THURSDAY, JULY 18, 1895.

ANALYSIS OF OILS, FATS, AND WAXES.

Chemical Analysis of Oils, Fats, and Waxes, and of the Commercial Products derived therefrom. From the German of Prof. Dr. R. Benedikt. Revised and enlarged by Dr. J. Lewkowitsch, F.I.C., F.C.S. (London: Macmillan and Co., 1895.)

TEN or twelve years ago, the analysis of oils was one of the most neglected branches of analytical chemistry. How the study of it has been taken up and developed since, may be gathered by turning over the 670 pages of this excellent volume, the first English work devoted exclusively to this subject. The information existing in 1882 was comprised within 140 pages (much smaller than these) of Allen's "Commercial Organic Analysis." In the second edition of the same work, published in 1886, the subject-matter had grown to 318 pages. Benedikt's "Analyse der Fette und Wachsarten," second edition, published in 1892, upon which the present work is based, contained 460 pages, and as the literature of the subject has accumulated since then, at an increasingly rapid rate, it is evident that a new volume was demanded, the preparation of which could not have devolved upon any one more capable than Dr. Lewkowitsch, whose practical experience in, and valuable contributions to, our knowledge of this branch of chemistry are well known. To regard this work merely as a translation of the work of Dr. Benedikt would, obviously, be absurd. As the author points out in the preface, every page bears evidence of the alterations and numerous additions which have been made. Obsolete processes have been abridged or entirely omitted, and the new work of the last four years has been sifted, and all that is of value has been incorporated, including a large number of the author's own experiments and observations hitherto unpublished. Benedikt's arrangement of the subject-matter has been generally adhered to, but an improvement has been effected by transferring to the end of the book the chapter on the analysis of soap, candles, glycerine, and other products of the fat industry.

The first two chapters contain a description of the sources and chief properties of the various acids and alcohols obtained, or derived by oxidation, from the fats and waxes, followed by an account of the chemical constitution and the chief chemical and physical characters of the oils, fats, and waxes themselves. Commercial fats and oils are not pure neutral bodies, but always contain more or less free fatty acids which, for some purposes, depreciate their value. The percentage of free acid is liable to increase on keeping, and it was until recently believed that the development of rancidity was connected with this change. But Ballantyne has disproved this by showing that an oil may become rancid without becoming acid, and Heyerdahl has proved that the converse may also be true. The discovery, by Kirchner, of micro-organisms in poppy-seed oil, lent support to the view that rancidity might be the result of a fermentation process; but Ritsert showed that a fat which had been sterilised by heating to 140° C., might subsequently become rancid if exposed to light and air. The latter investigator has also shown that moisture is by no means essential, and he has finally concluded that rancidity must be due to the direct oxidation of the oil or fat by the oxygen of the air acting in presence of light.

Chapter iii. describes the determination of water and other non-fatty admixtures, and the preparation of the pure fat for analysis. Then follow a chapter on the physical properties and methods of examining fats, and four chapters on chemical methods. In the two next chapters the application of the foregoing, and some other methods, to the examination of fats is discussed, and data obtained by submitting the various oils, fats, &c., to examination by each method are collected and arranged in tables. This, however, is hardly shown by the headings of the chapters. Thus, chapter iv., which is headed "Physical Properties of Fats and Waxes," should rather be "Physical Properties and Methods of Examining Fats and Waxes"; and chapters ix. and x., headed "Systematic Examination of Liquid and Solid Fats and Waxes," with the sub-headings "Physical Methods" and "Chemical Methods," would be better entitled "Application of the foregoing Methods to the Systematic Examination," &c., with sub-headings "Application of Physical Methods" and "Application of Chemical Methods." These eight chapters are admirably written, and the value of the information given is greatly enhanced by the able manner in which each method is discussed and criticised. The completeness of the treatment shows how thoroughly the author has ransacked the literature of the subject. Unfortunately the task of reading and sifting papers is rendered heavier than need be by the growing tendency to rush into print with trivial and ill-considered observations. Thus, "the excellent *Reichert-Meissl* process has not escaped the fate of nearly all modern methods used in fat analysis" (there is no need to limit the statement to fat analysis, as the literature of steel analysis would show), "viz., to receive at the hands of numerous analysts a number of supposed improvements, most of which are altogether insignificant and hardly offer any advantage whatever." Again, referring to the Hübl process: "The chemical literature of the last few years contains numerous papers by various authors purporting to give improvements or modifications of the original method. Most of these refer to minor and unimportant points, and some of them even reproduce methods which Hübl in his classical paper has rejected."

For the determination of unsaponifiable matter, the author recommends petroleum spirit in preference to ether, but he very rightly insists upon the necessity of carefully purifying and rectifying the spirit used. If this is not done, some of the lighter mineral oils occasionally used to adulterate rape oil, for instance, may be lost, and for that reason I prefer to use ordinary ether, which can be completely expelled at a very moderate temperature.

For the determination of resin, Twitchell's process is recommended as yielding the best results, but no process yet exists by which resin can be determined with absolute accuracy.

"If a correct method of determining accurately the oxygen absorbed were known, it would be possible to class the determination of the drying power, or, as it might be called, the 'oxygen value' amongst the quantitative reactions." Such an addition to existing methods would be of the greatest value in the examination of the various oils from cruciferous and other seeds which now pass under the name of "rape oil."

