corroboration. To all thoughtful objectors Darwin replied with courtesy and candour; of ignorant vituperation he took no note, except sometimes to lament, if it were the ill-considered utterance of a fellow-student in science. Knowing that he had built upon the solid rock of fact, he went about his work with unruffled calmness, little heeding the storm which might rage outside.

The publication of the "Origin" seemed to act as a stimulant to greater literary activity, for it was

followed in due course by the "Fertilisation of Orchids," the "Movements of Climbing Plants," "Variation under Domestication," the "Descent of Man," "Insectivorous Plants," the "Expression of the Emotions," "Cross and Self Fertilisation in the Vegetable Kingdom," the "Different Forms of Flowers," the "Power of Movement in Plants," and the "Formation of Vegetable Mould through the Action of Worms," besides new editions of some of them and of the "Origin," with sundry miscellaneous papers. This period is dealt with in the second volume of the present work, and the editors have grouped the letters (which in some cases go back to much earlier dates) under three principal heads: Man, Geology and Botany, with a short concluding chapter containing some on the Vivisection Controversy and miscellaneous subjects. In that controversy—needless to say—Darwin showed no favour to the noisy fanatics who set more store by a dog than by a man, though, as he writes to Lord Playfair, he strongly objected to "useless vivisection," namely, that undertaken for lecture-room experiments and without employing anæsthetics. That opinion had been also expressed fully in the "Life and Letters," but in view of "anti-vivisection tactics" the editors have been prudent in not omitting some reference to it in the present work.

The letters on geological subjects are very interesting, for with this science, though diverted from it in later life by pressure of other work, he never lost touch. As the volume of "Geological Observations" is still constantly in the student's hands, we need not enlarge upon its value, but the present work preserves for us numerous letters to Lyell and others on earth-movements, ice action, and the connection of cleavage with foliation, subjects in which Darwin's views may still be read with profit. In the first group he maintains that, as a rule, movements of elevation and depression generally affect large areas of the earth's crust, an opinion which has of late been gaining ground. Those on ice form a commentary on the views of its action, which were in process of change during his lifetime. Some of them relate to the noted Parallel Roads of Glenroy, on which he once wrote. He had then regarded them as old sea beaches, but abandoned this opinion in favour of the lake-side and ice-dam hypothesis. It would have been interesting to have seen how he would have dealt with the serious difficulty of the absence of glaciers from Glenroy, though an enormous dam is called into existence in neighbouring valleys. Perhaps this would have made him doubtful whether second thoughts are always best. As to cleavage and foliation, Darwin maintains that they have, as a rule, the same origin, instead of the latter being a result of stratification. That view is now accepted in a large number of cases, and his remarks on the connection of foliation with fluxion in igneous rocks show how acutely he observed and reasoned.

We are tempted to linger over these and the important group of letters on botanical subjects, but must hasten to a conclusion. It only remains to thank the editors for the way in which they have executed their task, and for these interesting volumes. They are most valuable, not only as a contribution to the history of science, but also as placing in clearer light the man himself. They were written *currente calamo*, as he rested in his armchair during the earlier afternoon, by way of relaxation from his more serious labours, so such slips of the pen as are indicative of fatigue or weakened health were not uncommon, yet they are often admirably expressed, and always attractive in their simplicity. Full of suggestive remarks, many of which will not readily become obsolete, they bring into clear relief Darwin's marvellous steadfastness of purpose, unflagging industry and patient endurance of the burden of chronic ill-health. This alone would have rendered many a man fretful or despondent; the letters, no less than the testimony of his family, prove that Charles Darwin had learnt the hardest of all lessons, "to suffer without complaining." We find in them repeated evidence of his freedom from acrimony or resentment, of his sympathy with other workers, and of that grand combination of a genuine humility with an almost unconscious intellectual strength, which impressed itself so deeply on all younger men. The life and the letters of Darwin have an ethical as well as a scientific value, for he was one of those who wore "the white flower of a blameless life," and could have faced without shrinking "that fierce light which beats upon a throne."

T. G. BONNEY.

CAN THESE BONES LIVE?

Grundrisz der Mineralogie und Geologie, zum Gebrauch beim Unterricht an höheren Lehranstalten sowie zum Selbstunterricht. By Prof. Dr. Bernhard Schwalbe. Edited by Prof. Dr. H. Böttger. Pp. xviii + viii + 766. (Braunschweig: Vieweg und Sohn, 1903.) Price 13.50 marks.

IT was in the forest-country south of Greifswald, where the wind sweeps down the highway from the grey-green Baltic, and crashes the pine-stems one against another, and blots out the shafts of a cold sunlight in sudden sheets of rain—it was here that we took shelter in a little wayside inn, and meditated on the vast uniformity of the Pomeranian plain. And here our host was a quiet old gentleman, a Vorsteher of something that demanded the imperial regard, the headman of a hamlet of five houses, and of finer education than the average burgess of an English country town.

He found out where we came from, and read to us from the English Bible, commenting on its archaic style. He then turned to Shakespeare, and finally left us with a copy of Carlyle's "Frederick the Great." When asked where he acquired this learning, he replied, "In the gymnasium at Greifswald."

And the work the full title of which stands above is also a product of gymnasia. In the hands of an inspired teacher, pupils might even become fond of it; but we are lost in admiration, tempered with sorrow, for those who would enter on it with a view to "Selbstunterricht." Our host in the Pomeranian flatland was probably capable of such greatness. House after house, moreover, throughout Germany boasts a "Con-

versationslexicon," in many volumes, as the principal ornament of its parlour, and here Schoedler's "Book of Nature" might also find a home. Dr. Schwalbe's volume, now before us, forms a part of the twenty-third edition of Schoedler's stately work, a "circle of the sciences" that still continues to revolve. The first part of the "Buch der Natur" has, it appears, already dealt with the life of plants and animals, and the palæontological history given by Dr. Schwalbe (pp. 193-230) is consequently only a slight sketch. The tremendous changes that have taken place from epoch to epoch in the predominant life-forms on the globe appeal to most minds that seek self-instruction in geology; to such the present treatise must appear phenomenally dry. Dr. Ernst Schwalbe, however, a son of the author, interpolates thirteen pages styled "Einige Worte vom Darwinismus," which lead to most just conclusions, but which are far more zoological than geological. The author's decease during the progress of the book has thrown much labour on the editor, Dr. Böttger, who has been asked to piece together detached portions of manuscript, and to supply important passages himself. He has certainly kept the work very fairly up to date, as in the description of the human remains in the Krapina valley, in Croatia (p. 592), and the expanded section on crystallographic symmetry (pp. 603-646); but such additions are often far removed from the matter on which they bear in the main text. The book opens, in fact, with a severe and very chilling account of crystal-forms, in which Naumann's symbols are prevalent, and in which the positions adopted for some of the drawings leave much to be desired. The optical characters, which are so much relied on nowadays, are dismissed in two pages, and the distinction between uniaxial and biaxial crystals is given with time-honoured incompleteness. The blowpipe-examination of minerals, so fascinating to schoolboys and to those working by themselves, is not dealt with from a practical point of view; and the description of minerals would give the beginner little conception of the connection of these bodies with the earth on which we live. The beauty of the objects is occasionally dwelt on; but their common mode of occurrence, and their geological relations, are left to a general chapter on mineral deposits, which follows the detailed catalogue of species. The account given of the felspars and other rock-forming minerals has very little value for the geologist, and bears signs of considerable antiquity.

The petrography is similarly in need of vitalising touches. The group of "lavas," as distinct from basalts and trachytes, is retained; and the inner meaning of rock-structures is not discussed. After a palæontological and stratigraphical episode, we return to petrography, on p. 216, with the almost extinct division of igneous rocks according to geological age. Then we swing back to palæontology, and to a table "nach Gümbel," which naturally takes no account of the recently disclosed richness of the Cambrian fauna of America. And so on, classically enough, until we ask why, with so many good German text-books in existence, gymnasia are to be treated to these special products of desiccation. May not the pupil exclaim, "And it was full of bones; and he caused me to pass by them round about; and lo, they were very dry"?

The sections on denudation and aggregation are, however, much more cheering, and the photographic illustrations are mostly new and excellent. From them the student may gain a real feeling for the varied aspects of the earth. The three plates showing the changes in the Karlseisfeld, in the Austrian Alps, at intervals of about ten years, are beautiful and impressive. But we are soon after (p. 603) drawn on into a series of "gemischte Waaren" in the form of separate articles, confirming or expanding what has gone before. Thus, "Crystallographic systems," 45 pages; "Nomenclature," 35 pages, in which the derivation of mineral names is given, with original Greek words and their transliterations into Latin letters; "On Caves," 22 pages; "Orogeny," 35 pages, with many modern features and admirable illustrations. Dr. Böttger has clearly had a difficult task in pouring new wine into old bottles. We gather (p. 744) that geology has no distinct place in the curriculum of the Prussian high schools, although mineralogy and petrography are admitted; and the late Dr. Schwalbe worked hard to introduce geological illustrations into the experimental work of other subjects. In the twenty-fourth edition of the "Buch der Natur," Dr. Böttger may have the opportunity of recasting this volume, and of abolishing the system of appendices; but for school work something more practical is required. It is to be feared that the Prussian scheme of education does not favour individual experiment; but the pupil cannot understand geology unless he has scratched his minerals with a knife, and gathered his fossils on the bare hillside. The Pomeranian plain is not ideal for such a purpose; but, even there, every field contains its treasures, and the glorious ice-borne blocks from Scandinavia give colour to each village street. The history of one of these, from pre-Cambrian to gymnasial days, is worth a thousand pages of conscientious compilation.

GRENVILLE A. J. COLE.

CURIOSA MATHEMATICA.

Opinions et Curiosités touchant la Mathématique. Deuxième Série. By Georges Maupin. Pp. 332. (Paris: C. Naud, 1902.) Price 5 francs.

THIS is a very entertaining miscellany in which every reader will find something to his taste. Thus we have extracts from the works of sixteenth century mathematicians, still influenced by the methods of scholasticism; part of the debate in the Chamber of Deputies (August, 1835) on the French jury system, when Arago appealed without effect to the mathematical theory of probabilities; two specimens of circle-squaring (1852, 1855); and so on. Two or three extracts will serve to show how amusing some of these chapters are.

John Wilkins, after criticising adversely the cabalistic methods of the Jews, argues in true scholastic

fashion against the existence of more than six principal planets :—

"Or si quelqu'un demande, pourquoy il n'y a que six orbes des Planettes, Keppler respond :—Parce qu'il ne faut pas qu'il y ait plus de cinq proportions, tout autant qu'il y a de corps réguliers és Mathematiques, dont les costez et les angles sont esgaux les vns aux autres.—Or six termes accomplissent le nombre de ces proportions; et par conséquent il n'y peut auoir que six principales Planettes."

Could anything be more convincing? Perhaps, after all, Uranus and Neptune are mere *simulacra*, will-o'-the-wisps contrived by Satan to deceive a reprobate race of astronomers no longer faithful to the great principles of analogy.

We have the authority of the Reverend François Chevillard (1667) for believing that mathematicians are (or should be) born under the sign of the Twins. He says :—

"*Les Iumeaux*.—Ce signe rend son homme beau, misericordieux, sage, ingenu, libre, vn peu menteur, coureur et voyageur, mediocre en commoditez, assez fidelle pour estre Intendant des Finances, propre aux Mathematiques, aux Loix, et à l'Arithmetique, sçachant dissimuler sa cholere, mais il sera pour courir danger vers l'âge de trente-deux ans ou du feu, ou du fer, ou de la morsure de quelque chien. . . ."

Here is something more properly mathematical. John Abraham (1607) gives the product $6757 \times 346 = 2337922$, and after explaining the test by "casting out the nines," proceeds as follows :—

"Et d'autant que la preuue de 9 n'est si certaine que le contraire ou la preuue de 7 (*sic*). Nous auons fait la preuue par 7. Et pour ce faire faut chasser les 7 dizaines de la somme à multiplier, sçauoir de 67 restent 4 de 45 restent 3 et de 37 restent 2 qu'il faut poser à l'un des bras de la croix" (that is, the cross used in the old-fashioned way of casting out the nines : but Abraham's cross is like a big +), "puis en la forme susdite faut aussi chasser les 7 du multiplieur, sçauoir de 34 restent 6 et de 66 restent 3 qu'il faut poser à l'autre bras de la croix, et multiplier les deux figures l'vne par l'autre, sçauoir 2 fois 3 sont 6 qu'il faut poser sur le haut de la croix et pour la fin de la preuue faut chasser les 7 des 2337922 de 23 restent 2 de 23 restent encores 2 de 27 restent 6 de 69 restent 6 de 62 restent 6 et encores des 62 restent encores 6 qu'il faut poser au bras de la croix."

It will be observed that this amounts to finding the least positive residues of the factors with respect to the modulus 7, and comparing their product with the residue of the product of the given numbers. The residues are found by actual division, not by any special rule; curiously enough, it does not appear how the author found the 9-residues for the other test. No proofs are given to justify the process in either case.

The second part of Mr. Maupin's book (p. 160 to end) deals mainly with the notes of Albert Girard to the mathematical works of Stevinus. Both these men were very competent mathematicians, and a study of their work is very instructive. In their day, the science of mathematics was but little advanced beyond the stage at which it had been left by Pappus, Diophantus, and Ptolemy; the notation of analysis was still very imperfect; the methods of analytical geometry and infinitesimal calculus, as we now know them, had not been invented; the prevailing style of demonstration, as it appears to a modern reader, was both involved and diffuse. But the times were ripening for the great discoveries of Newton, Descartes, and Leibniz; and if, as compared with the achievements of their immediate successors, the work of men like Stevinus seems poor and insignificant, we must remember that the work of these humble pioneers was probably more important than appears at first sight. No one who has studied the history of mathematics can have failed to see how advance in the subject has accompanied improvement in notation. Now the essential features of modern notation are due to the mathematicians of the earlier part of the seventeenth century; and their service in devising it is really considerable. Besides this, they were the teachers of the younger mathematicians of their time; and we may not unfairly credit them with having done nothing to spoil and something to stimulate the minds of men with greater genius than their own.

The ingenuity of some of these old worthies, especially in diophantine analysis, is really remarkable, and it is not always easy to see precisely their method of procedure; for, after the manner of their time, they publish results without demonstrations. Some very curious results obtained by Girard (pp. 203-9 of Mr. Maupin's book) seem to show that he was acquainted with the reduction of a quadratic surd to a periodic continued fraction; thus he obtains $1039681/328776$ as an approximate value for $\sqrt{10}$, and this rational fraction is, in fact, the eighth convergent to the infinite continued fraction which represents $\sqrt{10}$. G. B. M.

ASTRONOMY FOR EXPLORERS.

Grundzüge der astronomisch-geographischen Ortsbestimmung auf Forschungsreisen. By Prof. Dr. Paul Güssfeldt. Pp. xix+368. (Braunschweig : Vieweg und Sohn, 1903.)

AS the field of the geographical explorer daily narrows, so do the number and excellence of books dealing with geographical exploration continually increase. The book under review treats of the determination of time, latitude and azimuth with a transit theodolite, and the methods described are the simplest in use by the explorer; it will serve, however, as an introduction to field astronomical methods generally.

The author leaves nothing unexplained, and commences with elementary definitions of number and quantity. A quarter of the book deals entirely with elementary arithmetic, algebra, trigonometry and analytical geometry. This is, perhaps, an excess of thoroughness; for the explorer in most cases wants to get to business as soon as possible, and if he has not previously obtained a knowledge of the elements of these matters, he is more than likely to be content to use accepted formulæ without investigation, so that it is not quite clear for what class of reader the book is written.

It appears from the publishers' preface that Dr. Güssfeldt has had considerable experience of field

astronomical methods, having spent some ten years exploring in tropical Africa, Egyptian deserts and in the Andes of Chile and Argentina. The methods described are sound and practical, and taking the book as a whole, it will undoubtedly serve well as a course of astronomical study for those explorers who can afford time to read it.

But the day of the explorer is nearly over, and it is very desirable to substitute topographical for exploratory methods wherever possible. This is actually being done at the present moment on the Gold Coast, where Major Watherston is making a topographical survey by means of long rigorous traverses controlled by azimuths. In difficult countries where rapid triangulation is impossible, this system should always be adopted. As regards the perennial difficulty of the initial longitude, it is not always realised that we have now a series of well determined longitudes throughout the whole length of Africa, that there has been a great increase in the number of telegraph lines in that continent, and that wireless telegraphy promises to be of vast assistance in the determination of longitude differences of quasi-geodetic accuracy.

As this book is no doubt primarily intended for German students, it is worth while noting that the German colonial empire throughout the world has an area of about one million square miles, and that the largest single block of German territory is German East Africa, with an area of less than 400,000 square miles. It is in the long run cheaper to survey such a country by topographical rather than by rough astronomical methods, and the results are far more trustworthy, topographical work including the determination at wide intervals of zenith telescope latitudes and telegraphic differences of longitude. It is believed that the German authorities are fully alive to the importance of these considerations, as may be inferred from the excellent work of Captain Hermann and Dr. Kohlschütter in East Africa, and from the recent boundary surveys in Togoland.

The importance of purely astronomical exploration diminishes yearly, and though it will be some time before the astronomical explorer becomes extinct, the scope of his usefulness grows continually less; his last home will perhaps be in Central Asia, in Brazil, or at the Poles. Meanwhile, he will find Dr. Güssfeldt's an excellent text-book in which to study elementary field astronomical methods, but he should only employ these when topographical methods are impossible.

C. F. CLOSE.

OUR BOOK SHELF.

The Tutorial Physics. Vol. ii. *Higher Text-book of Heat.* By R. Wallace Stewart, D.Sc. Pp. viii + 396. (London: W. B. Clive, 1903.) Price 6*s.* 6*d.*

THIS is a new and considerably enlarged edition of a book which we have previously noticed (December 21, 1893). We then declared our belief in the writer as one capable of stating with all clearness and necessary accuracy the various laws, and of showing their practical application by means of appropriate examples. In its present form, he appeals to a more advanced class of student than hitherto; and the question arises whether the accuracy which was sufficient in an elementary statement is adequate in a more advanced exposition. With regard to the main part of the volume, we answer in the affirmative. The author has evidently been at great pains to secure lucidity and simplicity without a sacrifice of precision; and we cordially recommend the book to those who are willing to use it rightly. By this last phrase we mean to imply that it should be read to the accompaniment of prolonged work in the laboratory under the personal guidance of an efficient teacher. Granted this accompaniment, we think the book will be very helpful to those who are not taking physics as a principal subject of study, and who therefore do not wish to be confused by the bewildering detail and complication which larger treatises supply.

In a few places the above commendation must be qualified. On p. 244, Dulong and Petit are stated to have "found that for a given excess of temperature the rate of cooling depended not only on the temperature of the body, but also on that of the enclosure." That stumbling-block of expounders, the Joule-Thomson experiment, trips up the author repeatedly; though we readily admit that he goes straight on the whole. For example, on p. 272 it is declared to involve no performance of external work; on p. 281 the amount of external work done is expressed in the equation; on p. 382 the work is once more declared to be altogether *internal*. The first word on p. 283 should be *increase*, not *decrease*.

Vergleichende Anatomie der Wirbelthiere. Fünfte, vielfach umgearbeitete und stark vermehrte Auflage des "Grundriss" der Vergl.-Anatomie der Wirbelthiere. Von Dr. Robert Wiedersheim. Pp. xix + 686. (Jena: Gustav Fischer, 1902.) Price 16 marks.

ALTHOUGH in the title of the present work the word "Grundriss" is subordinated, the book is the fifth edition of that originally so named. Its second edition of 1888 replaced the author's Lehrbuch (1882 and 1886), and its third, of 1893, which formed the basis of the second edition of an English translation, was practically a new book. In this, certain modifications were first introduced which have characterised all subsequent editions, including the present one, in which the method of treatment remains unchanged.

The most marked advance in the book under review is the addition to eight of the nine sections of a series of short *résumés*, which materially enhance the value of the work, in the past a book of reference only.

In his preface the author enumerates fifteen subjects which have been especially modified and extended, chief among them the morphology of the head-skeleton, as lately determined by Gaupp. There are many minor curtailments and rearrangements in various parts of the book, and the recognition of the work of Milani and Häcker on the reptilian lung and avian larynx, of Paulli on the nasal labyrinth, of Budgett on the external gills of Gymnotus, of Oppel on the alimentary viscera, of Strong on the metamorphosis of the cranial nerves, and Bles on the nori abdominales, is sufficient to show that anatomists of all nationalities have been duly recognised, and that the book is up to date.

There are in all 711 text-figures, grouped to form 379 sets, and there is still the single coloured plate, designed to render clear the changes undergone by the cranial nerves in the passage from the aquatic to the terrestrial state. The bibliography, so largely the secret of the popularity of past editions, now reaches the appalling limit of 120 pp. In using this record

rightly, the student will soon realise that the bare titles but point the way to endless records of facts and considerations of importance not mentioned in the text, which it is the duty of the writer of a standard text-book to indicate. There are omissions in the list, but as matters go in comparative anatomy, the wonder is that it is so complete.

The book fully maintains the reputation of its predecessors, and we wish it success.

Nature and the Camera. By A. Radclyffe Dugmore. The Dainty Nature Series. Pp. xiii + 126. (London: Wm. Heinemann, 1903.)

THE author of this delightful book gives us an ideal essay on "Nature Study," for he carries the reader away into country lanes and woods, far from the regions of smoke and habitations, and shows us samples of bird, animal, insect, reptile, and plant and tree life, which is now so admirably portrayed by the photographic lens. Undoubtedly the best study of Nature is Nature, and it may be added that the best way of recording it is by the utilisation of the photographic lens and sensitive plate, which are capable of giving us accurate and faithful pictures of occurrences which otherwise would be out of the reach of many of us.

In these pages, the author, who has made a speciality of this subject for many years, gives us an account of how to accomplish successfully the art of photographing things living under their natural conditions. Technicalities are reduced to a minimum, and the story is clear, straightforward, and to the point. Naturally, many difficulties are met with in attempting to photograph these various subjects, and the author describes each in turn, and shows how he has been able to overcome them. From a collection of nearly three thousand negatives taken by the author himself, he has been able to utilise some excellent examples for all the objects to which reference in these pages has been made, and these, 53 in number, have been here beautifully reproduced. Besides being a useful book for those who wish to photograph along these lines, it should be read with interest by those who enjoy hearing about the habits and peculiarities of the birds and other small creatures mentioned.

The Twentieth Century Atlas of Popular Astronomy. By Thomas Heath, B.A. Pp. 121; with frontispiece and 21 plates. (Edinburgh: W. and A. K. Johnston, 1903.) Price 7*s.* 6*d.*

IN addition to the atlas this volume contains a very useful account of the elements of astronomical science, mathematical and spectroscopic, as it appears at the beginning of the twentieth century.

As the title indicates, the account is primarily intended for amateurs, and it will be found sufficient to give the beginner a fair working idea of the astronomy of the present day.

The fourteen chapters deal with time, celestial distances and apparent movements, solar physics, the moon and planets, eclipses, comets, meteors, &c., and the text is plentifully illustrated with diagrams, star charts and photographic reproductions of various objects.

Plates i.-xiv., inclusive, illustrate the appearances and apparent movements of the various members of the solar system, eclipses, comets, star clusters, nebulæ, spectra, the appearance of the corona at different eclipses, &c.; xv.-xx., inclusive, are star maps containing stars down to the fifth magnitude, nebulæ, &c., and xxi. shows the apparent yearly paths of various planets. All the plates are printed in white, or colours, on a blue ground.

The whole volume has been carefully compiled and well printed, and, with one or two exceptions of minor importance, appears to be free from typographical errors. W. E. R.

Official Report of the Nature Study Exhibition and Conferences, August, 1902. Pp. 303. (London: Blackie and Son, Ltd., 1903.) Price 2*s.* 6*d.* net.

THE Nature-study Exhibition held last year served the purpose of bringing together the work due to the efforts of independent individuals or institutions, and thereby enabled teachers to get a correct estimate of their results and obtain suggestions for future developments. The official report directs attention to the more successful results both in the list of awards and also in a too brief reference to work of special excellence. The report of the executive committee embodies extracts from the information supplied by principals with regard to their aims and ideals, from which useful hints may be gathered. It would have been convenient if this information had been arranged under subjects of study, or according to the phase of the subject. The addresses presented at the conferences occupy the greater part of the book. The paper offered by Prof. Lloyd Morgan is eminently practical and broad in scope. Prof. J. A. Thomson confined himself to advocating the seasonal method of nature-study, which offers a definite scheme of work. Herein lies an important point, which has not been sufficiently emphasised, that observation of objects taken at random does not train the mind, and that with correct observation should be combined a systematic course of study.

Friedrich Schleiermacher's Monologen—Kritische Ausgabe—Mit Einleitung, Bibliographie und Index. By Friedrich Michael Schiele. Pp. xlvi + 130. (Leipzig: Dürr'sche Buchhandlung, 1902.) Price 1.40 marks.

Si sic omnia dixisset, the name of Schleiermacher would not have been so important as it is, for the thought of the "Monologen" is generally too impalpable and elusive, and the reader is often little helped or stimulated as the changes are rung on Freedom and Necessity, Time and Eternity, Outer and Inner. Besides, the style is often unnatural: poetic prose and too consciously so. Still, the book throws an interesting sidelight on Schleiermacher and his age—when "to be young was very heaven," for the last monologue is a hymn to youth. This edition is most purposeful; its basis is the 1800 text with the original spelling, the variations of the 1810 and 1822 editions being given at the foot of each page. The introduction is sensible, and the bibliography ranges over the whole field of Schleiermacher's ethical philosophy. In the elaborate index the winnowed grain of the "Monologen" is neatly stored. R. G. N.

The Mycology of the Mouth. By Kenneth W. Goadby, D.P.H., L.R.C.P., M.R.C.S., L.D.S. Pp. xv + 241. (London: Longmans, Green and Co., 1903.) Price 8*s.* 6*d.* net.

A TEXT-BOOK of mycology suited to the needs of the dental profession has long been a desideratum, and Mr. Goadby has succeeded in the task of writing one. The first half of the book is devoted to general principles and methods, the remainder to the special bacteriology and mycology of the mouth and its diseases, such subjects as dental caries and pyorrhœa alveolaris being treated at length. We have noted but few mistakes, e.g. Wedl for Widal (p. 41), Buchner's *tube* for Buchner method. In hanging drop preparations, the usual and convenient hollow ground slides are not mentioned, the antitoxin unit is not quite accurately defined, and the dose of diphtheria antitoxin recommended is too small. The book is well and profusely illustrated. R. T. H.

LETTERS TO THE EDITOR.

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

The Quadrantids, 1903—A Coincidence.

A FRIEND of an astronomical turn of mind called a few evenings ago and related to me the following :—

"At 5 p.m. on the first Saturday in January, *i.e.* January 3, I was on a hill outside Bangor, Co. Down, looking westwards, when a large bright meteor, magnitude = Jupiter, appeared above the south-western horizon, and rose slowly and perpendicularly until it attained an altitude of about 30 degrees: duration, two or three seconds: no sound or explosion, but a fine sight in the strong moon or twilight."

Observers will notice the agreement of the date of this meteor with that of the Quadrantids, and one is tempted to ask if it could be a member of that system, drawn out of its course, or was it an ordinary slow, direct-motion, fireball from the west? My informant says, judging from the position of Jupiter and the moon at the time, that its path lay in the ecliptic.

I may remark in connection with this subject that on or about the date of maximum of some of the larger showers, I have frequently noticed, and sometimes had reported to me, the observances of slow, irregular meteors which, although obviously connected in some way with the shower under observation, were yet quite unconformable as to the radiant; and I came to the conclusion that they were meteors which had been trapped or captured at former returns, and were then members of those sun-earth systems referred to by M. Schulhof in his papers "Sur les Étoiles Filantes" (*Bull. Astron.*, March–September, 1894, pp. 64, 65).

The question may not have hitherto received the attention it deserves, but I leave it to those more competent to judge. The outside planets control their cometary systems and swarms. Why not the earth on a smaller scale?

My own observations of the shower this year were not at all satisfactory, and were briefly as follows :—

January 2.—12–1 a.m., Quadrantids nil.
January 3.—Overcast.
January 4.—2.30–3 a.m., Quadrantids 15.

The display was evidently closing when I took up my watch. I, however, placed the hourly rate as high as sixty for the short time it lasted. Several of the meteors were fine, bright, steel-like flashes, straight from the radiant through the zenith, in marked contrast to others, which were of a much slower and sporadic-like character.

W. H. MILLIGAN.

26 Cooke Street, Belfast, March 23.

THE phenomenon referred to in his letter, by Mr. Milligan, that the principal star-showers of the year are in general accompanied simultaneously, or nearly so, by a somewhat more than ordinary abundance of shooting-stars from centres not very far distant from that of the principal display, has long been observed, and has indeed received an elaborate amount of attentive study, as a pretty clearly distinguishable character of several of those showers; but it can hardly be said that observations of those dispersed contemporaneous meteor-flights have yet been made with such satisfactory exactness as either to assign them all to real centres, or to say with certainty how many of them are stragglers from the main and from the neighbouring shower-sources. In the present imperfection of our knowledge of the phenomenon's real features, no recourse, it may be feared, can yet be had with any prospect of successful issues to hypothetically ventured explanations of these, either closely grouped together, or else, by perturbative attractions, erratically scattered and deflected contemporaneous meteor-systems.

The Quadrantid shower appears to have reached its maximum this year in the evening and night of January 3; for in watches of about two hours towards midnight on that date, rather rapid hourly rates of appearance of the Quadrantids were noted both by Mr. T. H. Astbury, at Wallingford, and by Mr. A. King, at Leicester, some of the meteors recorded being very bright ones;[1] and this date of its greatest brightness was thus confirmed by the considerable intensity of the shower observed at a later hour on the same night by Mr. Milligan in Belfast. Much clouded sky, and rain prevailed on that night at Slough, but in a clear interval of about 1 hour, between 12h. 35m. and 13h. 50m., nine meteors were mapped, of which four or five diverged from Quadrans. During a watch of nearly 5 hours on the preceding night of January 2–3, from 12h. 10m. to 17h. 5m., with continually clear sky,[2] thirty-four meteors were mapped and three or four more were seen, appearing at a steady rate of seven or eight per hour. Of the mapped meteors five were Quadrantids, three of them equal to or brighter than first magnitude stars; all seen in the last 1½ hours, and none in the first 3½ hours of the watch, denoting apparently a distinct beginning of the shower at about 3h. 30m. a.m. on the morning of January 3.

The radiant-point of four Quadrantid tracks was well marked at 235°+54°; but with five more on January 3, all from about 225°+49°, the mean of the nine paths was at 229°+52°. At 16h. 38m. on January 2, a Sirius-like brief white flash was quite stationary for half a second, at 228°+59°. A mean place of the radiant-point at 228½°+52½° was also obtained by Mr. W. E. Besley, at Clapham, from six Quadrantid tracks among seventeen to twenty meteors mapped and glimpsed in a watch, with clear sky from 11h. to 13h. 20m., on the night of January 3. Evident signs of radiation by three or four meteors from each point were also noted here from 180°+55° (δ Ursæ Majorids, II.), 258°+44° (β Draconids), and 235°+36° θ Coronids), round the Caput-Böotid, or Quadrantid radiant-region, and notably also from one more distant source (ε Craterids), at about 160°–8° (five meteors), and from a weaker one at about 210°+6°, Mons-Mœnalids or (15) Böotids.

The large meteor described by Mr. Milligan as having been seen at Bangor, Co. Down, at 5h. p.m. on January 3, shooting upwards in the S.W. nearly along the path of the ecliptic, or from some radiant-point near β Aquarii in the sunset vicinity, was indeed, as early evening fireballs sometimes are, directed from an exceptionally far western quarter. But as its radiant-source was at least 100° off from that of the Quadrantids, then near the N.W. horizon, it could only, surely, be in a course of countless ages that we might suppose it to have become so widely divergent in its route from the star-shower's path-direction, since this would need many times repeated, always like-acting close approaches to the earth, with the only small deflecting actions in each of them which the earth by its attraction would be able to exert on the direction of its motion.

A. S. HERSCHEL.

Observatory House, Slough, March 28.

Analogue to the Action of Radium.

Is not the generation of radiant energy by radium analogous to the humming of telegraph wires and poles? In each case the emission of energy is a response to surrounding disturbances which elicit no response from bodies in general. The disturbances from which the energy is drawn are irregular movements, of the air in the one case, and of

[1] From Mr. King's description in the *English Mechanic* of February 6, 1903 (vol. lxxvi. p. 544), of his view of 8 to 10 Quadrantids seen and mapped in 45m. of cloudless, only slightly hazy sky, after 9h. (none having appeared in the previous hour, from 8h. to 9h., of equally clear watch), their rate of appearance then, allowing for haze, and for time spent in registration, was about 17 to 23 per hour, and they were "coming as frequently as the Perseids in the early hours of their maximum dates." The eight mapped flights (of which one was as bright as Sirius, and five were equal to or brighter than second magnitude stars) showed a radiant-point at 228° + 52°. Mr. Astbury saw 19 Quadrantids during a watch of 1h. 45m. between 6h. and 10h. 30m. The thirteen mapped paths gave "two good centres, one at 231° + 54° (5 Quadrantids) and a second at 225° + 53° (5 Quadrantids)." The three remaining "fell near, but not *on*, these centres."