In the eleventh chapter, which extends over 273 pages, the natural oils, fats, and waxes are systematically arranged and separately described, a very excellent and most valuable feature being a series of tables appended to the description of each oil, fat, and wax, giving the physical and chemical constants (1) of the oil itself, (2) of the mixed fatty acids, and (3) of the wax alcohols. It is a pity these tables were not arranged so as to be readable without having to turn the book half round, which might have been done by cutting each table in half. No less than 106 oils, &c., are thus separately described, and their physical and chemical constants are collected and arranged in about 175 tables. The usefulness of these tables to the analyst cannot be over-rated, though it does not appear to be clear in all cases by what method the melting and solidifying points of the fatty acids were determined. The "saponification values" are expressed per mille, and the iodine and other values per cent., but there is no reason why the simpler plan of expressing all the quantitative values in percentages should not be adopted. The section on butter fat, the analysis of which was the first to be placed upon a scientific basis, occupies twenty-three pages.

In chapter xii. the analysis of the raw materials and products of the fat and oil industries is treated, and in the concluding chapter some examples of the interpretation of results are given; but space does not admit of further reference.

This book is unique: the analyst will find in it practically all the available information upon the subject up to date, with full references to the original papers; and it will increase the author's already high reputation.

L. ARCHBUTT.

TRACES OF A DELUGE.

On Certain Phenomena belonging to the Close of the last Geological Period, and on their bearing upon the Tradition of the Flood. By Joseph Prestwich, D.C.L., F.R.S., &c. (London: Macmillan and Co., 1895.)

HAD the story of the Deluge a foundation in fact; in other words, is it a record of some inundation which affected a considerable area of the earth's surface? This is the question which Prof. Prestwich sets himself to answer in the small volume before us—a volume which combines a paper read to the Victoria Institute with some of the material communicated to the Royal and the Geological Societies.

In the south of England, especially in the neighbourhood of the coast, a drift is often found, varying in thickness from a few inches to a few feet, which consists of angular fragments of rock with loam derived from adjacent higher ground, and lies on the slopes of the hills and at the bottom of the valleys. Frequently it is absent, but where hollows occur in the surface of the underlying rocks, it has accumulated in greater quantities, and occasionally even exceeds eighty feet in thickness. In some localities it rests on an old raised beach, and is banked up against a buried sea cliff; in others it fills up fissures in the rocks. In the last case it frequently contains the bones of mammals, many of them now extinct—at any rate in Britain. These are neither worn nor gnawed, but are commonly broken and split. Its fossils, almost without exception, are of terrestrial origin. Similar deposits occur in the Channel Isles and on the French coast, and in many places around the Mediterranean, not to mention others. What is the origin of this "rubble drift," "head," osseous or fissure breccia?

Prof. Prestwich refers all these deposits to one epoch of very limited duration. He supposes that there was a rather widespread subsidence, amounting, in some places, to a few hundred feet, during which the sea overflowed the lower land. This was sufficiently rapid to make the invading water muddy; then, before the marine molluscs had time to establish themselves in the new territory, the land was upheaved by jerks (with intervening pauses). These sudden disturbances of its bed set up currents in the sea, strong enough to sweep heavy débris, and even largish blocks of rock, from the higher to the lower ground, and to precipitate the material into any open fissures. By this tumultuous action the bones of the terrestrial mammals which had been drowned by the submergence would be dispersed and shattered, and it explains, in his opinion, all the phenomena better than any other hypothesis. As man was living at the time, it gave rise to the tradition of the Flood.

An adequate discussion of Prof. Prestwich's hypothesis is impossible in our limited space; but we may be permitted to remark that it is not free from serious difficulties. Many geologists would dispute the assumption that these deposits all belong to one and the same epoch. Others will doubt whether the sudden upheavals, which he postulates, would be adequate to produce currents, capable of moving the larger débris, or whether the earth movements would suffice, as he supposes, to make gaping fissures. Some will think that he hardly appreciates the effect of "cloud bursts," such as may be seen in many mountain and even lowland districts of Europe, in transporting débris very similar in character to the "head." It is admitted that since this was deposited denudation has wrought some changes in the contours of the country, and this may explain the apparent isolation of some patches of the "head," whether it fill fissures or cap tabular hills. In several cases the ordinary explanation of breccias (admitting as an adjunct the action of snow) seem to us more simple than that proposed by Prof. Prestwich, and his mode of accounting for the abundance of hippopotamus bones at San Ciro, near Palmero—that as the land sank they were embayed between its precipitous face and the advancing sea, and at last were drowned—can hardly be called probable. Lions and hyænas might have perished in that way, but the hippopotamus seems far from helpless in the water, and is likely to have saved itself.

We think, then, that Prof. Prestwich's hypothesis will be received with some scepticism; nevertheless, it demands careful consideration as an attempt to solve a very difficult problem, which is put forward by one who may now be termed the Nestor of British geologists, and who has paid especial attention to questions of this nature.

AN ECLECTIC HISTORY OF SCIENCE.

Progress of Science. By J. Villin Marmery. Pp. 357. (London: Chapman and Hall, Limited, 1895.)