[2] Three or four flashes of lightning were noticed on that night, as also happened on that date in the bright return of the Quadrantid shower in 1900. In the clear watch of 5½ hours kept at Slough on the latter night, considerably more meteors (35 together) than the 28 observed well centred paths from Quadrans, appeared to diverge from the following five positions, which, with the δ Ursid centre seen this year, were distributed round the January shower's radiant region near the Huntsman's head pretty closely, and pretty evenly in all directions, thus:—216° + 34° (ρ Böotids, 8 meteors), 243° + 20° (ξ Coronids, 8 meteors), 257° + 44° (β Draconids, 7 meteors), 260° + 65° (ζ Draconids, 7 meteors), and 242° + 75° (γ Ursæ Minorids, 5 meteors).

the ether in the other. The responsive power is due to structure, which in the one case is on the large, and in the other on the molecular scale. J. D. EVERETT.

11 Leopold Road, Ealing, W., March 31.

FIG. 1.—Triangulation at Spitsbergen, for the measurement of an Arc of Meridian.

MEASUREMENT OF AN ARC OF MERIDIAN IN SPITSBERGEN.

THE *Revue générale des Sciences* for December 15 and 30, 1902, publishes an account of the measurement of a meridian-arc in Spitsbergen from the pen of M. A. Hansky. Other accounts of the same enterprise have appeared in various journals, and some of them are before me.[1] The history of the undertaking is as follows:—In the year 1823 Sir Edward Sabine was sent to Spitsbergen and Greenland to make "experiments to determine the figure of the earth by means of the pen-

[1] Carlheim Gyllensköld in *Ymer*, 1900, h. 2; O. Backlund in *La Géographie*, April 15, 1901, p. 287, and later numbers; Rapport till Kongl. Kommitten för gradmätning på Spetsbergen (Stockholm, 1900, &c.).

dulum vibrating seconds in different latitudes." Sabine's experiences in Spitsbergen led him to conclude that that country, and that alone in the Arctic regions, owing to its exceptionally mild climate for so high a latitude, was suited for the actual measurement of a meridian-arc of any valuable length. Accordingly he wrote a memorandum advocating the undertaking, which will be found in the *Quarterly Journal of Science and the Arts* for 1826 (pp. 101-8). Nothing was done in the matter, but the proposition was not lost sight of. When the Swedes, in and after 1858, made their remarkable series of scientific expeditions to Spitsbergen, they set before themselves as one of their objects a preliminary survey and the choice of stations for an arc-measurement, and as long as Sabine lived they kept him informed of their interest in his proposal.[1] The detailed proposal, with a map of the net, was published by Dunér and Nordenskiöld in a paper presented to the Swedish Academy on September 27, 1866.[2]

It was hoped for a long time that England would join Sweden in carrying out this work, but nothing was ever done, and the years passed. At length, all hope of English cooperation being abandoned, the Swedes turned to Russia, and, in or about 1897, an agreement was come to by the two Governments for a series of joint expeditions to perform the measurement. The work was actually begun in 1898, and concluded in 1902. The observations are now being reduced, and the result will probably be published in 1904.

The southern extremity of the arc is Mount Keilhau, near the South Cape; the northern is Little Table Island (Fig. 1). The difference in latitude between the two is 4° 10′. The Russians undertook the southern and easier part of the arc, from Mount Keilhau to Thumb Point, at the south end of the Hinloopen Strait. The Swedes took the northern part. Both nations established winter stations—the Russians in Horn Sound, on the site of the old whaling station of the London Muscovy Company; the Swedes in Treurenberg Bay, close to the harbour, where Parry's station was established in 1827. Horn Sound is always easily accessible. Treurenberg Bay is not accessible at all in many seasons. The Swedes had bad luck in this respect, and the best part of two seasons had to be wasted in painful efforts to reach their base station.

FIG. 2.—Whales Point, where the Russian base was measured.

The year 1898 was devoted to a preliminary expedition by the Swedes. The Russians began work in 1899, and spent the following winter at Horn Sound. They likewise devoted the summer seasons of 1900 and 1901 to their share of the work. The Swedes were not able to finish in 1901, so they returned for one more long and arduous season in 1902, by which the whole undertaking was finally carried to a successful issue. M. A. Hansky's articles only describe the Russian expeditions. They are admirably illustrated by photographs, but, unfortunately, it is not always stated what is the exact subject of the view. Thus, Fig. 1 is entitled "Montagnes et Glacier au Spitzberg," a ridiculous title for any scientific journal to accept. I believe the view

[1] *Vide* Dr. Otto Torrell's letter to General Sabine, December 12, 1863, in *Proc.* Roy. Soc., xiii. pp. 83, 84; and Capt. Skogman's letter to the same, November 21, 1864, announcing the completion of the preliminary survey, in *Proc.* Roy. Soc., xiii. pp. 551-553.

[2] K. S. Vet. Akad. Handl. Bd. 6, No. 8.

was taken in Fair Haven, the great bay at the north-west angle of the main island, but it may be in Magdalena Bay. Incidentally, I may also mention that the geographical nomenclature employed is very inaccurate, thus the name Mount Hedgehog, which belongs to Hornsundstind, is given to a hill on the east coast, and other names are likewise misapplied. Mr. Arnold Pike is called Mr. Pikes.

The Swedes measured their base at Treurenberg Bay, the Russians theirs near Whales Point (Fig. 2). For this purpose they used the Jäderine apparatus, in which a wire consisting of Guillaume metal (a steel and nickel alloy), about 25 metres long and 1·7 mm. thick, is supported at a fixed tension on a series of tripods, used in pairs successively. By this means the base was measured in four days, each measurement being repeated four times with two different wires. The limit of error is stated to be not more than 1 in 400,000.

At the beginning of the season of 1899 the Russians went up to Horn Sound, and began establishing their winter station close to a spot where Garwood and I spent a week in 1897, so that it was not, as they imagined, "a spot where for more than two centuries no human being has lived." Here, in fact, throughout the eighteenth and part of the nineteenth centuries the Russians themselves had a trappers' winter establishment. While the houses were building, the observers went for a trip to the north, but the weather was very bad. Then they went round to Wybe Jans Water (which they call Storfiord) to commence the observation of their ten triangles, one of which had a side 130 kilometres long. They found the sea free of ice—an unusual condition to the eastward—and were able to land anywhere with ease. They were astonished by the relatively rich vegetation on Anderson Island. Not until August 6 could they actually begin observations from the signal point at Cape Lee, where they spent twenty days and could only work on three. They had to abandon the place before their work was done. The wintering party settled in whilst the others returned home. The winterers next spring made overland expeditions to Mount Keilhau, and began work there. In June, 1900, the other observers returned from Europe. It was several weeks later before the Keilhau observations were complete. Meanwhile, others were exploring the interior of the ice-sheet from Klaas Billen Bay, to find a junction signal-point for the Swedes and Russians. They succeeded after forty-five days, and built a pyramid on Mount Tchernycheff, a point first discovered by me in 1897. At Whales Head the observations were very protracted, and ice cut the observers off, so that it was long before they could get away. An expedition went overland to relieve them from Low Sound (wrongly called Van Mijen Bay). This was about all that was accomplished that season.

In 1901 the weather was much more favourable. The Russian base was measured near Whales Point. The remaining stations were occupied as far as Thumb Point, and the work completed. A final visit was paid to the abandoned winter station, and the expedition returned home in safety and content.

MARTIN CONWAY.

SEISMOMETRY AND GEITE.

OBSERVATIONS on earthquakes which have transmitted vibrations to all points upon the surface of our globe apparently lead to conclusions respecting the physical nature of its interior. The following notes indicate the character of these conclusions, and at the same time suggest directions in which these may be harmonised with astronomical and other requirements.

Within a radius of 10° or 20° of a centrum, the velocity of transmission of the larger earthquake waves varies between 1·8 and a little more than 3 km. per second, such variations being usually attributed to the nature of the medium through which the waves have passed. Beyond these limits, and up to 165°—that is, to near the antipodes of an origin—speeds which are practically constant prevail.

The large waves have a velocity which, if regarded as "arcual," is constant at about 3 km. per second, whilst the preliminary tremors, if it is assumed that they travel along paths approximating to chords, quickly attain a velocity exceeding 9 km. per second.

The constant velocity for the large waves and the high velocity for their precursors preclude the idea that either of them were transmitted through the heterogeneous quasi-elastic crust.

If the large waves are regarded as the outcroppings of mass waves, then as pointed out by Dr. C. G. Knott the law which would govern their transmission so that their apparent arcual velocity should be constant would be "most complicated and improbable." Considering this uniformity of speed in conjunction with observations which indicate that as they pass beneath country after country they give rise to tilting phenomena on the surface, and that the amounts of tilting recorded at different stations in areas like Great Britain are, at least for the smaller disturbances, practically equal, the conclusion arrived at is, that the large waves of earthquakes are transmitted through a comparatively homogeneous medium beneath the crust, which, as they pass, is forced to rise and fall like a raft upon an ocean swell.

If the preliminary tremors followed the same path as the large waves, then their velocity would not be constant, but would vary from 3 km. per second in the vicinity of their origin to 15 km. per second as they approached the antipodes. On the contrary, if it is assumed that the paths approximate to chords, then for chords of 10°, 20°, 30°, 40°, 50°, 60°, 80°, 90° and 150° the corresponding average velocities in kms. per second are from 3 to about 5, 7·3, 8·1, 8·5, 8·5, 8·8, 9·0, 9·3 and 9·3—these being minimum rather than maximum values.

The lower of these velocities, all of which are average values deduced from observations dating back to 1889, may be due to the fact that they refer to the shorter chords, a considerable portion of which lie within and near what is assumed to be the crust of the earth.

But even accepting as appears to be necessary an increase in average velocity along paths as they are taken nearer and nearer to the centre of the earth, the above figures show that this increase is not very great. The inference is that not only has the world a high rigidity, but also that its interior is probably fairly uniform so far as those properties are concerned which determine the rate at which it transmits vibrations. Possibly, therefore, it may have a density throughout its nucleus which is nearly uniform. Unless we assume that as we descend in the earth elasticity and density increase in about the same ratio, to which hypothesis there are objections, it seems likely that the nucleus of the earth has a density that is more nearly uniform than is generally assumed. Prof. Wiechert has shown that such a nucleus made of iron, density 8·2, and four-fifths of the earth's radius, covered by a shell of density 3·2, satisfies the astronomer. Such a world, however, does not comply with what appear to be the requirements of seismology. Iron or steel do not transmit vibrations at the observed rates, whilst chordal velocities within the assumed shell would closely approach those observed along chords which are largely within the core. If a homogeneous nucleus

not less than 19/20 of the earth's radius sufficiently dense and rigid to comply with astronomical tests can be defined, the same might also approximate to the conditions assumed not only by seismologists, but also by physicists. The shell covering such a nucleus would be about 200 miles in thickness. The physical characters of this shell would in all probability change rapidly from those of the crust of the world to those of its nucleus, corresponding to the observed rapid changes in chordal velocities. At a comparatively shallow depth, say 40 miles, high temperatures would result in fusion, and inasmuch as ice, iron, copper and other substances at or near their melting point float on their own solutions, fusion is a state that would partly be promoted by high pressure. At greater temperatures, whatever the pressure might be, fluids would become gaseous, and the gases would be dense, but slightly compressible and viscous. In certain respects, therefore, they would resemble a solid. This is the view of Arrhenius, who assumes a core of gaseous iron the dimension of which is that assumed by Wiechert.

One reason for selecting iron or gaseous iron in an equally dense state is that a nucleus of such material of the specified size will account for the weight of the world as a whole. What, however, is sought for is a body probably a mixture of the commoner elements in a state approaching that of closest crystalline atomic packing, which has a radius 19/20 that of the earth, a specific gravity less than that of iron, but greater than 5·5, which keeps fairly homogeneous, and can transmit compressional vibrations half as fast again as steel. This material may be called *gēite*, a term as much required as *magma* and *crust*, by which gēite is enveloped, and *gēoid*, which refers to the form these materials collectively exhibit.

Whether solid or gaseous, *gēite* may possibly find its chemical equivalent in certain meteorites, and therefore largely consists of iron alloyed with a small proportion of nickel and other elements. If we assume that the shell covering this mixture has a thickness 1/20 of the earth's radius, and an average density of 2·7—the density of the world being taken at 5·5—it follows that the density of the gēite core is 5·96, or approximately 6. The elastic modulus for a core of this density which conveys vibrations with a speed of at least 9·5 km. per second is 451×10^{10} C.G.S., or roughly speaking, a little more than twice the Young's modulus for Bessemer steel (207×10^{10} C.G.S.).

With improvements in seismometrical arrangements, it seems likely that speeds somewhat higher than those here given will be recorded. Within the core itself, a velocity of 9·5 km. per second must be exceeded. For the moment let this be increased to 10 km. per second whilst within the crust let the average speed be 3 km. per second. With such assumptions, if the covering shell is about 40 miles in thickness, the *calculated* times to traverse chords corresponding to axes of 20, 30, 40, 50, 60, 80, 90 and 150 degrees would be 6·1, 7·5, 8·7, 10·2, 11·6, 14·5, 15·7 and 21 minutes. The *observed* times for these paths are 5, 6·5, 8·5, 10·5, 12, 15, 16 and 22 minutes. These approximations between calculations and observations suggest that the region of rapid change between crust and gēite commences where melting temperatures probably prevail.

In venturing these speculations on a gēitic core which will satisfy seismometrical and other tests, the fact must not be overlooked that, as earthquake measurements are yet in an embryonic state, figures which have been given relating to the same, although they represent the work of many years, are subject to modification. Amongst the various earth cores which are in harmony with the requirements of astronomy and geodesy, there is at least one which is homogeneous. If the radius of this can be increased 1/7 and it can have the properties of gēite, it will also accord with seismometrical observations.

Other speculations respecting the arrangement and character of materials beneath the earth's crust are based upon the fact that at certain observatories magnetic needles are disturbed by the large waves of earthquakes. These perturbations do not appear to be explained by the assumption that the magnetometers have been tilted. An alternative is to assume that they are due to changes in magnetic intensity possibly brought about, as Capt. E. W. Creak, F.R.S., points out, by changes of stress in a near magnetic medium. If this is the case at those stations where needles are caused to rotate, magnetic intensity and gravity should have abnormal values. This appears to be true for Batavia, near to which there are many volcanoes, indicating the proximity of dense magnetic materials, and for Bombay, where there is basalt, and at no great distance a hidden chain of heavy matter revealed by gravitational observations. At Kew and Greenwich and other stations where needles are not disturbed, magnetic intensity and gravity are not abnormal. Generally speaking, where horizontal force is comparatively low, the difference between the value of g as observed and as expected is also low, and to a certain extent the contrary holds good. On these points, however, until more material has been collected, it is impossible to speak definitely.

What seismometrical observations then lead us to suspect is that beneath the light crust of the earth, which we know to be thinner in some places than in others, there is a magnetic medium of density greater than the crust, which, as we descend in depth, may rapidly pass into a fairly homogeneous nucleus of gēite, the dimensions, physical and chemical characters of which have been suggested. J. MILNE.

THE SOUTHERN CROSS ANTARCTIC EXPEDITION.

THE magnetic observations made in this expedition[1] have been reduced and prepared for printing by Dr. Chree, F.R.S., and M. Bernacchi, and the meteorological by Commander Hepworth, C.B., and Mr. Curtis, of the Meteorological Office, under the direction of Dr. W. N. Shaw, F.R.S., secretary of the Meteorological Council, and the results have been published by the Royal Society. In this expedition, fitted out by Sir George Newnes, the magnetic observations were made in about equal proportions by M. Bernacchi and Lieut. Colbeck, R.N.R., other observers also giving their assistance in the meteorological work.

The magnetic observations consist of determinations of declination, horizontal force, and inclination, made at Cape Adare, in latitude 71° 18′ south, and longitude 170° 9′ east, with some detached observations of inclination at other places. At Cape Adare observations of declination were made on a number of days in the months of April, May, October, November and December, 1899, giving a mean easterly declination of 55° 49′. Corresponding observations for horizontal force give a mean value (C.G.S. units) of 0·04143, and observations for inclination a mean value of 86° 34′. Observations for the diurnal variation of declination were made on three days, in April and May, 1899, and January, 1900, respectively, giving on the whole a diurnal movement of some 2°, that on the April day

[1] Magnetic and Meteorological Observations made by the *Southern Cross* Antarctic Expedition, 1898–1900, under the direction of M. Borchgrevink, Commander of the Expedition.

being very much greater than that on the day in May —three times as great—indicating in a short time a seasonal change that seems to require further observation to confirm. The material is insufficient for much to be said as regards diurnal variation of horizontal force.

Dr. Chree adds the remark that though at first sight the changes in declination seem quite out of proportion to the changes of the force, this is not really the case, but that, as a matter of fact, the changes in direction and intensity are occasioned by disturbing forces which are of the same order of magnitude. He makes some comparison also with results found in the *Erebus* and *Terror* voyage.

There are notes of aurora. On one occasion, May 30, 1899, it is remarked that the movement of the magnet was most conspicuous during the active time of the aurora. Dr. Chree adds that many of the observations were taken in disadvantageous circumstances, and with a limited instrumental outfit, so that some of the conclusions arrived at should be accepted with reserve, at the same time remarking that the zeal and care of the observers under physical discomfort seemed to merit this attempt to do full justice to their work which, it is thought, might help to direct attention to special points of inquiry as regards other expeditions setting out, or likely so to do.

The meteorological results include a daily record of barometric pressure, air temperature, depression of wet bulb, direction and force of wind, character and amount of cloud, bright sunshine and precipitation, from March, 1899, to January, 1900, the observations (excepting of the last two mentioned elements) being taken at intervals of two hours day and night in the months of June and July, and in the remaining months at intervals of two hours from 9h. a.m. to 9h. p.m., in all cases accompanied by descriptions of weather; there are also various monthly abstracts of meteorological phenomena. Interesting descriptions of the numerous appearances of aurora are given, but whether synchronising or not with unusual magnetic motion does not directly appear, excepting on the one occasion already mentioned. The meteorological section is preceded by an introduction by M. Bernacchi explanatory of various matters, at the end of which he says it is of course premature to attempt to give a truly satisfactory description of the prevailing winds and temperature conditions in high southern latitudes until one year's observations at numerous stations on Antarctic lands are obtained, but expresses the hope that the Cape Adare observations may yet make our knowledge of the region less hypothetical than before.

NOTES.

THE death is announced, in his eightieth year, of Prof. Julius Victor Carus, professor of zoology in Leipzig.

THE German Association of Naturalists and Physicians will hold its seventy-fifth annual meeting this year at Cassel, on September 20–26.

THE annual meeting and conversazione of the Selborne Society will be held on Tuesday, May 5. The president, Lord Avebury, will occupy the chair.

AN international agricultural conference will be opened at Rome on April 13. Sir Thomas Elliott, secretary to the Board of Agriculture, will represent the Board at the conference.

LORD BLYTHSWOOD has been elected a member of the Athenæum Club under the rule which empowers the annual election by the committee of nine persons "of distinguished eminence in science, literature, the arts, or for public services."

THE University of Toronto has, *Science* reports, received subscriptions amounting to 6000*l.* toward a convocation hall, of which sum Mr. Chester Macy has given 1000*l.*, and Prof. and Mrs. Goldwin Smith 400*l.*

THE following are the subjects of lectures arranged for the Wednesday evening meetings of the Society of Arts after Easter:—"Modern Bee-Keeping," by Mr. W. F. Reid; "Automatic Wagon Couplings," by Mr. T. A. Brockelbank; "The Construction of Maps and Charts," by Mr. G. T. Morrison; and "Preservation of Big Game in Africa," by Mr. E. North Buxton.

THE Carnegie Institution has granted 1200*l.* to be expended under the direction of Dr. T. C. Chamberlin, of the University of Chicago, in research relative to fundamental problems in geology. The Institution has also made a grant to Dr. J. E. Duerden, late curator of the Jamaica Museum, to assist him in his work on the morphology of recent and fossil corals.

THE council of the Geologists' Association has arranged an excursion for April 18 to New Cross to examine the reopened cutting south of the L.B. and S.C.R. station, which shows the junction of the London Clay and the beds below. This interesting section will be hidden again shortly, and geologists who have not yet examined it will be glad to hear of the excursion, the details of which were arranged too late for insertion in the April circular of the Association.

REPLYING in the House of Commons to a question by Mr. Schwann asking what is the present position of Mr. Jamsetjee N. Tata's scheme for a scientific research institution in India, and what support has been given to the scheme by the Government of India, Lord George Hamilton, the Secretary of State for India, said that he understood that Mr. Tata's scheme for a scientific institution is in abeyance for a time.

A MINERAL survey of Ceylon has been commenced with Mr. A. K. Coomaraswamy as director, and Mr. J. Parsons as assistant. It is intended to carry on investigations for three years, the results afterwards to be embodied in a report on the mineral resources of the island. Chemical work in connection with the survey will be carried out at the Imperial Institute, South Kensington. The headquarters of the survey are for the present to be at Peradeniya.

A CORRESPONDENT of the *Lancet* reports that Mr. Henry Phipps is so pleased with the purposes to which the Viceroy decided to devote his donation of 20,000*l.*, viz. between a central agricultural laboratory and a Pasteur institute for southern India, that he has increased his gift by another 10,000*l.* The Government of India hopes to be able to carry out measures for combining agricultural education, scientific research, and practical experiment in one locality.

THE Paris correspondent of the *Times* announces that Dr. Roux, of the Pasteur Institute, has been awarded the Prix Osiris of 100,000 francs by the Institute of France. We learn from the same source that the prize owes its existence to the generosity of M. Osiris, and is now awarded for the first time. It has been founded as a stimulus to original discovery and valuable work in the domain of science, art and letters. In unanimously deciding to give the prize to Dr. Roux, the Institute of France has recognised the high value of his scientific labours in preventive medicine and bacteriology.

THE Elliott prize for scientific research will be given this year, the *Pioneer Mail* announces, to the author of the best original essay composed during the year 1903 giving the results of original research or investigation by the essayist on chemistry. Any native of Bengal, including any Eurasian or domiciled European residing in Bengal, may compete for the prize. Essays of competitors must be sent in to the president of the Bengal Asiatic Society by the end of December, 1903. Preference will be given to researches leading to discoveries likely to develop the industrial resources of Bengal.

THE following earthquakes have been reported within the last week:—April 3.—Several earthquake tremors, two of them alarmingly violent, have occurred during the last three days, in the Andijan region. Similar shocks have been felt contemporaneously in the Southern Urals. April 4.—Violent shocks of earthquake are reported from various parts of the province of Catania. A shock of earthquake was felt at 2 a.m. at Mentone. Houses were shaken. There was no recurrence of the shock, which only lasted half a second.

A NEW turbine steamer was launched at Dumbarton from the yard of Messrs. Denny Bros., on April 4, for the Cross-Channel service of the South-Eastern and Chatham Railway. The new vessel is of the same type, though larger, as the vessels which have been successful on the Clyde. The machinery will consist of Parsons's turbines, three being fitted, with three lines of shafting. In manœuvring, the centre shaft runs free, and the two side shafts then take the place of ordinary twin screws. The builders have undertaken that this vessel shall have an average sea speed of 21 knots, and it is expected that the vessel will perform the voyage from Dover to Calais in forty-five to fifty minutes.

REUTER'S Agency is informed that Dr. T. Rubin, of Upsala, the leader of the scientific expedition which has been dispatched to Africa by the British South Africa Company, has left England. He was accompanied by Dr. Stoehr, the medical officer. After conferring with Sir David Gill, the Astronomer Royal at Cape Town, Dr. Rubin and the other members of the expedition, who will join him in South Africa, will leave for Chinde *en route* for Fort Jameson. He will then confer with the Administrator of North-East Rhodesia, and at once proceed to the work of the geodetic survey.

THE *Geographical Journal* announces further details of the programme of the International Geological Congress to be held in Vienna in August next. There will be discussions on overfolded or overthrust planes relating to the structure of the mountains of Scotland, the Jura, and the Alps. A special sitting will be devoted to questions concerning the geology of the Balkan Peninsula and the East. The surface geology of the town of Vienna will also be discussed. The extensive engineering works carried out in the neighbourhood during the last ten years have exposed many deposits which have led to important discoveries by Prof. Suess. A paper on the subject will be illustrated by a large geological map on a scale of 1 : 10,000, and numerous sections.

THE Board of Trade has informed the secretary of the Engineering Standards Committee that the sum of 3000*l.* has been included in the Board of Trade vote, for 1903-4, as a contribution towards the funds of the Engineering Standards Committee for that year only, on the understanding that the Treasury is not thereby pledged to continue the grant in later years. The actual expenditure under the vote will have to be authorised by the Railway Department of the Board of Trade on the recommendation of a committee specially appointed for the purpose by the Institution of Civil Engineers. The committee appointed by the Institution includes:—the president and the senior vice-president of the Institution of Civil Engineers; Mr. James Mansergh, F.R.S., Sir John Wolfe Barry, K.C.B., Sir William Preece, K.C.B., Sir Benjamin Baker, K.C.B., and Sir Douglas Fox, past presidents of the Institution; Mr. Archibald Denny; with a representative of the Board of Trade.

THE spring meeting of the Institution of Naval Architects was held in the rooms of the Society of Arts last week, when the annual report of the council was presented, and new officers were elected. The report states that a committee of the council has, during the past year, been considering the possibility of raising a fund for the construction of an experimental tank at Bushey, in connection with the National Physical Laboratory there, in accordance with the resolution passed at the summer meeting held in Glasgow in 1901. The proposal is still under consideration. A cordial invitation from the Lord Mayor of Belfast (Sir Daniel Dixon) to hold a summer meeting in that city has been accepted by the council, and a further invitation, to include a visit to Dublin, has been received from the president of the Institution of Civil Engineers of Ireland (Mr. J. H. Ryan), and has also been accepted. A gold medal of the Institution has been awarded to Captain G. Russo, R.I.N., for his paper on the navipendular method of experiments as applied to some warships of different classes, and a gold medal to Prof. S. Dunkerley, for his paper on the straining actions on the different parts of a crank shaft. Among the numerous papers read during the three days of the meeting the following may be mentioned:—On the effect of modern accessories on the size and cost of warships, Mr. W. H. Whiting; on the lines of fast cruisers, Vice-Admiral C. C. P. FitzGerald; the training of engineers in the United States, Prof. W. E. Dalby; the modification of the mean pitch due to twisting the blades in screw propellers, Prof. Angelo Scribanti; the screw as a means of propulsion for shallow draft vessels, Mr. A. F. Yarrow; marine installations for the carriage of refrigerated cargoes, Mr. R. Balfour; and the corrosion of metal pipes on board ship, Mr. A. W. Stewart.

A DEMONSTRATION of the Orling-Armstrong system of wireless telegraphy and telephony was given at the Alexandra Palace on Thursday last. We have already referred to this system on several occasions in NATURE, and described the capillary relay which is used as a receiver some time ago. The transmitter is so connected that both the primary and secondary circuits of the induction coil are simultaneously earthed, a combination which it is claimed produces remarkable effects. An experiment was shown in which two bombs were exploded at a distance of three or four hundred yards, the earths of the transmitter being about one hundred yards apart; either bomb could be exploded at will, the receiving circuit of each being syntonised to a different period. Syntonisation is effected with a telephonic receiver which actuates a sensitive flame in a tuned chamber; the flame heats a platinum wire in the relay circuit. Presumably, therefore, it is the period of the interrupter which is syntonised, not the oscillation period of the spark; apart from this objection a sensitive flame does not appear a very practical arrangement. Wireless telephony from a distance was also demonstrated; the received speech was plainly audible, but owing to the fact that a key had to be depressed or released for speaking or listening respectively, conversation was not possible; this is, however, a minor difficulty, which can doubtless be overcome. It is

not easy to see how any widespread extension of telephony of the sort could take place without interference, but possibly the principle may be useful for private isolated installations or military and field work generally.

SIR C. EUAN-SMITH, who presided at the general meeting of Marconi's Wireless Telegraph Co. last week, referred to the wireless telegraph conference which it is proposed should be held in Berlin. He stated that "generally speaking, the company thought that the inauguration of a system intended to be applicable to international wireless communication all over the world, and to be adopted for use by the many more or less imperfect systems of wireless telegraphy in vogue, was fraught with apparently insurmountable difficulties, some of a technical, but others of a business and practical character." They awaited further details of the programme of the conference, however, before forming any definite opinion upon it. Reference was also made to the anticipated arrangement with the Post Office; since that date, according to last Saturday's *St. James's Gazette*, these negotiations have resulted in a further deadlock, the Post Office having imposed conditions which the Company cannot accept. Mr. Marconi also spoke at the meeting at some length, referring mainly to the opposition which his system has met with in the Press; experience had proved, he claimed, that the difficulties, real or imaginary, which had been raised had been overcome one by one, and he hoped that in the near future those still outstanding would likewise be surmounted. Mr. Marconi also spoke of the syntony experiments made by Prof. Fleming, which he hoped shortly to repeat before Lord Kelvin and Lord Rayleigh.

PROF. G. P. MERRILL writes from Washington to point out that in the volume entitled "The Elements of Agricultural Geology," by Mr. P. McConnell (Crosby Lockwood and Son), noticed in NATURE of November 13, 1902 (p. 31), his work on "Rocks, Rock-Weathering, and Soils" (1897) is misquoted, and he is made responsible for statements which do not appear in the book. Mr. McConnell states (pp. 20–21):—"According to Merrill, the *whole* of the original soil formation of New England has been eroded off by glaciers and dumped into the Atlantic, while a new lot—a mongrel horde—has been brought from the *far* north and laid down." Again, writing of the Huronian formations of the Green Mountains of Vermont, he says (on p. 164):—"As previously stated, an American author holds that the *whole* of the soils originally formed in *this region* have been swept off by glaciers and dumped into the Atlantic." Prof. Merrill informs us that he does not hold and never has held these opinions; and he shows by reference to the original that his words have been misconstrued.

THE opal mining industry of Queensland, by Mr. C. F. V. Jackson, forms the subject of Report No. 177 of the Geological Survey of Queensland (1902). While nearly all varieties of opal are found in the western portion of the country, the examples of precious opal there met with are unsurpassed in quality and brilliancy. These examples are found almost entirely in the Desert Sandstone Series (Upper Cretaceous), which has a thickness of from 100 to 200 feet, and so far they have been discovered only in outlying patches of the formation. The Desert Sandstone consists of soft sandstones and clays with a capping of hard siliceous rock, frequently converted into a porcellanite. This "Top Rock" has, in places, a kind of nodular or spherical structure, and there has apparently been a tendency to the solution and redeposition of its siliceous contents. The surface is much disintegrated. The precious opal occurs chiefly in the softer beds underlying the "Top Rock," but occasionally it is found in it. Common forms of opal are prevalent, but the precious variety appears only here and there in patches, sometimes in nodules of siliceous ironstone at all horizons, at other times in the false-bedded sandstones and clays in a more definite band. In places, the mineral is found scattered over the surface, being set free by denudation, but such occurrences furnish little or no evidence of precious opal below. Prospecting is a hazardous business, as the site for a shaft is most frequently chosen in the vicinity where scattered specimens have been found at the surface. The average depth of shafts is 14 feet, and the deepest is about 65 feet. The great difficulty in the progress of the industry is the scarcity of water, the annual output, as the author observes, being dependent on the rainfall.

A TREATISE by Dr. E. Mazelle, director of the Trieste Observatory, on the connection between the movements of the microseismic pendulum and meteorological phenomena, was recently submitted to the Vienna Academy by Hofrath Dr. J. Hann. The movements of the instrument exhibit a decided yearly period, a maximum in winter and an almost complete absence of disturbance in summer; also a daily maximum and minimum between 9h. and 10h. in the morning and evening respectively. When submitted to harmonic analysis, the whole-day period exhibits a perfect agreement of the phase epoch with that of the stormy Bora at Trieste. The other relations are not so marked; disturbances occur with both days of high and low barometric pressure, but pronounced disturbances appear to be more probably connected with low pressure. With regard to the possible connection of microseismic disturbances with the state of the sea it was found that these have a greater tendency to occur when the sea is rough. For further details we suggest a reference to the work in question.

DR. T. BYARD COLLINS, writing in the *Scientific American*, describes some experiments on the action of birds' wings. By attaching incandescent lamps to the tips of a pigeon's wing, and inducing the bird to attempt to fly, the path of the tip was found to be an oval curve agreeing fairly well with the results described by Prof. Marey in his "Vol des Oiseaux." The author considers that the only way of solving the problem of flight is by beating wings—a method experimented on many years ago by Pénaud.

A MAGNETIC survey of the neighbourhood of the summit of the Puy de Dôme has led to some interesting results, which are described in this month's *Journal de Physique* by MM. B. Brunhes and P. David. The declination was found to be nearly normal along a line through the centre of the tower, 15° west of north, and it varied from 10° 5′ at 200 metres east of the tower, 80 metres lower than the summit, to 19° 45′ at 300 metres from the tower, 150 metres below the summit. The horizontal component varied from 0·193 of a C.G.S. unit at 100 metres from the tower in a direction 15° west of north to 0·225 of a C.G.S. unit at 156 metres south of the tower. A diagram of the disturbing force shows that it is directed towards the summit, but not quite uniformly in different directions.