THE custom of inserting laudatory prefaces or introductions, written by well-known men, in works of science by lesser lights, which was commented upon in these columns a few weeks ago, reaches the ridiculous in the case of this book. A letter from Mr. Samuel Laing to the publishers is printed, in the course of which he says: "I have now had time to read Mr. Marmery's book, and find it a work of great learning and research . . . and I can confidently recommend it as alike interesting and instructive." What induced the publishers to print this purely business letter as a testimonial to the book's good qualities, passes our comprehension. A book usually finds its proper level, and the effort to force it into a higher position by means of a letter of introduction from a more or less distinguished individual, must prove futile; for in literature, scientific or otherwise, authors are judged entirely by their own works.

Every one will recognise that to attempt to condense the history of science into a volume of about three hundred and fifty pages, is to court failure. All that can be accomplished in so small a space is to describe the well-defined steps of advancement along the road of natural knowledge, and to exhibit the continuity of scientific developments. Mr. Marmery has done this with a fair amount of success. After briefly noting the knowledge of the Egyptians and Chaldeans so far back as 3000 B.C., he surveys the successive stages in the history of science, and devotes a few lines to men and matters of first-rate importance in each. His statement of the progress made by the Arabians from the ninth to the fifteenth centuries, brings into view the substantial achievements of a people which then stood in advance of the whole world. Our obligations to the Arabs are indubitable; nevertheless, few European historians have expressed them. "Eminence in science is the highest of honours" was a maxim which represented the bearing of Islam towards scientific knowledge at a period when Europe was ruled by monkish philosophy, and when investigators were stamped as heretics.

The review of the science of the Greek, the Arabian, the Mediæval, and the Revival periods, leads to the science of the Modern period, from the end of the sixteenth century to the present time. And here the author treads upon dangerous ground. He has had, perforce, to create invidious distinctions by selecting from the host of scientific workers those that appear to him to have added most to the store of knowledge. Huxley got over the difficulty in his address on "The Progress of Science," published among his collected essays (vol. i.), by omitting references to all living men, and by dealing only with results. Mr. Marmery might have saved himself from hostile criticism by following the same method; but, in that case, his volume would have wanted the very information which is the chief justification for its existence. His selection of names has, he says, been determined "by what appears *typical originality* in the work, rather than by what is imposing in extent and weight." Here and there we fancy this criterion has not been applied; but in a book covering so wide a scope, such deficiencies may well be excused. Modern investigators are divided into seven groups, viz. (1) biologists, (2) geologists, (3) chemists, (4) mathematicians, (5) astronomers, (6) physicists, (7) eminent practical men. Short accounts of the main achievements of the individual workers in each group are given, and are fairly trustworthy. In an appendix, the names of foremost men of science in all the periods are tabulated, and a copious index makes it easy to find the sketch of the works of any one of them.

Many imperfections the book certainly has, but in spite of them we think it deserves some words of commendation. Those who wish to know something about the evolution of scientific knowledge, and the multitude of readers who like to dip into a book to find what this or that man of science has done, may obtain from this handy volume the information they seek. We could easily enumerate a score of names which ought to find a place in the book, but are wanting. Probably it was because the author was aware of the incompleteness of his record, that he omitted the definite article from the title of his book.

MICROSCOPIC STUDY OF ROCKS.

Petrology for Students: an Introduction to the Study of Rocks under the Microscope. By A. Harker. (Cambridge University Press, 1895.)

THIS latest addition to the Cambridge Science Manuals is intended by the author as a guide to the study of rocks in thin slices under the microscope In scarcely another English text-book on the subject has the treatment of rocks from the purely petrographical point of view of microscopic examination been so strictly adhered to throughout as in the book before us. "Microscope" is almost the first word in the book, and sounds the key-note of the whole.

After a short introduction, containing a few notes on the optical properties of minerals, the author plunges at once into the systematic description of the different rock species. The usual chapters on the characters and methods of separation and determination of the rock-forming minerals are omitted altogether; for all such mineralogical points, the reader is referred to standard works on the subject. The book, therefore, corresponds, though on a much smaller scale, to the second volume of such text-books as those of Rosenbusch and Zirkel.

In the classification of the massive igneous rocks the author divides them into *plutonic*, *intrusive* and *volcanic*, but is careful to point out that the divisions themselves are based upon the *structural* characters resulting from the different conditions of consolidation. This classification resembles that of Rosenbusch, but the author's intrusive groups do not correspond exactly with the Ganggesteine of Rosenbusch, for he extends them to the basic family, whereas even Rosenbusch considered this to be impracticable. In this connection we notice that those much abused terms "diabase" and "porphyrite" receive new definitions. Diabase is in this book used to designate, not pre-Tertiary or altered dolerites, but the group of intrusive basic rocks corresponding to the volcanic basalts, while porphyrite is applied to the intrusive rocks corresponding to the volcanic andesites. The author, of course, follows the British school in admitting no criterion of geological age in the nomenclature of the rocks.

Throughout the book, each rock group is treated for the most part under the three headings: constituent minerals, structure, illustrative examples. Under the last heading, purely petrographical descriptions are given of typical examples, chosen generally from British rocks.

The sedimentary rocks are treated under the divisions, arenaceous, argillaceous, calcareous, and pyroclastic. In perhaps no other English text-book have the microscopic characters of the sedimentary rocks been so minutely described. The subject of metamorphism is treated under the two heads of thermal metamorphism and dynamic metamorphism, and the effects produced on arenaceous, calcareous, argillaceous and igneous rocks are separately described. The book concludes with a short chapter on various crystalline rocks, including gneisses, granulites, &c. It is, perhaps, almost inevitable, owing to the nature of the subject, that the book should give the general impression of consisting of a series of descriptions of rock-sections; but, be this as it may, there can be nothing but praise for the clear and straightforward way in which the author has presented his facts, and for the wealth of new matter which the book contains. The book shows evidence of most careful research into the literature of the subject, and is in fact thoroughly up to date, containing many extracts from papers which have appeared within the present year. G. T. P.

OUR BOOK SHELF.

Garden Flowers and Plants: a Primer for Amateurs. By J. Wright. With fifty Illustrations. (London: Macmillan and Co., 1895.)

ONE of the great advantages of gardening and of a love of flowers consists in the fact that they may be indulged in by rich and poor alike.

The rich have no monopoly in the beauty of flowers, the poor are not debarred from their enjoyment. The costliest orchid in a ducal garden is not one whit more beautiful than an Iris which may be bought for a few pence. If a slug devour the one it is easily replaced, if such an accident befall the other the loss may be beyond repair. Nor by those who look beneath the surface and seek to penetrate the significance of the diversity of form, and the meaning of the beauty they witness, is costly expenditure needed. The cheapest and commonest afford as copious materials for research and investigation as the dearest plant in the nurseryman's price list. Anything that will lighten the sordid conditions under which so many of the poorer classes live, anything that will brighten their homes and give them an interest in something beyond their daily toil, must be considered as a boon of incalculable value. Such a boon is offered by the pursuit of gardening. In country districts, moreover, where small gardens and allotments can be had, gardening may be made to add considerably to the resources of the family. It may be doubtful whether market-gardening on a large scale will always be profitable, but there can be no doubt that the small plot of the labourer may be turned to good account, provided circumstances are even only moderately favourable. To provide for the needs of small gardeners and amateurs, Mr. Wright has published the little manual before us. The author is an accomplished practitioner, and his experience as a County Council lecturer has enabled him to ascertain precisely what is wanted by his auditory. Mr. Wright begins at the beginning by telling his readers how to make a garden, how to lay down gravel walks, what to grow on walls, what on beds, even what may be cultivated in areas. The principal categories of hardy plants are passed in review, such as annuals, perennials, bulbous plants, bedding plants, and so on, and clear directions are given as to their management from beginning to end. In all this there is not much that needs comment from a reviewer, who can only say that the little primer is well done, and excellently suited for its purpose.

An explanation of the real cause of "damping" off would have been of value, as the most "practical" of gardeners is not desirous of cultivating fungus at the expense of cherished seedlings.

The small illustrations are helpful, and a full index adds materially to the value of the book.

The Time Machine. By H. G. Wells. (London: Wm Heinemann, 1895.)

INGENIOUSLY arguing that time may be regarded as the fourth dimension of which our faculties fail to give us any distinct impression, the author of this admirably-told story has conceived the idea of a machine which shall convey the traveller either backwards or forwards in time. Apart from its merits as a clever piece of imagination, the story is well worth the attention of the scientific reader, for the reason that it is based so far as possible on scientific data, and while not taking it too seriously, it helps one to get a connected idea of the possible results of the ever-continuing processes of evolution. Cosmical evolution, it may be remarked, is in some degree subject to mathematical investigations, and the author appears to be well acquainted with the results which have been obtained in this direction. It is naturally in the domain of social and organic evolution that the imagination finds its greatest scope.

Mounted on a "time-machine" the "time-traveller" does not come to a halt until the year eight hundred and two thousand, and we are then favoured with his personal observations in that distant period. In that "golden age," the constellations had put on new forms, and the sun's heat was greater, perhaps in consequence of the fall of a planet into the sun, in accordance with the theory of tidal evolution. "Horses, cattle, sheep, and dogs had followed the ichthyosaurus into extinction"; but, most remarkable of all, "man had not remained one species, but had differentiated into two distinct animals," an upper-world people of "feeble prettiness," and a most repulsive subterranean race reduced to mere mechanical industry. It is with the time-traveller's adventures among these people, and their relations to each other, that the chief interest of the story, as such, belongs.

Continuing his journey to an age millions of years hence, nearly all traces of life had vanished, the sun glowed only with a dull red heat, tidal evolution had brought the earth to present a constant face to the sun, and the sun itself covered a tenth part of the heavens. These and other phenomena are very graphically described, and from first to last the narrative never lapses into dulness.

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 Teaching University for London.

I HAVE read with surprise your article on the University of London.

Probably by some accident you had not seen my reply to Lord Kelvin's letter when you went to press. I now enclose a copy, and trust to your fairness to insert it:

"2 *St. James's Square, S.W., July* 9.