IN the West Indian *Agricultural News* for March 14 there is a descriptive account of experiments which have been commenced on the Island of St. Vincent with the view of testing the possibility of starting cultivation, with certain plants, on estates which are buried under from nine to ten inches of volcanic ash, resulting from the severe eruptions of the Soufrière in May, September and October, 1902. The plants selected for the experiments are sugar-cane (five

varieties), cotton, ground-nuts, arrowroot and sweet potato. The experiments were started in January, and valuable results were expected, "provided there are no further eruptions." It is to be feared, therefore, that the great quantity of ash thrown out from the Soufrière during the eruption of March 22 last will greatly interfere with the interesting investigation.

THE Imperial Department of Agriculture at Barbados has just issued a report giving "Information relating to Cotton Cultivation in the West Indies." Formerly the islands had a valuable export trade in cotton, in 1793 contributing 71 per cent. of the material used in Great Britain, but sugar became paramount, and for about three-quarters of a century past cotton has been practically unknown in the islands. Now that sugar has become to a large extent unprofitable, it is proposed to resuscitate the cotton-growing industry. The department commenced experiments in St. Lucia in 1900, and the results obtained have been so promising that planters there and in neighbouring islands have already devoted about 600 acres to the growth of cotton. So favourable are the conditions that it is stated "the days of the more lucrative production of sugar would appear to have passed away, and it is not improbable but that cotton may once more take its place amongst the staple products of the West Indies."

WE have received an official note issued by the Commission of the *Belgica* with reference to the publication of the scientific reports of the expedition. These are to be issued in parts, making ten volumes in all. Only fifty complete sets will be on sale to the public. The English agents are Messrs. Dulau and Co.

M. CHARLES RABOT contributes an interesting paper on the recent surveys and explorations of MM. Svenonius and Hamberg in Swedish Lapland to the March number of *La Géographie*. Topographical surveys have resulted in important modifications of existing maps, and the region is of great geological interest.

THE *National Geographic Magazine* for March contains three articles of considerable interest in relation to the question of the Canadian-Alaskan boundary. The Hon. John W. Foster, who has charge of the presentation of the United States case to the Boundary Commission, reviews the methods by which different parts of the boundary between Canada and the United States have been adjusted since 1783. Mr. Ferdinand Westdahl, of the Coast and Geodetic Survey, gives extracts from his official reports on a survey of the mountains of Unimak Island, Alaska; and an article on the opening of the Alaskan Territory, by Mr. Harrington Emerson, is reprinted in abstract from the *Engineering Magazine*.

THE Foraminifera and other organisms in the Raised Reefs of Fiji are described by Mr. R. L. Sherlock (*Bull.* Museum of Comp. Zool. Harvard College, vol. xxxviii. 1903).

WE have received the first number of the "Naturalist's Library Guide," a quarterly journal edited by Mr. W. P. Westell, devoted to notices and brief reviews of books and other publications connected with natural history.

AMONG other zoological papers, the *Sitzungsberichte* of the Royal Scientific Society of Bohemia contains one by Dr. J. Palacký on the distribution of marsupials, and a second, by Dr. H. Matiegka, on the weight of the brain and cranial capacity in man. Much interest attaches to Herr A. Mrázek's account of the discovery of a fresh-water nemertine worm (*Stichostomma graecense*) in Bohemian streams. This paper is followed by a second from the same pen on the introduced faunas of hot-houses.

IN his report on the Zoological Gardens at Giza, Cairo, Captain Flower calls special attention to three specimens of that remarkable bird the shoebill, or whale-headed stork (*Balaeniceps rex*), now living in the gardens. With the exception of one specimen, now at Khartum, no other examples, it is believed, have been exhibited in captivity since the pair purchased for its menagerie by the Zoological Society of London in 1860. During the past year an aquarium was opened at Gezira, and contained at the date of the report examples of no less than twenty-two species of Nile fishes.

"FAMILIAR WILD BIRDS" is the title of a new illustrated work of which we have received the first part from the publishers, Messrs. Cassell and Co., Ltd. It is to be issued in fortnightly sixpenny parts, each of which is to have eight coloured plates. Mr. W. Swaysland is responsible for the greater portion of the text, although Mr. R. Kearton will communicate notes on eggs. The great attraction will be the coloured plates, most of which are to be from sketches by Mr. A. Thorburn. Those in the part before us are really exquisite, and the marvel is how the work is produced at the price.

Pearson's Magazine for April contains two articles, both illustrated, on natural history subjects. In the one Mr. H. F. Witherby describes some of the leading facts connected with bird-migration, in the course of which he draws attention to the important work on this subject carried out by Mr. W. E. Clarke, and likewise points out that it is an error to suppose that the migration routes are narrow. The illustrations include the Nore lightship in the midst of a migratory host, and a "rush" of birds against a lighthouse. It is perhaps not generally known that when such "rushes" take place in stormy weather thousands of birds perish by striking against the lighthouses. On one occasion "the balcony outside was completely covered with killed birds; they were five or six deep all round, so to walk round would be walking on killed birds." In the second article Mr. R. L. Garner reverts to his favourite subject of "monkey-language." From experiments conducted with a phonograph, the author is of opinion that monkeys understand this language as well as human beings interpret words and sentences.

OUR best congratulations to the Ulster Fisheries and Biological Association, which was inaugurated at a meeting held in Belfast on March 25, when Lord Shaftesbury, the patron of the new body, was in the chair. The president is Mr. H. H. Smiley, who is a large contributor to the funds, and the Association is fortunate in having secured the gratuitous services of Prof. G. Wilson, of Queen's College, Belfast, as Director, since that gentleman acquired a large experience in matters of this sort during his tenure of office as Inspector of Fisheries in England. It is expected that the Association will have an important influence on the development of Irish sea-fisheries, which have hitherto been somewhat neglected, as may be judged from the fact that most of the fresh fish sold in Ireland is imported from Great Britain. A steam launch has been already secured, and it is hoped that practical work may be commenced in Larne Harbour forthwith. Although the Department of Technical Instruction and Agriculture has promised a grant of 150*l.*, the Association is in urgent need of additional funds.

THE sixth edition of Prof. R. Frühling's "Anleitung zur Untersuchung der für die Zuckerindustrie in betracht

kommenden Rohmaterialien, Produkte, Nebenproduckte und Hilfssubstanzen" has been published by Messrs. Vieweg and Son, Brunswick. The work is a standard one on sugar from the point of view of the technical chemist, and the new edition contains several additions which increase its value.

MESSRS. VIEWEG AND SON, of Brunswick, have issued the third edition of Dr. Robert Fricke's treatise on the calculus and differential equations ("Hauptsätze der Differential und Integralrechnung"). It is writen primarily for use in technical schools, but it contains in the compass of 218 pages the principal subject-matter commonly studied by the average mathematical student, including an appendix on functions of complex variables.

MESSRS. J. AND A. CHURCHILL have published a sixth edition of "Quantitative Chemical Analysis," by Dr. Frank Clowes and Mr. J. B. Coleman. This edition differs from the last in that the section on organic chemistry has been revised, and processes for determining molecular weight by elevation of boiling point and for the analysis of aluminium alloys have been added. Moreover, to facilitate necessary calculations, tables of four-figure logarithms have been added.

THE first number of a new illustrated magazine dealing with scientific subjects, and called *La Science au XX^e Siècle*, has appeared. The magazine is published in Paris, under the editorship of M. G. Maneuvrier, by M. Ch. Delagrave. Judging by the contents of this issue, the new journal should be popular; there are, with others, articles on Mont Pelée, on wireless telegraphy, and on the scientific work of M. P.-P. Dehérain. Attention is also given to the experimental teaching of science in schools, several experiments suitable for school laboratories being described. Applied science receives due attention, and separate sections are devoted to zoology, applied chemistry, botany, physics and photography.

PROF. H. H. TURNER, Savilian professor of astronomy in the University of Oxford, contributes to the *Fortnightly Review* for April a reply to Dr. Wallace's article on "Man's Place in the Universe" which was published in the same review last month. Dr. Wallace suggested that the universe is limited in extent; that it has a definite centre at which the solar system is, and has been situated for millions of years; and that by reason of its position the earth has had an opportunity to develop humanity, and probably this opportunity has been nowhere else in the universe. Prof. Turner shows that the limitation of the universe is not proved; that there is no true centre of the universe, even if limited, and even if there were the solar system could not occupy it for long, on account of the sun's proper motion; he also shows that there is no reason whatever why life should not be developed in any part of the interior of even a limited universe.

THE new issue, the fortieth, of "The Statesman's Year-Book," edited by Dr. Scott Keltie, is conspicuous for its exhaustive completeness. An examination of its contents suggests that similar annual compilations dealing respectively with the data of each of the great divisions of science would be of great value to men of science everywhere. Dr. Keltie points out that recent important events have necessitated the addition of much further information. Among these occurrences may be mentioned the final incorporation of the two South African Republics in the British Empire, and the passing of the new Education Act. Further details have been embodied of the recent censuses taken in various countries—the British Empire (especially India), France, Germany, and the United States. The maps and diagrams, as usual, add greatly to the interest and value of the "Year-Book." There are maps of the new arbitration boundary between Chile and the Argentine Republic, the new Abyssinian boundary, and the transcontinental railway projects. Diagrams exhibit graphically comparative tonnage of merchant shipping belonging to the principal countries for the past twelve years, comparative outputs of iron-ore and of coal of the principal countries for the last twenty years, the public debt of the principal countries in pounds sterling for the past eleven years, and the emigration from the principal countries for the last ten years.

IN following up their researches on chemical affinity at low temperatures, Messrs. Moissan and Dewar describe in the current number of the *Comptes rendus* further experiments on liquid fluorine. Various substances, dried with care, and previously cooled to −190° C. by liquid air with the exclusion of atmospheric moisture, were brought in contact with liquid fluorine also at −190° C. No reaction was observed with iodine, oxygen, tellurium, nitrogen, antimony, carbon, silicon, and boron. On the other hand, sulphur, selenium, phosphorus and arsenic catch fire on contact with the liquid, the reaction with calcium oxide and anthracene being still more violent; potassium, after a short time, gives rise to a violent explosion. It is evident, therefore, that even at this low temperature the forces of chemical affinity are not suspended when so energetic an element as fluorine is concerned.

THE additions to the Zoological Society's Gardens during the past week include a Pinche Monkey (*Midas oedipus*) from Colombia, presented by Mr. A. G. Kemp; a Blood-rumped Parrakeet (*Psephotus haematonotus*) from Australia, presented by Mr. B. C. Thomasset; a Sparrow Hawk (*Accipiter nisus*) from Pekin, presented by Mr. W. R. G. Bond; a Moor Monkey (*Semnopithecus maurus*) from Java, ten Olivaceous Lizards (*Lacerta littoralis*, var. *olivacea*) from the Island of Brazza, deposited; a Bactrian Camel (*Camelus bactrianus*), a Mouflon (*Ovis musimon*), a St. Kilda Sheep (*Ovis aries*, var.), five North African Jackals (*Canis lupaster*), born in the gardens.

OUR ASTRONOMICAL COLUMN.

COMET 1902 *d*.—Herr F. Ristenpart gives a daily ephemeris for this comet in No. 3853 of the *Astronomische Nachrichten*. The following is an abstract therefrom:—

12*h*. *M.T. Berlin.*

Date.	α 1903·0 h. m. s.	δ 1903. ° ′ ″	log *r*.	log. Δ	Magnitude
April 10	7 6 22·58	+ 30 37 6·7	0·4447	0·4306	11·76
14	7 11 12·85	+ 31 10 38·1	0·4452	0·4395	
18	7 16 20·11	+ 31 41 34·7	0·4458	0·4482	
22	7 21 43·29	+ 32 9 59·6	0·4465	0·4567	
26	7 27 21·62	+ 32 35 57·0	0·4472	0·4650	
30	7 33 13·88	+ 32 59 29·5	0·4481	0·4731	11·94

An observation made by Herr Millosevich on February 21 gave a correction of −0·91s., −59″·6 to this ephemeris.

COMET 1903 *a*.—The apparent brightness of this comet is now rapidly declining, having reached its maximum value (eighty-two times its brightness when discovered) on March 28. The comet is now too near to the sun in R.A. to be observed, and in any case its great southerly declination would prevent its observation in these latitudes.

An ephemeris published by M. Paul Brück in No. 3851 of the *Astronomische Nachrichten* gives its position for April 13 as α = 0h. 8m. 58s., δ = −41° 5′·6, and its brightness as 36, taking its brightness when discovered as unity.

VARIATION OF SOLAR RADIATION RECEIVED ON THE EARTH'S SURFACE.—In a paper published in No. 11 (1903) of the *Comptes rendus*, M. Henri Dufour discusses a series of observations, extending from October, 1896, to March, 1903, which show that the amounts of the solar radiation recorded during December, 1902, and January, February, and the first half of March, 1903, were considerably below the average amounts received during these months, respectively, for the last seven years.

The observations on which the above statement is based were made at two stations about 20 kilometres apart, and during the whole of the period each set of observations has been recorded by the same observer. The observers have used exactly similar instruments, the actinometers of M. Corva, one of which has been verified by the inventor himself and the other checked by it, and the observations exactly corroborate each other.

The figures obtained for December were so small as not to warrant any conclusive statement as to the decreased insolation, but the figures obtained during January, February and part of March corroborate them, and show that for these three months the insolation, per sq. cm., was 0·11, 0·15 and 0·19 (calories—gramme-degrees—minutes) less than the mean for the same months during the past six years.

M. Dufour seeks to explain this decrease by supposing that the atmosphere at the present time contains some matter which is absorbing an abnormal proportion of the solar radiation, and suggests that the volcanic dust thrown out by Mont Pelée may be the cause.

ANNALS OF THE ROYAL UNIVERSITY OBSERVATORY OF VIENNA.—Vol. xiv. of these *Annals*, edited by Prof. Edmund Weiss, director of the observatory, contains the detailed results of the observations of minor planets and comets made with the 16·2-cm. Fraunhofer refractor during the period from August, 1895, to January, 1899, and with a 67-cm. Grubb refractor and a 38-cm. equatorial coudé during the years 1897 and 1898.

The tables include the details of the observations of the positions and magnitudes of twelve comets (1895 iii. to 1898 x. inclusive), the positions of twenty-nine NGC nebulæ and one new one, and the positions and magnitudes of many minor planets, including those of Eros observed during 1898.

Vol. xvii. of the same *Annals* contains a "dictionary" of B.D. stars, wherein references are given, opposite each star's B.D. number, to all the other catalogues containing details about the star in question.

A VARIABLE, OR TEMPORARY, STAR IN LYRA.—Herr Seeliger, in a communication to the *Astronomische Nachrichten* (No. 3857), describes and gives a chart showing the position of a faint star (10, 1903, Lyræ) which appears on two plates obtained with the 4½-inch telescope of the Munich Observatory by Herr E. Silbernagel on September 2 and 3, 1902. The star in question occupies the position $\alpha = 18h.\ 48m.\ 42s.$, $\delta = +32°\ 39'{\cdot}0$ (1855), and is about 30s. preceding and 12″·0 south of the Ring Nebula; on the two plates mentioned above it was equal in magnitude to two twelfth magnitude stars between which it is situated, but on plates taken on June 28 and December 10, 1902, on which these two stars are plainly visible, it does not appear. Neither is it shown on any one of thirteen plates, showing thirteenth magnitude stars, obtained with a 6-inch telescope on various dates between July, 1895, and July, 1902, nor does it appear on two plates taken with a 16-inch objective on July 10, 1901, and July 19, 1902, although these plates show stars of magnitudes 15 and 13½ respectively.

Prof. Max Wolf obtained two photographs of this region, one on January 14 and the other on February 6, 1903; the first showed images of stars of the thirteenth magnitude, and the second, which had 2h. 10m. exposure, showed much fainter objects, but on neither plate does the star 10, 1903, Lyræ appear.

In an editorial note appended to Herr Seeliger's notice is a communication from Prof. Hartwig, in which he states that he observed the star 10, 1903, Lyræ on the morning of March 8 (May 7, 16·25h., M.T. Bamberg) with a 10-inch refractor, and found it to be of about the fourteenth magnitude, 0·2m. brighter than its nearest neighbour.

THE FORMATION OF DEFINITE FIGURES BY THE DEPOSITION OF DUST.

IT was hardly to be expected that a fine dust when separating out from the air could easily be made to deposit in perfectly sharp, clear, and constant figures, but this is easily done by simply raising the plate, on which the deposit is to take place, a few degrees above that of the surrounding air, and in five to six minutes, in place of a uniform deposit, which would naturally be expected, a perfectly definite figure is formed; the dust will be heaped up in certain places, and in others the plate will be without a trace of deposit upon it. That a plate, bombarded on every side by a thick dust, should be able to compel by means of a very small amount of heat added to it the falling particles to arrange themselves in such definite forms is undoubtedly remarkable.

The active agents in bringing about these results are, no doubt, the currents of air set up round and on the plates, but that their flow should be so regular, so persistent, and so powerful, is more than could have been anticipated. The figures, although very easily formed, are in many cases very complicated, and, notwithstanding the deposit giving a clear and constant record, still at present it remains an unsolved problem how these complicated effects are brought about. Diminished atmospheric pressure does not affect the figures formed.

The material of the plate on which the dust is to settle is not a matter of consequence; it may be of metal, glass, ebonite, india-rubber, or cardboard, and the same figure will be formed, but obviously on some materials the dust will be more visible than on others. A glass plate is probably the best substance on which to receive the deposit, and the best dust to use is that produced by burning magnesium ribbon, for it is brilliantly white, and is readily obtained in any quantity. A glass receiver, or a box of any kind without a lid, will serve as a receptacle for the dust. Light the magnesium and invert the receiver over it, and if sufficient magnesium be used, a dense atmosphere of dust is formed. The plate on which the figure is to form should be raised about an inch above the table on a small support, and then the receiver, filled with the dust, placed over it and left there for six or seven minutes. The plate, previous to placing it in the dust must be warmed; if it be glass, pass it over the flame of a lamp until the moisture, at first condensed on the under side, disappears; other materials may be treated much in the same kind of way, or heated in an air bath. The essential point in order to obtain a good figure is that the plate should be a few degrees, 10° or 15° C., above that of the dust atmosphere. If it be of nearly the same temperature, then the figure is but faint, and the same happens if it be some 100° to 120° above the temperature of the surrounding air, and if of still higher temperature, no deposit of dust takes place.

Suppose now the experiment is made with a square glass plate, treating it as above described; on removing the plate from the dust receiver, most of the dust having subsided, the plate will be found not covered all over with a fine deposit, but a clear and most delicately drawn cross, consisting of four rays, each starting from a corner of the plate and reaching to the centre, is seen. Under the above conditions, the figure is absolutely constant; it may be dense or faint, and it may be slightly distorted by conditions now well known and described, but on a plate of this shape it is always a cross that is formed. The figure starts from the four corners, but vary the form of the plate and you vary the form of the figure deposited on it. The corners being the agents which principally, if not entirely, determine the figure, and in this simplest case a square, it is not difficult to imagine that even the slight heating of the plate is sufficient to start currents of air, which, flowing round the edges of the plate, carry the dust with them, and allow it only to fall where a comparatively still atmosphere exists. In other cases, the flow of the currents seems very difficult to follow, still with such definite and easily produced pictures it may be possible to follow the changes they undergo.

On the square plate, the action of each corner is evident, and this action of corners is still more clearly shown if a plate in the form of an octagon be used (Fig. 1). With a triangular plate, a figure of three limbs is produced, and so on with other shapes, the corners always determine the general figure, and if there be no corners, if the plate be

a circle, no deposit forms. It does not appear as if the composition of the dust used to produce these figures is a matter of importance, the dust from ashes, from ammonium chloride, the fine spores of a fungus, all produce the same figures, but the magnesia produced by burning magnesium is, as before mentioned, more brilliant in colour, and more readily produced than any other dust. There is, however, one essential character necessary in whatever dust is used, namely, that it be very fine.

To obtain these figures perfectly regular in form, care has to be taken that the atmosphere surrounding the plate shall be fairly uniform in temperature. If the reservoir of dust be a glass vessel, and an ordinary Bunsen burner be at a distance of one to two feet from the plate and outside the receiver it is sufficient to spoil the symmetry of the cross by either making one limb of it much thicker than the others or by pushing it more or less on one side. Again, by placing a hot body under the plate while the dust is depositing, curious modifications of the deposit are produced, but require the photographic pictures to show exactly what has taken place. At first this extra heating causes an increase of deposit, but when the temperature rises beyond a certain point, it gradually diminishes the amount of deposit, and if the plate rest on a metal support which is at a temperature of about 150° C., no deposit takes place. In fact, for each different way that the heat is applied a different form of deposit is produced. For instance, if the plate be *not* heated, but is placed on a small metal cylinder which is heated, a remarkable deposit is formed; so again when a hot or cold metal cylinder is placed on the top of the plate instead of below it, curious and complicated figures are formed. When the plate is not exactly horizontal, the figures formed on it are no longer symmetrical, but have the appearance of sliding down the plate. Very remarkable effects are produced on these dust deposits by proximity to the plate of different-sized bodies; for instance, stick up a piece of glass against the plate, and then expose it to the dust. The glass screens the plate from the currents of air formed, and a deposit takes place according to the size of the obstruction. Fig. 2 shows what happens when an ordinary pin is placed with its point on a level with a square plate, and at a distance of 3 mm. from it. The cross is still formed, but the pin has caused a realm of calm from the centre towards the edge of the plate. Again, Fig. 3 shows strikingly the delicacy of this kind of action; the fine deposit ending in a fine point was produced by sticking a human hair vertically against the side of the plate and exposing it to the dust atmosphere.

It is then unnecessary for this pin or post to be in contact with the plate; it may be at a distance of some 8 to 10 mm. from the plate. It may be above the level of the plate, on a level with it, or even below its level, and still influences the deposit of dust. In all cases, as the pin recedes from the plate, so does the deposit recede from the edge, getting smaller and smaller, until at last it disappears at the centre. It is difficult to realise that a pin held so that its point is at 6 mm. below the level of the plate and 2 mm. away from it should be able to induce on the plate a definite and decided deposit, but such is the case. In using glass plates for the figures to deposit on, care must be taken that the edges are quite smooth, for if not, the small pieces forming the rough edge of a cut piece of glass are sufficient to cause spikes of deposit to shoot out from the centre on other parts of the figure.

FIG. 1.

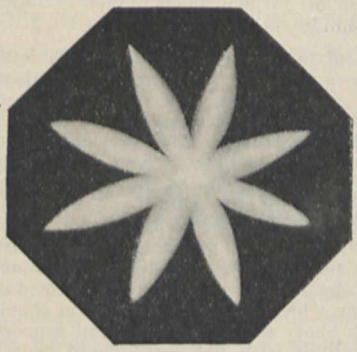


FIG. 2.

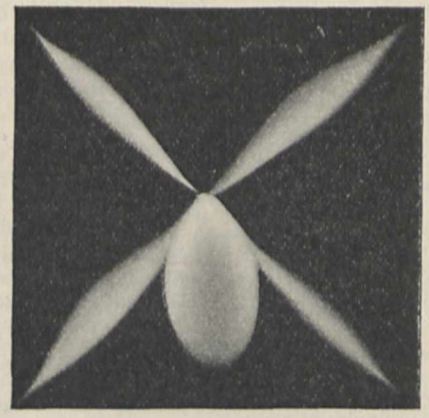


FIG. 3.

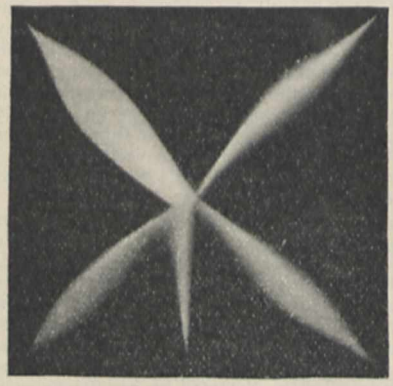
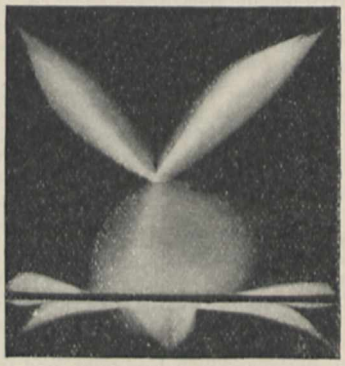


FIG. 4.



There still remains another way of studying the formation of these singular figures and influencing their formation, by offering obstructions to the free deposition of the dust; for instance, if a strip of glass be placed across a square plate, and the strip be not more than 1 mm. high, the deposit takes no notice of it, and the cross forms as if the strip was not there; but increase the height of the strip, make it 4 or 5 mm. high, and the figure becomes much altered, and the form of the deposit is much changed. Again, if the obstruction to the free flowing of the currents be produced by hanging a strip of glass or a point above the plate to receive the deposit, an interesting series of figures is formed, but these cannot be discussed without the illustrations. Fig. 4 may, however, serve to give some idea of the kind of changes which are produced. This represents a square glass plate with a strip of glass some 25 mm. high, and longer than the plate, placed across it, and a pin pressed against it at the middle of the lower side. The influence of the four corners of the plate, of the pin and of the strip are all clearly indicated; also it will be seen that the right hand ray at the top of the picture has two points, the smaller one is produced by some splinter of glass which was very near to the corner. In the full paper to be printed in the *Phil. Transactions*, there are some fifty pictures showing the formation of different figures.

If the fine powder from burning magnesium is used on a glass plate, it is, when first deposited, easily removed by the slightest touch, but if allowed to remain on the glass for some time, say a fortnight, it becomes comparatively fixed there, and may even be lightly rubbed without being removed.

If mercury in a square vessel be used in place of a solid plate, the same figure of a cross forms upon it. If water be used, entirely different figures form, the sinking of the powder gradually through the water producing other changes.

W. J. RUSSELL.

ON THE FORMATION OF BARRIER REEFS AND OF THE DIFFERENT TYPES OF ATOLLS.[1]

THE results here presented are based upon observations carried on during the past twenty-five years in Florida, the Bermudas, Bahamas, Cuba, Jamaica, and the West Indies in the Atlantic. They include in the Pacific the Galapagos, the Hawaiian Islands, the Great Barrier Reef of Australia, the Fiji Islands, and the Coral Reefs and Islands of the tropical Pacific, from the Marquesas to the Paumotus, the Society Islands, the Cook Archipelago, Niue, the Tonga, Ellice, Gilbert, and Marshall Islands, the Carolines and Southern Ladrones, and the Maldives, in the Indian Ocean.

Recognising that Darwin's theory did not explain the conditions observed, my reports were limited to descriptions of the different types of Coral Reefs and of the causes to which they probably owed their formation, and no attempt was made to establish any independent general theory.

Beginning with the Barrier Reefs, we find that those of Fiji, the Hawaiian Islands, and the West Indies usually flank volcanic islands and are underlaid by volcanic rocks. Those of New Caledonia, Australia, Florida, Honduras, and the Bahamas are underlaid by outliers of the adjoining land masses, which crop out as islands and islets in the very outer edge of the Barrier Reefs. Some of the Barrier Reefs of the Society Islands, of Fiji, and of the Carolines, show that the wide and deep lagoons, separating them from the land mass, have been formed by erosion, from a broad fringing reef flat. Encircling reefs, such as characterise especially the Society Islands, hold to their central island or islands the same relation which a Barrier Reef holds to the adjoining land mass. Denudation and submarine erosion fully account for the formation of platforms upon which coral reefs and other limestone organisms may build, either barrier or encircling reefs, or even atolls, rising upon a volcanic base, of which the central mass may have disappeared as in Fiji, the Society and Caroline Islands.

We may next take the type of elevated islands of the Paumotus, the Fiji, the Gilbert, and the Ladrones, many composed only of Tertiary limestones, others partly of limestone, and partly volcanic. We can follow the changes from an elevated island, like Niue, or Makatea in the Paumotus, to an island like Niau, through a stage like Rangiroa to that of the great majority of the atolls in the Paumotus. The reef-flats and outer reefs flanking elevated islands hold peculiar relation to them; they are partly those of Barrier Reef and partly of Fringing Reef. We may also trace the passage of elevated plateaux like Tonga, Guam, and islands in Fiji, partly volcanic and partly limestone, to atolls where only a small islet or a larger island of either limestone or volcanic rock is left to indicate its origin. Atolls may also be formed upon the denuded rim of a volcanic crater as at Totoya and Thombia in Fiji, as well as in some of the volcanoes east of Tonga.

In the Ellice and Marshall group and the Line Islands, are a number of atolls, the underlying base of which is not known and where we can only follow the formation of the land rim of the atoll, as far as it is due to the agency of the trades or of the monsoons in constantly shifting the superficial material (prepared by boring organisms) which goes to form its rim. Many of the atolls in the Pacific are merely shallow sinks, formed by high sandbanks, thrown up around a central area.

Throughout the Pacific, the Indian Ocean, and the West Indies the most positive evidence exists of a moderate, recent elevation of the coral reefs. This is shown by the horses, pinnacles, and undermined masses of modern or Tertiary limestone left to attest it. The existence of honeycombed pinnacles of limestone within the lagoons of atolls, as shoals, islands, or islets, shows the extent of the solvent action of the sea upon land areas, having formerly a great extension than at the present day. Signs of this solvent action are to be seen everywhere among coral reefs. Atmospheric denudation has played an important part in reducing elevated limestone islands to the level of the sea by riddling them with caverns and by forming extensive sinks, often taken to be elevated lagoons.

[1] By Alexander Agassiz, For. Mem. R.S. Read at the Royal Society, March 19.

Closed atolls can hardly be said to exist; Niau in the Paumotus is the nearest approach to one, yet its shallow lagoon is fed by the sea through its porous ring. Sea water may pass freely into a lagoon at low tide over extensive shallow reef flats where there are no boat passages. The land area of an atoll is relatively small compared to that of the half-submerged reef flats. This is specially the case in the Marshall Islands and the Maldives where land areas are reduced to a minimum.

The Maldivian plateau with its thousands of small atolls, rings, or lagoon reefs, rising from a depth varying from twenty to thirty fathoms is overwhelming testimony that atolls may rise from a plateau of suitable depth, wherever and however it may have been formed and whatever may be its geological structure. On the Yucatan plateau similar conditions exist regarding the formation of atolls, only on a most limited scale.

The great coral reef regions are within the limits of the trades and monsoons and areas of elevation, with the exception of the Ellice and Marshall Islands and some of the Line Islands. The extent of the elevation is shown by the terraces of the elevated islands of the Paumotus, Fiji, Tonga, Ladrones, Gilbert, and West Indies, or by the lines of cliff caverns indicating levels of marine erosion.

In the regions I have examined the modern reef rock is of very moderate thickness, within the limits of depth at which reef builders begin to grow and within which the land rims of atolls or of Barrier Reefs are affected by mechanical causes. This does not affect the existence of solitary deep sea corals, of extensive growths of Oculina or Lophohelia at great depths, or in any way challenge the formation of thick beds of coraliferous limestone during periods of subsidence.

The Marquesas, Galapagos, and a few islands in the Society and West Indies have no corals, although they are within the limits of coral areas. Their absence is due to the steepness of their shores and to the absence or crumbling nature of their submarine platforms. Coral reefs also cannot grow off the steep cliff faces of elevated, coraliferous limestone islands.

Corals take their fullest development on the sea faces of reefs; they grow sparingly in lagoons where coralline algæ grow most luxuriantly. Nullipores and corallines form an important part of the reef-building material.

UNDERGROUND WATERS.

"THE Motions of Underground Waters" is the title of an essay by Mr. Charles S. Slichter, and it is issued as No. 67 of the Water Supply and Irrigation Papers of the United States Geological Survey. The author, in the first place, discusses the origin and extent of underground waters, remarking that these are included only in the zone of saturated rocks, the surface of which is known as the *water table* or *water plane*. The lowest depth at which ground waters can exist is regarded as approximately six miles. The region above this limit is distinguished as the zone of fracture, for in it pressures and stresses result in the breaking of the rocks. Below, all cavities and pores in the rock are completely closed. The amount of ground water within the crust of the earth is estimated to be nearly one-third the amount of the oceanic water, and to be sufficient to cover the entire surface of the earth to a uniform depth of from 3000 to 3500 feet. But these "waters under the earth" are, of course, only recoverable in useful quantities at limited depths; even the thermal springs arise from a level much above the geologic limit of depth.

Attention is directed to the fact that water is found in notable quantities in crevices of schists and gneisses, as in the St. Gothard tunnel; but the greater part met with in rocks is stored up in the minute pores and openings between the rock particles themselves, in sands, sandstones and limestones, in clay loams, while even the strongest rocks, such as the Montello granite, are measurably porous.

The author then discusses the cause and rate of movement of water through the strata, according to the size of the pores, the pressure and the temperature, the flow being noticeably greater for high than for low temperatures. This subject is illustrated by microscopic sections of rocks,

and the author then passes on to the laws of flow, as determined by the length, shape and number of the openings between particles. In the mechanical analysis of soils, the mean diameter of the grains is known as the *effective size*, and is such that if all grains were of that diameter, the soil would have the same transmission capacity that it actually has. The effective size is determined from the dimensions of the mesh of a sieve which will permit 10 per cent. of the sample to pass through it, but will retain the other 90 per cent. That is, in any soil, 10 per cent. of the grains are smaller than the effective size and 90 per cent. are larger. It is remarked that the velocity of flow through porous strata is much less than might at first be supposed. In the sands of the Dakota formation, from which remarkable artesian wells draw their supply, the flow does not exceed a mile or two a year.