"MY DEAR RÜCKER,—I am sorry I could not immediately answer the letter which you have forwarded to me on behalf of

Lord Kelvin and other members of the Royal Society, but I only received it this morning, as I was away from home. I observe that most of those who have signed it are (as they themselves say) not members of Convocation, and consequently not constituents of mine. Still, I should welcome any opportunity of co-operation with such high authorities in the promotion of those interests which we all have at heart. I regret, however, that before publishing the letter they did not give me an opportunity of conferring with them, in which case, I think, I could have given good reasons for what I have said in my letter to Prof. Foster. I am glad to observe that the only point objected to is the reference of any new charter to Convocation. In this, however, I am not asking that any privilege which they do not at present possess should be conferred on my constituents, but only supporting what is now their legal right. As the law now stands no change can be made in the charter without the consent of the graduates. This right I know they highly value, and it is surely natural that, as their representative, I should do my best to preserve it. Moreover, in view of the difficulty of passing a Bill strongly opposed, as any Bill would be, which seeks to abrogate the present right of veto possessed by Convocation, I can imagine nothing more likely to wreck any scheme such as you desire than to link it, quite unnecessarily, with an attack on that right. Your objection to the reference to Convocation implies the belief that a Statutory Commission would arrange a wise charter for the University, and that the graduates would reject it. But why should it be assumed that they would do so? It has been my proud boast that I represent a constituency second to none in education and ability, and I am sure you will not, on reflection, be surprised if I have every confidence that when any new charter is submitted to my constituents, they will exercise the rights well and wisely, and with an earnest wish to further the interests of Learning and Education.

"I am, yours very sincerely,
"JOHN LUBBOCK."

I must also ask you to let me say a few words on your own article.

In the first place, I have not "accepted the views" of those who altogether oppose the Reorganisation Scheme. Some, indeed, of the modifications suggested seem to me important improvements, but that is a very different thing.

You say that Convocation is only one of the bodies affected. In the case of the Colleges and Medical Institutions certain privileges are granted, but the University is the only body whose constitution it is proposed to change.

At present, this cannot be done without the consent of Convocation, and you blame me for endeavouring to maintain that right. Your whole article assumes that the Commissioners will make a wise scheme, and then you allege that a reference to Convocation would wreck it. This, however, is an attack on my constituents and not on me. JOHN LUBBOCK.

High Elms, July 15.

The Density of Molten Rock.

IN a review of Lord Kelvin's "Geology," in NATURE, July 26, 1894, vol. l. p. 292, the question of whether solid rock sinks or swims in molten rock was left open for further experimental evidence.

My impression is that this was in accordance with the views of the writer of the book; but if I had had proper acquaintance with the work of Mr. Carl Barus, of the Smithsonian Institution, Washington, I should at least have referred to it. Permit me to do so now, and to give the references:—*Am. Journ. of Science*, 1893, vol. xlv. p. 1; *Phil. Mag.*, 1893, vol. xxxiv. p. 1; vol. xxxv. pp. 173 and 296; also certain *Bulletins* of the U.S. Geological Survey, particularly No. 103, which contain the most complete account. OLIVER J. LODGE.

The Earliest Magnetic Meridians.

IN NATURE of June 6, p. 129, Captain E. W. Creak, F.R.S., questions a statement of mine with regard to this subject, as published in NATURE of May 23, p. 80. I there credited Yeates instead of Duperrey with the first construction of the magnetic meridians for the whole earth. I was careful not to say that Yeates *originated* the idea of magnetic meridians.

Euler, to my knowledge, about the middle of last century, appears to have first appreciated the importance of those lines, from a theoretical standpoint. He defines them as those curves on the earth's surface, the tangents to which mark out the actual direction of a compass needle. He did not actually construct them, however, if I remember correctly.[1]

It was my belief then that Yeates first drew these curves, as based upon observations. Captain Creak, however, thinks that John Churchman deserves this honour.

So far as I know, Churchman published but two magnetic charts or atlases, one in 1790, the other in 1794. The chart referred to by Captain Creak is the earlier one, if I mistake not. A text to this chart was also published, called "An Explanation of the Magnetic Atlas," Philadelphia, 1790. It was my belief that this was an isogonic chart—a chart giving the lines of equal variation—not a chart of the magnetic meridians. Churchman's later work, "The Magnetic Atlas or Variations Charts," London, 1794, contains charts which, according to Prof. Hellmann, are more theoretical. Prof. Hellmann mentions and briefly describes both of Churchman's charts, and gives the impression that they are isogonic charts.[2]

As I have no means at present of verifying this matter, may I ask Captain Creak to make further examination, and state if Churchman's magnetic meridians are based upon observation? L. A. BAUER.

The University of Chicago, June 29.

Curious Habit of the Spotted Flycatcher.

I HAVE been watching, at intervals during the last week, a pair of Spotted Flycatchers feeding their young in a nest on a ledge of the wall of this house. The nest is embowered by a very free blossoming white rose. I noticed to my surprise the parent birds again and again, after taking food to their offspring, plucking off the petals of the rose near the nest, and transporting them to an acacia tree about ten yards distant, where they let the petals drop upon the ground. The rose blossoms are now quite cleared away from the neighbourhood of the nest, and the lawn beneath the acacia thickly strewn with them.

The rose flowers do not obstruct the approach to the nest, to which the birds have access by running a short distance along the ledge. It is also difficult to suppose that the object of the birds is to admit more air and light to the nest, which is more open to the sunlight than very many nests of this species which I have found. Moreover, the birds take no trouble to remove any of the dead leaves which are near the nest, having objection, as it appears, only to the blossoms of the rose. I can offer no explanation of this curious conduct of the flycatchers.