Underground waters are divided into three principal zones:—(1) The unsaturated zone, (2) the surface zone of flow, and (3) the deeper zones of flow. The motion of water in the unsaturated zone is essentially vertical—downward in supplying the saturated sheet below, and upward in supplying the surface evaporation and the requirements of vegetation by means of the capillary action of the soil during rainless periods.

The surface or upper zone of flow extends from the level of the water table to the first impervious rock floor. The deeper zones of flow are those that lie below the first impervious stratum, and the direction and character of the

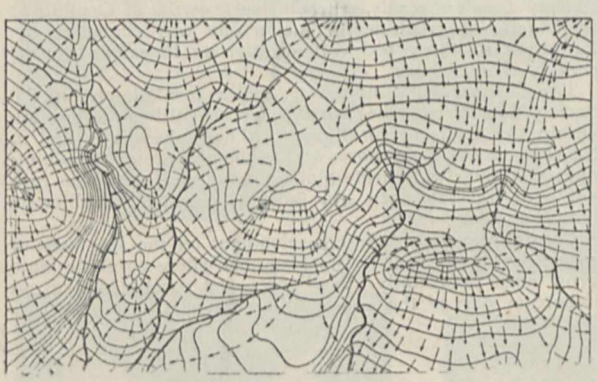


FIG. 1.—Contour Map showing position of water table (continuous lines), supposed lines of motion of ground water (arrowed lines), and the thalwegs or drainage lines (heavy lines).

flow are usually quite independent of the surface topography, being controlled by large regional and geologic conditions.

The author points out that the unit of the surface zone of flow of ground waters is the river valley, and the rate and direction of motion conform primarily to the slopes and grades of the land surface. The underground flow, in fact, follows the trend and direction of the surface drainage. The water table has a slope which is essentially similar to the slope of the surface of the ground, though less steep. The motion of the underground seepage into the streams and rivers is similar to the lines followed by the surface drainage into the same streams.

The lowest line of drainage of the valley is known technically as the *thalweg*. Topographically, it is a line upon a contour map which is a natural water-course (Fig. 1). Beneath the thalweg there is usually a similar drainage line for the underground current, in general coincident with the thalweg. For other parts of the valley the actual lines of motion of the underground water are represented by a set of curves which cut the contour lines of the water table at right angles. The similarity of the contours of the water table to those of the land surface enables one to sketch approximately the lines of underground seepage from a contour map of the surface. For the most part the lines of flow run into the surface streams or thalwegs, but between A and B, and X and Y, there is indication of an underflow or general movement in the direction of the surface streams and independent of the same.

These views are worthy of attentive consideration and study in connection with the geological structure, for, as the author justly remarks, they must not be taken too literally. The surface topography is only one, and often not the most important, element in the control of the underground current. He points out how irregularities in the form of the first impervious layer and the amount of rainfall will influence the distribution and motion of the ground water. He directs attention also to the fact that much ground water returns to the surface in the form of seepage which is more important, though less obvious, than the springs. Much ground water, moreover, may not find its way immediately into open channels, but may even take a general course down the thalweg and flow through coarse materials toward the sea in large underground streams or moving sheets of water. This underflow is well known in the Great Plains of America, although the movement is excessively slow. Sometimes the underflows appear to be independent of the surface streams, as indicated by chemical analyses.

The deep zones of flow and artesian wells are finally discussed by the author; he deals also with common dug wells and the influence of pumping on contiguous wells, as well as the mutual interference of artesian wells. H. B. W.

LONDON FOG INQUIRY, 1901–02.[1]

IN November, 1901, the Meteorological Council appointed Captain Carpenter, R.N., D.S.O., a member of the council of the Royal Meteorological Society, to conduct an inquiry into the occurrence and distribution of fog in London, initiated, with the assistance of a grant from the County Council, in response to requests for more detailed forecasts of the occurrence of fog. Captain Carpenter at once put himself into communication with Captain Wells, R.N., the chief officer of the Metropolitan Fire Brigade, and made arrangements for the systematic observation of fogs at some of the river stations and at other stations of the Metropolitan Fire Brigade. He also arranged for supplementary observations to be taken at certain of the Metropolitan Police stations, at Battersea Park and Regent's Park, at a number of coast-guard stations in the Thames estuary, and by one or two private persons. Observations of temperature and other meteorological conditions were obtained from a number of the stations and from the parks; self-recording thermometers were installed on the Victoria Tower at Westminster, the Golden Gallery at St. Paul's, on the roof of the Meteorological Office and at a private house at Banstead. Regular records of fog in accordance with a conventional scale distinguishing the kind and intensity of the fog were thus obtained from a series of points in or round London. By arrangement with Captain Wells, special observations were made during fog or when fog was anticipated by the forecast branch of the Meteorological Office.

Attention may be called to the following points in Captain Carpenter's report, which is now issued:—

(1) The first result of the inquiry is the suggestion of a scale of fog intensity, arranged according to the interference with traffic upon road, rail, river, or sea, and represented by the serial numbers 0 to 5.

(2) Next it appears that on account of smoke the extreme limit of visibility in winter from an elevated position in London, in most favourable circumstances, is set at 1½ miles. That limit is diminished as the tendency to form fog is developed until the well-known effects of dense fog are reached.

(3) No evidence has been obtained of any special connection between fogs and geological conditions.

(4) The commencement of a fog is not identified with any particular locality; it seems to be a general process depending upon general atmospheric conditions. There is no evidence that fogs formed outside invade or drift into London. The London fogs are produced in London; they do not come from the country.

(5) The meteorological conditions for the formation of fog are set forth and illustrated by charts and diagrams. An interesting point brought out is a tendency to indraught

[1] Report to the Meteorological Council by Captain Alfred Carpenter, R.N., D.S.O.

of air from all sides to the central parts of London during dense fogs.

(6) No severe fog occurred with an air temperature above 40° F. The minimum air temperature prior to fog coming on averaged 9° below the normal mean temperature for the day. The relation between the occurrence of fog and the minimum temperature in November and December, 1901, is shown in Fig. 1.

(7) During the period of observations, in twenty-two cases out of twenty-five during the nights preceding days of fog, a thermometer on the grass at Regent's Park fell much below the river temperature, the amounts of difference on these occasions varying from 6° to 25° F.

Attention is called to one point of special importance in connection with temperature observations, which requires to be followed up. On March 7, during fog, the temperature in the streets of London was nearly 10° F. below that on the roof of the Meteorological Office, the elevated stations, and the surrounding country on the southern and western sides.

The outstanding parts of the inquiry are :—

(1) To ascertain whether the proposed scale of classification of fogs puts the observations of locality upon a more satisfactory footing, and whether additional observations throw any further light on local distribution.

(2) The further investigation of temperature conditions, including temperature observations in the early morning (5 a.m.), and vertical distribution of temperature.

With regard to the last point, we learn that an opportunity was recently afforded for determining the conditions

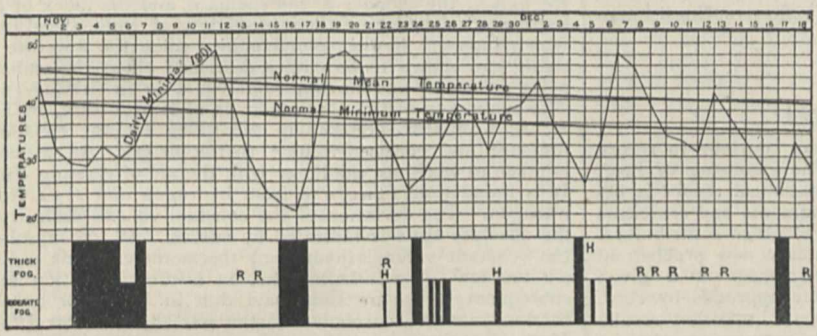


FIG. 1.—Part of diagram showing the occurrence and duration of fog in London and the daily minimum of temperature at Kew. H signifies "high fog," R a rainfall of 0·05 inch or more.

under which such investigation could be carried out in London by the loan of a captive balloon and self-recording instruments. Captain Carpenter was himself unable, on account of his health, to continue the conduct of the inquiry beyond the close of the winter of 1901–2. The conclusions drawn in his report are based exclusively upon observations during that period, and are expressly subject to possible revision in the light of further observations. At his suggestion the observations were recommenced in September, 1902, and have been continued during the winter; they include a number of special observations of temperature at 5 a.m. The continuation of the inquiry has been under the superintendence of Mr. R. G. K. Lempfert, of the Meteorological Office.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

THE annual exhibition of scholars' work from the Board Schools of London will be held at the Examination Hall, Victoria Embankment, W.C. (adjoining Waterloo Bridge), on Saturday, May 9, and on the following Monday, Tuesday and Wednesday (May 11–13). The exhibition will be opened by Lord Reay (chairman of the Board), and will include among the exhibits specimens of modelling, science apparatus and metal-work from the day and evening schools, and also work from the schools for the blind, deaf, special instruction, truant, and industrial schools.

THE council of Owens College, Manchester, has, under a scheme of the Board of Education, resolved to establish a scholarship and exhibition in zoology and botany out of the accumulations of the Robert Platt fund, which has hitherto been applied only to physiology. The scholarship will be of the yearly value of 50*l*., will be open for competition to persons who have studied zoology or botany in any university or college laboratory, and will be awarded to the candidate who shows most promise and ability for the prosecution of research in zoology or botany.

AN interesting ceremony took place at the gardens of the Royal Botanic Society on Wednesday, April 1. The Earl of Aberdeen presided, and Mr. Alfred James Shepheard, chairman of the Technical Education Board of the London County Council, declared the newly erected laboratory open for botanical and horticultural work. Instruction on the lines of the syllabus of the Board of Education will be given in botany, and attention will also be paid to horticultural chemistry, elementary and advanced, in connection with the practical gardening school. Other classes will, if necessary, be carried on and research work undertaken. The school of which the laboratory is the outcome was, as Dr. C. Adams pointed out at the opening ceremony, started five years ago with nine students; now there are thirty-five—of whom twenty-one are boys and fourteen girls. Some 2000*l*. has been spent over the undertaking, of which the Technical Education Board has provided 850*l*. The work has been very successful, and no difficulty has been found in obtaining appointments for the students who have been through the three years' course. Mr. Shepheard in his speech pointed out that to endeavour to grow plants with only practical knowledge was like attempting to cure the sick after the fashion of a quack doctor, without having mastered the science of medicine. Miss Shepheard presented diplomas to successful students at the school, and Dr. Kimmins, Dr. Garnett and Mr. Brinsley Marlay also spoke. The Royal Botanic Society is decidedly to be congratulated upon adding theoretical instruction to the practical teaching already carried on, though it seems advisable that the special principles underlying horticultural practice should figure in the syllabus as well as pure botany.

THE Education Bill for London was introduced in the House of Commons on Tuesday. It is proposed to make the London County Council the education authority, so that the London School Board will disappear. The new education committee will contain ninety-seven members, this total being made up as follows :—Representatives of the borough councils—one for each borough and two each for Westminster and the City of London—31; London County Council, 36; representatives (including women) of various secondary schools, the University of London, technical institutions and bodies contributing to the maintenance of education, 25; and (for the first five years) representatives of the London School Board, 5—total 97. The object of the Bill is thus to abolish the School Board, and to link education in London with municipal government. The County Council, as the education authority, is to have the rating powers of a county borough under the Education Act of 1902. The management of public elementary schools is to be entrusted to the borough councils, subject to the general direction of the education authority, which is to have complete financial control. The borough councils are to have the right to appoint and dismiss teachers, the custody of the buildings, and the right to select the sites for new schools in their prescribed areas. These powers, however, do not apply to secondary schools and technical institutions.

A BIRMINGHAM correspondent describes in the *Times* for April 2 the four great German commercial high schools, those namely at Aachen, Cologne, Frankfurt, and Leipzig. There is a special appropriateness just now about such a

study, since during the present period of organisation and development at the University of Birmingham it is of importance that those responsible for its new commercial department should be intimate with German experience. It is not sufficiently remembered, the writer of the article insists, that these German institutions are new and in an experimental stage, that they are characterised by great diversity of organisation, and are the outcome, not of Governmental initiative, but of the demands of the commercial classes; in most cases, indeed, their financial basis was provided by private generosity and municipal support, not by grants from the State. At Aachen, where the commercial "course" is simply a department of the technical college, the authorities abide by the general rule for admission to universities and technical colleges, and refuse to receive into full membership any who have not passed the leaving examination of the Gymnasia, Realgymnasia, or Ober-realschulen. In most cases the certificate is not secured until nineteen. The three other institutions admit men who have left school three years earlier (with the certificate shortening their military service to one year), on condition that they have spent the three following years in an apprenticeship or in some definite business experience. At present the Aachen plan is hardly practicable, and tends to restrict the numbers. "The German movement is," the article shows, "full of interest and instruction for foreign observers. Its ideals are rising; and the two years which form the present period of study are already beginning to seem inadequate. There are grave difficulties to be met; but an amount of ardour, of ability of a high order, and, what is not unimportant, of money also, is being devoted to the task, which ought to sting a reflective Englishman with a sense of shame."

SCIENTIFIC SERIAL.

Biometrika.—The last three numbers continue to record results of high biological interest. The excellence of Prof. Karl Pearson's elaborate studies in statistical theory is becoming widely recognised, and his comments and criticisms add much to the value of the work of other contributors. In vol. i. part iv. Mr. F. Galton states a new problem in the variation of a population with respect to a given character, which, generalised in a note appended by Prof. K. Pearson, is seen to be likely to have important results in statistical inquiry.—The same part contains an attempt by Dr. J. Y. Simpson, good as far as it goes, to demonstrate the inequality of results in the binary fission of the Protozoa. Dr. Simpson's conclusions so far recall those of Maupas, but the difficulties in the way of a successful investigation of this problem are extreme, and it cannot be said that he has met every possible objection. The inquiry is obviously of importance for the general theory of variation, and it is to be hoped that in spite of their difficulty the observations will be continued.—The thorough-going study of the Naqada crania carried out by Miss Fawcett with the help of Miss Alice Lee and other biometric students at University College occupies the bulk of the present issue, and the part concludes with a careful research, by C. Hengsen, on the variations of *Helix nemoralis*.—The subject of gasteropod shells (*Nassa obsoleta* and *N. trivittata*) also finds a place in the opening part of vol. ii., in which number will likewise be found Prof. Weldon's strictures on the ambiguity of some of Mendel's categories, *e.g.* "green" and "yellow" as applied to the cotyledons of peas.—The co-operative paper on inheritance in the Shirley poppy marks another long step towards the establishment of a working theory of heredity, the results reached being in general accordance with Galton's law.—Among the "Miscellanea" may be noted Mr. Whitehead's paper on variation in *Adoxa moschatellina*, and the first instalment of what promises to be a most important series of test experiments, by Mr. Darbishire, in the Mendelian theory of heredity. Japanese "waltzing mice," the colour of the coats of which is white with patches of pale fawn, were crossed with European albinos, the hybrids being crossed *inter se* and also with the albino parent stock. These experiments, some later results of which are recorded and discussed in vol. ii. part ii., have yielded data which are by no means easy of interpretation, and their further outcome will be awaited with keen interest. One remarkable result is that every hybrid of the first generation was dark-eyed, though the eyes of all the parents were pink. In a certain proportion, however, of the progeny of the first hybrids the pink eyes reappeared, as did some other parental characters. A recent letter in NATURE shows that Mr. Bateson, at all events, is not disposed to admit that the facts so far obtained are discordant with Mendel's law, but it must be allowed that much of the evidence is *primâ facie* in favour of ancestral inheritance.

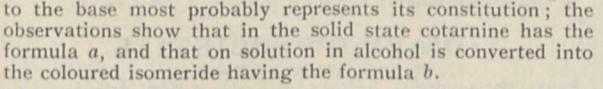
SOCIETIES AND ACADEMIES.

LONDON.