W. CLEMENT LEY.

Tellack Vicarage, Ross, Herefordshire, July 11.

A Brilliant Meteor.

ON Sunday, July 7, about 10.45 p.m., I observed a meteor of rather peculiar character. Contrary to the general method of appearance of these objects, it came into view very gradually, and its motion was so uniform and slow that its form could be clearly discerned.

The meteor was double, the two components being about $\frac{1}{4}°$ apart, but travelling together, the smaller one being ahead of the larger. The combined magnitude was probably equal to that of Venus as seen earlier on the same evening.

Some trace of trail could faintly be made out, but this was rendered uncertain by the sky being very luminous in consequence of the moon's position near the meridian at the time.

While visible the meteor travelled about 20° in a path approximately parallel to the horizon, and a rough estimate of its position would be:

	R.A.	Decl.
Appearance	13h. ...	+ 20°
Disappearance ...	11h. 30m. ...	+ 35°.

No explosion of any kind was noticed, nor any accompanying sound. CHARLES P. BUTLER.

Royal College of Science, July 9.

Newton and Huygens.

UPON Newton's conception of the universe, space is considered to be void. A fluid or gas would oppose resistance to the motion of the planets, and however small this resistance might be, it would cause a diminution of the linear velocity of the planets. The central attraction being unchanged, a diminution of the linear velocity of the earth

[1] See Gehler's "Physikalisches Woerterbuch," article "Magnetismus."
[2] "Neudrucke von Schriften und Karten über Meteorologie und Erdmagnetismus," No. 4, p. 22.

would cause an augmentation of its angular velocity around the sun. The period of revolution would take less time, and the length of the year would gradually decrease. Observation proves that this is not the case, and the necessary conclusion is, that there is no resisting medium in space, which must be, therefore, considered as perfectly void.

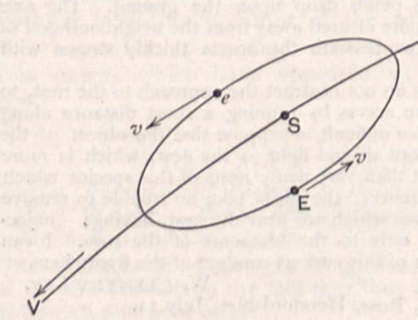
There is no objection to be made to this reasoning so long as we suppose the sun immovable in space, which was the generally accepted belief in Newton s time. But we know at present that the sun, with all the planets, has a motion through space; and this knowledge changes the conditions of the problem, as may be demonstrated by what follows.

In the accompanying figure, S is the sun in a certain point of its orbit in space. E is the earth in a certain point of its orbit around the sun. Let the linear velocity of the sun in its orbit be V, and the linear velocity of the earth in its own orbit be v.

When the earth is on one side of the sun's orbit, say in E, then V and v are opposite in direction, and the absolute velocity of the earth in space will be $V - v$. When the earth is on the other side of the sun's orbit, say in e, then V and v have the same direction, and the absolute velocity of the earth will be $V + v$.

Now it seems evident that we have here what may be called a self-acting regulation of the angular velocity of the earth in its orbit around the sun. For the absolute linear velocity of the earth is periodically accelerated and retarded, and the mean velocity would remain exactly constant if the sun's orbit were a straight line.

Most probably the sun's orbit through space will prove to be a curve. If this is the case, then the part of the earth's orbit on



the concave or outer side of the sun's orbit will be somewhat longer than the part on the convex or inner side.

If this be so, then the acceleration on the outside part will be somewhat greater than the retardation on the inner side of the earth's orbit. Thus the surplus velocity, gained in each revolution around the sun, will compensate the loss of linear velocity which the earth might suffer in its yearly orbit around the sun by the resistance of a supposed medium in space.

It might, however, be asked, Why it is that this compensation is so exact as we find it to be? For Laplace, in his well-known work on the "Système du monde," explains clearly that no change in the period of revolution of the earth around the sun has been observed.

But we may quite as well wonder why the temperature of our blood is nearly constant; and the best answer to such questions is in the well-known words: "Philosophy does not ask what agrees, but what is."

The sun's motion in space is a discovery with far-reaching consequences for science in general; and if space be allowed, a few other corollaries must follow upon it. For the present, it is better to limit research to the single question as to whether we may admit the existence of a resisting medium in space. The answer is that the discovery of the sun's motion in space allows us to settle this much disturbed question in a positive sense.

This result has a particular value, because it takes away the contradiction between two theories which are both generally admitted. The undulatory theory of light, which was first enunciated by Huygens, supposes the existence of an elastic medium in space. When it is demonstrated that the supposition of this medium is not incompatible with Newton's theory of central forces as applied to our planetary system, this must certainly be considered as a step in advance. A. HUET.

Delft, Holland, July 5

THE INTERNATIONAL CATALOGUE OF SCIENTIFIC PAPERS.

THE following report of the International Catalogue Committee was presented to the President and Council of the Royal Society on July 5, and the recommendations contained in it were approved.

At the first meeting of this Committee (February 8, 1894), the Memorial to the President and Council (July 1893) which led to the appointment of the Committee, and the Minute of Council of December 7, 1893, appointing the Committee, having been read, it was resolved to request the President and Council to authorise the Committee to enter directly into communication with societies, institutions, &c., in this country and abroad, with reference to the preparation, by international co-operation, of complete subject and authors' catalogues of scientific literature.

Subsequently, a draft circular letter was prepared, which, on February 22, 1894, received the approval of the President and Council, who also authorised its issue.

This letter was sent to 207 societies and institutions selected from the exchange list of the Royal Society, and to a few others. It was also sent to the Directors of a number of Observatories and of Government geological surveys, to the Foreign Members of the Royal Society, as well as to those of the following Societies:—Chemical, Geological, Physical, Royal Astronomical, Linnean, Royal Microscopical, Entomological, Zoological, Physiological, and Mineralogical, and of the Anthropological Institute. A special letter was addressed to the Smithsonian Institution.

More than a hundred replies to the letter have been received; several of these are reports of Committees specially appointed to consider the suggestions put forward by the Royal Society. A list of answers received up to December 1894, with brief excerpts from the more suggestive, was issued to members of the Committee early in this year. It should, however, be added that from some important institutions no answer has as yet been received.

It may be said at the outset that in no single case is any doubt expressed as to the extreme value of the work contemplated, and that only two or three correspondents question whether it be possible to carry out such a work. It is a great gratification to the Committee that the matter has been taken up in a most cordial manner by the Smithsonian Institution, the Secretary of which, in his reply, refers to the desirability of a catalogue of the kind suggested as being so obvious that the work commends itself at once. The importance of having complete subject catalogues, and not mere transcripts of titles, is also generally recognised.

Some bodies and individuals take the matter up very warmly and urge that steps be taken forthwith to put the scheme into action, this being especially true of the replies received from the United States; others, while giving a general approval, dwell upon the difficulties of carrying out the suggestions put forward; and others, again, ask for more details before committing themselves to any answer which may seem to entail future responsibility, especially of a financial character.

Incidentally it may be pointed out as very noteworthy that over and over again reference is made to the great value of the Royal Society's "Catalogue of Scientific Papers." There is abundant evidence that considerable use is made of this on the continent of Europe. And it is clear that a proposal to carry out a more comprehensive scheme initially under the direction of the Royal Society of London is likely to meet with general approval owing to the fact that the Society is credited with having already carried out the most comprehensive work of the kind yet attempted. Indeed, the Academy of Natural Sciences of Philadelphia, U.S.A., directly advocates the establishment of a central bureau under the Royal Society; and several others more or less clearly imply that they would favour such a course.

Over and over again, it is stated that the production by international co-operation of a catalogue such as is contemplated is not only desirable, but practicable. The Americans who, as already stated, are the most enthusiastic supporters of the scheme, especially dwell on the importance of early action being taken. Prof. Bowditch, of Harvard University, in particular, points out that if the Royal Society of London wish to guide the enterprise, it ought to announce its views and put forward a comprehensive scheme with the least possible delay. It may be added here that he also urges that in determining the scope of the catalogue a very wide interpretation should be given to the word "Science."

No very precise information as to the best mode of putting the scheme into operation is to be gathered from the replies as a whole.

It is generally agreed that the enterprise should be an international one. Many think that international financial support should and would be accorded to it, but no method of securing this is indicated; others express the view that the cost may be met by subscriptions from societies, libraries, booksellers and individuals without Government aid, and this is, perhaps, on the whole, the prevailing feeling among those who have discussed the matter from a financial point of view. But in no case is any attempt made to form any exact estimate of the cost.

A number of scientific bodies and institutions express themselves prepared to work in such a cause. The Secretary of the Smithsonian Institution suggests that as the Institution receives all the serials and independent works published in America, a branch office might be established there, and that it is not impossible that a sum of money might be given yearly in aid. The Royal Danish Academy is willing to render as much assistance as possible. It would charge an official of one of the Danish chief libraries in receipt of all Danish publications with the task of editing slips, and would defray the cost of this work. The Société des Sciences of Helsingfors would furnish the central office with information as to the scientific work done in Finland. The Kongl. Vetenskaps Akademie of Stockholm would organise a Committee for Sweden.

As regards language, there appears to be more unanimity than could have been expected. Over and over again the opinion is expressed that English should be the language of the subject catalogue. Frequent reference is made to the importance of quoting titles in the original language, although some suggest that this should be done only in the case of those published in English, French, or German, and perhaps Italian.

Some form of card catalogue appears to be generally favoured, especially in America, as the basis of the scheme; the Committee of Harvard University, whose reply is very full, in particular discuss this point in detail.

In an interview with the Committee in March last, Prof. Agassiz spoke very warmly in favour of the scheme, and of the support which it would meet with in the United States, especially from libraries. As others have done, he strongly urged that the co-operation of booksellers and authors should be secured. Prof. Agassiz also expressed the view that the regular issue to libraries and scientific workers from the central office of cards or slips which would afford the material for the construction of card catalogues would form an important source of income, at all events in his country.

From various sides it is urged that an International Congress should be held to discuss plans. This is advocated as a first step in a reply received from the Königl. Gesellschaft der Wissenschaften in Göttingen, a reply to which, not only as regards this point, but also in respect to the whole matter, the Committee attach very great weight, since it embodies in an official form views arrived at by the academies of Vienna and Munich, and by the scientific societies of Leipsic and Göttingen, who have considered the matter in common. Prof. Agassiz strongly urged the calling of a conference, and among others who share this view, Dr. Gill, of the Cape Observatory, in his letter particularly dwells on the great value of such meetings as the means of securing unanimity of action.