Physical Society, March 27.—Dr. R. T. Glazebrook, F.R.S., president, in the chair.—On refraction at a cylindrical surface, by Mr. A. **Whitwell.** The object of the paper is to describe and illustrate the position and form of the focal areas produced by the refraction, at a cylindrical surface, of light diverging from or converging to a point. In general, if a plane can be drawn through the point to cut the surface symmetrically, then all the light passes really or virtually through an area in this plane. In the case of the cylinder there are two such planes. One contains the radiant point and the axis of the cylinder, the other contains the point, and is normal to the axis. The equation of the locus of intersections of symmetrical rays which intersect in the first plane, for small apertures, is obtained in terms of the distance of the radiant point from the axis of the cylinder a, the radius r, and the index of refraction μ. The loci of the intersections of symmetrical rays which intersect in the second plane, when the aperture is small, are shown to be circles described about the radiant point as centre and having radii equal to $(\mu-1)(a-r)$.—The evaluation of the absolute scale of temperature, by Dr. R. A. **Lehfeldt.** Formulæ are given for the constant-pressure and constant-volume thermometers. An attempt is made to work out the latter with the aid of existing data. It is found that $T_0=273{\cdot}18$ from hydrogen and 273·2 from nitrogen. The deviation of the constant-volume scale from the absolute scale is indicated by curves. At 100° absolute the constant volume (hydrogen) thermometer reads 0·1 or 0·2 too low.—Prof. **Callendar,** in a communication sent subsequent to the meeting, said that in his paper on the thermodynamical correction of the gas thermometer (*Phil. Mag.*, January) he had incidentally mentioned that the correction for the constant-volume gas thermometer could not be directly deduced from the Joule-Thomson cooling-effect alone, without additional data, unless a formula were assumed for the variation of the cooling-effect with temperature; but that the value of the absolute zero could be deduced from the pressure coefficient if the Joule cooling-effect in free expansion were known. The experimental measurement of the latter was, however, impracticable.—Mr. **Blakesley** exhibited and described a lens possessing the following properties:—The two conjugate foci always move with the same relative rate along the axis. The size of the object always bears to the size of the image the same ratio, so that using the same object the image is always of the same size. The instrument is of one piece of glass, and constitutes a telescope the magnifying power of which is the ratio which the object bears to the image in size, linear. The relation of the rate of motion of the object to that of the image is the square of the magnifying power.

Chemical Society, March 18.—Prof. J. Emerson Reynolds F.R.S., president, in the chair.—The following papers were read:—Essential oil of hops, by Mr. A. C. **Chapman.** This oil consists principally of two terpenes, one being identical with that present in oil of bay, and named by its discoverers myrcene, and the second a sesquiterpene, which has been named humulene; there are present in addition to the foregoing small quantities of the odoriferous alcohols linalool and geraniol, the latter being present in the form of its isononoic ester.—A compound of dextrose with aluminium hydroxide, by Mr. A. C. **Chapman.** When dextrose dissolved in alcohol is treated with aluminium chloride there separates a white amorphous compound of the formula $3C_6H_{12}O_6,5Al_2O_3,11H_2O$.—Action of phosphorus haloids on dihydroresorcins. ii. Dihydroresorcin,

by Messrs. **Crossley** and **Haas.** A description of the derivatives obtained by the action of phosphorus tri- and pentachlorides on dihydroresorcinol.—The constitution of cotarnine, by Messrs. **Dobbie, Lauder** and **Tinkler.** The authors have examined the ultra-violet absorption spectra of solutions of this alkaloidal derivative in various solvents in order to ascertain which of the three formulæ assigned to the base most probably represents its constitution; the observations show that in the solid state cotarnine has the formula *a*, and that on solution in alcohol is converted into the coloured isomeride having the formula *b*.



—Decomposition of mercurous nitrite by heat, by Dr. P. C. **Ray** and Mr. J. N. **Sen.** The products of this reaction are mercuric nitrate, metallic mercury, nitric oxide and peroxide. —The action of nitrogen tetroxide on pyridine, by Mr. J. F. **Spencer.** The first product of this reaction is a molecular additive compound, but eventually there is formed a yellow substance of the composition $(C_5H_4O_2N_2)_4$, and a purple product of still more complex constitution.

Entomological Society, March 18.—Prof. E. B. Poulton, F.R.S., president, in the chair.—The Rev. F. D. **Morice** exhibited with drawings a dissected gynandromorphous specimen of a bee (*Osmia fulviventris*, Panz.).—Mr. A. **Bacot** exhibited a number of specimens of *Malacosoma neustria* × *castrensis* in various stages, including a series of six ♂ ♂ and sixteen ♀ ♀ imagines reared during 1902 from one batch of ova laid by a ♀ Castrensis, which had been mated with a ♂ Neustria, and two ♀ ♀ reared from another batch of ova the result of a similar cross; also blown larvæ of hybrid parentage, and twigs showing attempts at ovipositing on the part of ♀ ♀ hybrids that had paired with hybrid ♂ ♂ of the same brood; also a series of *M. Neustria, M. Castrensis* and the hybrid moths reared during 1901 for comparison.—Mr. H. St. J. **Donisthorpe** exhibited specimens of *Trimium brevicorne*, Reich., from Chiddingfold, Surrey, an unusually southern locality for this species.—Mr. C. P. **Pickett** exhibited specimens of *Hybernia leucophaearia* and *Phigalia pedaria* taken at Chingford on February 14, and ova of *Endromis versicolora* on birch twigs, laid March 16. —Mr. G. C. **Champion** exhibited a long series of specimens of a species of *Cneorrhinus* (*? pyriformis*) from Piedrahita, Spain, and called attention to the great dissimilarity between the sexes, and also to the possibility of the females being dimorphic, one form clothed with green scales, and the other with grey scales like the male. He also exhibited *Dorcadion dejeani*, Chevr., from the Sierra de Bejar, a species peculiar to that district.—Mr. R. **McLachlan,** F.R.S., exhibited a dragonfly belonging to a small species of the genus Orthetrum, attacked by a fly almost as large as itself of the family Asilidæ, taken in Persia in June, 1902, by Mr. H. F. Witherby. The fly had inserted its proboscis at the junction of the head and prothorax, a vulnerable point. He also exhibited a female specimen of a large Æschnid dragonfly, *Hemianax ephippiger*, Burm., captured in a street at Devonport on February 24. The species occasionally visits Europe in migratory swarms or sporadically, but is especially African, and its presence at Devonport in February might probably be due to the example having flown on board a vessel off the African coast. Mr. F. Merrifield suggested that there might be some connection between the appearance of the insect in England and the reported showers of fine dust which are generally supposed to have come from the Sahara.—Prof. E. B. **Poulton,** F.R.S., exhibited seasonal forms of *Precis antilope*, parent and offspring, bred by Mr. G. A. K. Marshall in South Africa, and *Precis coelestina*, from the Victoria Nyanza region, with the dry-season form of that species, now taken probably for the first time.—Mr. W. J. **Lucas** exhibited with the lantern a slide showing the larva of *Cossus ligniperda* in its gallery in a tree trunk.—Dr. T. A. **Chapman** exhibited with the lantern a series of slides illustrating the life-history of *Liphyra brassolis*, Westw., a Queensland species, the larva of which lives in ants' nests, and feeds upon the ant-larvæ. The imago on emergence from the pupa is clothed with scales highly distasteful to the ant, which protect it during emergence from attack, and until such time as it is able to fly, when they drop off.—Mr. G. C. **Champion** read a paper on an Entomological Excursion to Bejar, Central Spain.—Dr. F. A. **Dixey** read a paper, illustrated by lantern slides, on Lepidoptera from the White Nile, collected by Mr. W. L. S. Loat; with further notes on seasonal dimorphism in butterflies.—Mr. E. **Saunders,** F.R.S., communicated a paper on Hymenoptera Aculeata collected by the Rev. A. E. Eaton in Madeira and Teneriffe, in the spring of 1902.

Royal Microscopical Society, March 18.—Dr. H. Woodward, F.R.S., in the chair.—Mr. J. W. **Gordon** gave an account of his paper on the Helmholtz theory of the microscope, which contained a rough sketch of the theory of diffraction, and considered this from a new point of view, expanding the Helmholtz theory from this position. The paper then dealt with the Helmholtz theory, starting with the proof of the sine law as given by Helmholtz. Having proved the sine law, Helmholtz made deductions from it, and drew the inference that the resolving power of the most perfect optical system must necessarily stop short at an object which was less than half a wave-length of the light by which its observation was attempted. Mr. Gordon then proceeded to set out the points of his own paper, including a description of some vibrating screens by the aid of which the definition of high powers was much improved, when the image was greatly super-amplified by eye-piece magnification.

Linnean Society, March 19.—Prof. S. H. Vines, F.R.S., president, in the chair.—Mr. Clement Reid exhibited drawings by Mrs. **Reid** of fruits and seeds of British pre-Glacial and inter-Glacial plants (Thalamifloræ). In each case the specimens illustrated were the earliest known representatives of the species. Most of the plants are still living in Britain; but among the Thalamifloræ from the Cromer Forest-bed occur seeds of Hypecoum, a genus specially characteristic of the Mediterranean region, and no longer found living nearer than Southern France. The fossil seeds correspond closely with the living *Hypecoum pendulum* of Southern France, and either belong to that species or to a closely-allied extinct form. The seeds of all the species of Hypecoum are covered by a curious close mosaic of cubic crystals, apparently calcium oxalate, which fill square pits in the surface of the testa. Traces of these pits are still found on some of the fossil seeds.—Mr. G. Claridge **Druce** read a paper on *Poa laxa* and *Poa stricta* of our British floras. For some years past, doubts have been expressed by critical botanists as to the correct naming of these two plants. The author's conclusions are, that the plants named *Poa alpina*, var. *acutifolia*, and *P. laxa*, var. *scotica*, have been misunderstood and variously named; he therefore gives detailed descriptions of these two plants, with synonymy so far as British floras are concerned. The paper was illustrated by specimens from the author's herbarium, and the type-specimen of *Poa flexuosa* from Smith's herbarium.—The botany of the Ceylon patanas, part ii., by Messrs. J. **Parkin** and H. H. W. **Pearson.** In a former paper on the same subject (Pearson, *Journ.* Linn. Soc. Bot., vol. xxxiv. 1899, pp. 300–365) the main features of these grassy uplands, locally known as "patanas," were given, the probable causes which have led to their development discussed, and the general biological characters of their flora described. An account of the anatomical examination of the plants collected was promised for a separate paper; this communication is the fulfilment of the promise.

PARIS.

Academy of Sciences, March 30.—M. Albert Gaudry in the chair.—On affinity at low temperatures; the reactions of liquid fluorine at −187° C., by MM. H. **Moissan** and J. **Dewar** (see p. 544).—On the alkyl- and acyl-cyanocamphors and the alkylcamphocarbonic esters. The influence of the double linkage of the ring containing asymmetric carbon on the rotatory power of the molecule, by M. A. **Haller.** The enolic and ketonic forms are simultaneously produced in the formation of derivatives of cyanocamphor, which are distinguished by their behaviour on treatment with hydrochloric acid. Measurements of the rotatory power showed that higher values were always given by the enolic forms than with the ketonic forms.—Problems in biological energetics, raised by a note of Lord Kelvin on the regulation of the

temperature of warm blooded animals. The permanence of the processes producing heat of combustion, by M. A. **Chauveau.** In searching for a means of explanation of the constancy of temperature of an animal when placed in a medium at a higher temperature than the normal, the suggestions of Lord Kelvin are subjected to an experimental examination; it was found that under the experimental conditions of Crawford, venous blood is neither poorer in carbonic acid nor richer in oxygen; the expired air under the same conditions contains practically the normal amounts of oxygen and carbonic acid. There is thus no reason to suppose the existence of endothermic reactions in animals placed in a medium warmer than their normal temperature.—Remarks by M. Edmond **Perrier** on a work on embryogenic acceleration.—Prof. Ray **Lankester** communicated to the Academy two drawings of the head of a gigantic mammal recently discovered in the Upper Eocene Sands at Fayum, Egypt.—M. de Forcrand was nominated a correspondant in the section of chemistry in the place of the late M. Reboul.—On an eruption of the volcano at St. Vincent, by M. A. **Lacroix.**—On a mechanical calculator called the arithmograph, by M. **Troncet.**—On the absolute temperature deduced from the normal thermometer, by M. H. **Pellat.** As a first approximation, it is shown that the usual formula for the absolute temperature gives results about 0·11° C. too low.—The action of hydrogen on the sulphides of arsenic in presence of antimony, and on the trisulphide of antimony in the presence of arsenic, by M. H. **Pelabon.** Antimony completely displaces arsenic in its sulphides if the two bodies are in the liquid state. Hydrogen gas, heated in presence of sulphide of antimony and a mixture of arsenic and antimony, forms hydrogen sulphide, the proportion of which increases with that of the arsenic in the mixture.—On pyrophosphorous acid, by M. V. **Auger.** Crystals of pyrophosphorous acid can be obtained by shaking together for some time a mixture of phosphorous acid with an excess of phosphorus trichloride.—On the action of phosgene on the organo-magnesium compounds, by M. V. **Grignard.** Either a symmetrical ketone or a tertiary alcohol can be obtained, according to the experimental conditions.—New researches on the decomposition of organic acids, by MM. Oechsner **de Coninck** and **Raynaud.** Various organic acids have been heated with strong sulphuric acid and with glycerol, and the conditions under which carbon monoxide and dioxide are given off have been determined.—The constitution of the nitrocelluloses, by M. Léo **Vignon.** The nitrocelluloses, reduced in acid solution by ferrous chloride, give oxycellulose. This reaction clearly differentiates cellulose from mannite and other polyatomic alcohols which have been previously studied from the point of view of nitration.—On the nitrogen compounds contained in arable earth, by M. G. **André.**—Remarks on the general morphology of the muscles, by M. J. **Chaine.**—On the fishes of the family of Atherina in Western Europe, and on the connection between their species, by M. Louis **Roule.**—The structure of the rootlets in *Trapa natans*, by M. C. **Queva.**—On the problematic bodies and the Algæ of the Trias in Lorraine, by M. P. **Fliche.**—The defence of the organism in the newly-born, by MM. A. **Charrin** and G. **Delamare.**—On the influence of the chemical state under which an element is presented to an organism on the rapidity of the passage of this element through the blood, by M. A. **Mouneyrat.**—On a law of decrease of effort as given by the ergograph, by M. Charles **Henry** and Mdlle. J. **Joteyko.**—Biot's hypothesis on the height of the atmosphere, by W. **de Fonvielle.** From the consideration of the fall of temperature as the distance from the surface of the earth is increased, there would appear to be a sharp limit to the possible height of the truly gaseous atmosphere.

GÖTTINGEN.

Royal Society of Sciences.—The *Nachrichten* (physico-mathematical section), No. 6 for 1902, and No. 1 for 1903, contain the following memoirs communicated to the Society:—

November 29, 1902.—C. **Jacobj**: On the pharmacological action of the cyclic isoximes.

July 26.—V. **Cuomo**: Measurements of electric dissipation in the open air at Capri (March–September).

January 24, 1903.—E. **Riecke**: Contributions to the theory of atmospheric electricity. (1) On the dissipation of electricity in enclosed spaces.

January 10.—W. **Voigt**: On the magnetic induction of regular crystals.—A. **Schœnflies**: On the proof of a fundamental theorem in the theory of point-aggregates.

February 6.—E. **Riecke**: Contributions to the theory of atmospheric electricity. (2) On the dissipation of electricity in uniformly moving air.

DIARY OF SOCIETIES.

WEDNESDAY, APRIL 15.

ROYAL MICROSCOPICAL SOCIETY, at 8.—On a New Method of Using the Electric Arc in Photomicrography: E. B. Stringer.—An Exhibition of Mounted Rotifers of the genus Brachionus: C. F. Rousselet.

ROYAL METEOROLOGICAL SOCIETY, at 7.30.—The Prevalence of Gales on the Coasts of the British Islands, 1871–1900: F. J. Brodie.—The Duration of Rainfall: J. Baxendell.

THURSDAY, APRIL 16.

MATHEMATICAL SOCIETY, at 5.30.—Exhibition of the Logo-Logarithmic Slide-rule: C. S. Jackson.—On the Deduction of Schlömilch's Series from a Fourier Series, and its Development into a Definite Integral: R. F. Gwyther.—On those Functions which are Defined by Definite Integrals with not more than Two Singularities: E. T. Whittaker.—Note on Exact Solutions of the Problem of the Bending of an Elastic Plate under Pressure: Prof. A. E. H. Love.

LINNEAN SOCIETY, at 8.—On some Points in Connection with the Ordinary Development of Vaucheria Resting Spores: Dr. H. Charlton Bastian, F.R.S.—The Labial and Maxillary Palpi in Diptera: W. Wesché.—On Freshwater Rhizopods and their Classification: Prof. G. S. West.

SATURDAY, APRIL 18

GEOLOGISTS' ASSOCIATION.—Excursion in Conjunction with the Geological Section of the Croydon Natural History Society. Directors: N. F. Robarts and W. Whitaker, F.R.S. Members meet at New Cross Station (L. B. & S. C. R., down platform), at 3.21 p.m. Object: To see the Reopening of the Cutting S. of the Station, showing the Junction of the London Clay with the Beds below.

CONTENTS.