Such being the tenour of the correspondence, your Committee are convinced that initial steps of a definite nature in furtherance of the scheme ought now to be taken.

They accordingly request the President and Council to take measures with the view of calling together, in July of next year (1896), an International Conference, at which representatives of the several nations engaged in scientific work should be invited to attend, with the view of discussing and settling a detailed scheme for the production by international co-operation of complete authors' and subject catalogues of scientific literature.

London will probably be found the best place in which to hold such a conference. It may be desirable to summon the representatives of the different countries through their respective Governments, and it will obviously be necessary that a detailed scheme be prepared, to serve as a basis for discussion at the conference. These and other points will require much consideration before any action at all can be taken; meanwhile, it is desirable that a beginning should be made during the autumn, before the winter session of the Society. The Committee therefore recommend that the President and Council should give the Committee (which includes the President and officers) executive powers in order that they may take, in the name of the Society, such steps as they may think desirable with the view of calling together the above-mentioned conference.

SCIENCE SCHOLARSHIPS AT CAMBRIDGE.

WITHIN the past academical year an attempt has been made by the college tutors at Cambridge, in consultation with representatives from Oxford, to come to an understanding as to the times at which examinations for entrance scholarships shall be held. Headmasters have frequently complained of the interruption to school work caused by the present somewhat haphazard arrangements, and have suggested the grouping of colleges and other expedients in mitigation of the difficulty. Some of the colleges, notably Caius, Jesus, Christ's, and Emmanuel, Pembroke with King's, and Clare with Trinity Hall, have agreed to group their examinations, candidates entering for the combined examination being required to indicate the colleges, in the order of their preference, which they desire to join if successful. The larger colleges, Trinity and St. John's, have for various reasons found it impracticable to form such combinations; but they have agreed at least to avoid clashing by fixing their examinations about a month apart. Nine of the colleges offer scholarships and exhibitions for natural science, the rest confining the competition to the old-established subjects of classics and mathematics. In the ensuing academical year, examinations in natural science for these awards will be held as follows: at Trinity, November 5; at Peterhouse (physical sciences only), November 19; at the group—Caius, Jesus, Christ's, Emmanuel—November 26; at the group—Pembroke, King's—and also at St. John's College, December 3; at Sidney, Sussex, December 12; at the group—Clare, Trinity Hall—January 1; and at Downing, about March 17. The value of the scholarships varies from £80 to £40 a year, of the exhibitions from £50 to £20. They are usually tenable for three or four years, with a condition that by the end of the second year the scholar shall have approved himself sufficiently in the college examinations. Scholars are practically required to become candidates for honours in the natural sciences tripos, though the new mechanical sciences tripos will no doubt attract some. The new Salamon scholarships at Caius are, indeed, specially intended for students of engineering. It should be added that candidates for scholarships, who are not yet members of the university, must be under nineteen years of age; there is no restriction of age in respect of the science exhibitions. Though only nine colleges specifically offer entrance scholarships in science, an examination of the awards to the first, second, and third year students shows that in many more good work in science, as tested by university or inter-collegiate examinations, does not go unrecognised. The large body of medical students, now approaching five hundred in number, is distributed over all the colleges, and their presence has apparently brought home, even to the most conservative, the fact that intellectual ability, high-minded devotion to study, and social energy are not confined to students of classics and mathematics alone. Thus, though something remains to be done in certain quarters in the direction of placing science on an equal footing with the older subjects as a fit object of college recognition and reward, it must be owned that a great advance has been made within the last ten years. The natural sciences tripos now attracts a larger number of candidates than any other, and this notwithstanding that its standard has steadily been raised. In the majority of the colleges, distinguished eminence in this tripos has been admitted as a qualification for a fellowship, and in not a few instances governing bodies have felt the need of strengthening themselves on the side of science, and have departed from Cambridge custom by selecting scientific members of other colleges for this honour.

The endowments for research, other than scholarships and fellowships, have in late years been substantially increased. In addition to post-graduate studentships at the larger colleges, such as the Hutchinson at St. John's (physical and natural science), the Coutts-Trotter at Trinity (physics and physiology), the Frank Smart at Caius (botany), the university has of late received a number of benefactions for the same purpose. The Balfour studentship in animal morphology, worth £200 a year, the Harkness scholarship in geology about £100, the Clerk Maxwell scholarship in physics about £185, the John Lucas Walker studentship in pathology £200 to £300, the Isaac Newton studentships (three) in astronomy £200, and the Arnold Gerstenberg studentship, for natural science students pursuing philosophical study, about £55, are among these recent foundations. They are expressly intended to foster advanced study and research, and they have already produced excellent results. The university still lacks the means of providing similar encouragements for higher work in chemistry, in anatomy and anthropology, in botany, in mineralogy, in physiology, in pharmacology, and in scientific engineering. It is to be hoped that the line of generous benefactors is not yet extinct, and that some of these important subjects may ere long receive the benefit of their munificence. The new scheme for the promotion of post-graduate study and research, which has received the approval of the senate, and now only awaits the assembling of Parliament for the sanction of the necessary statutes, will render such endowments opportune and fruitful.

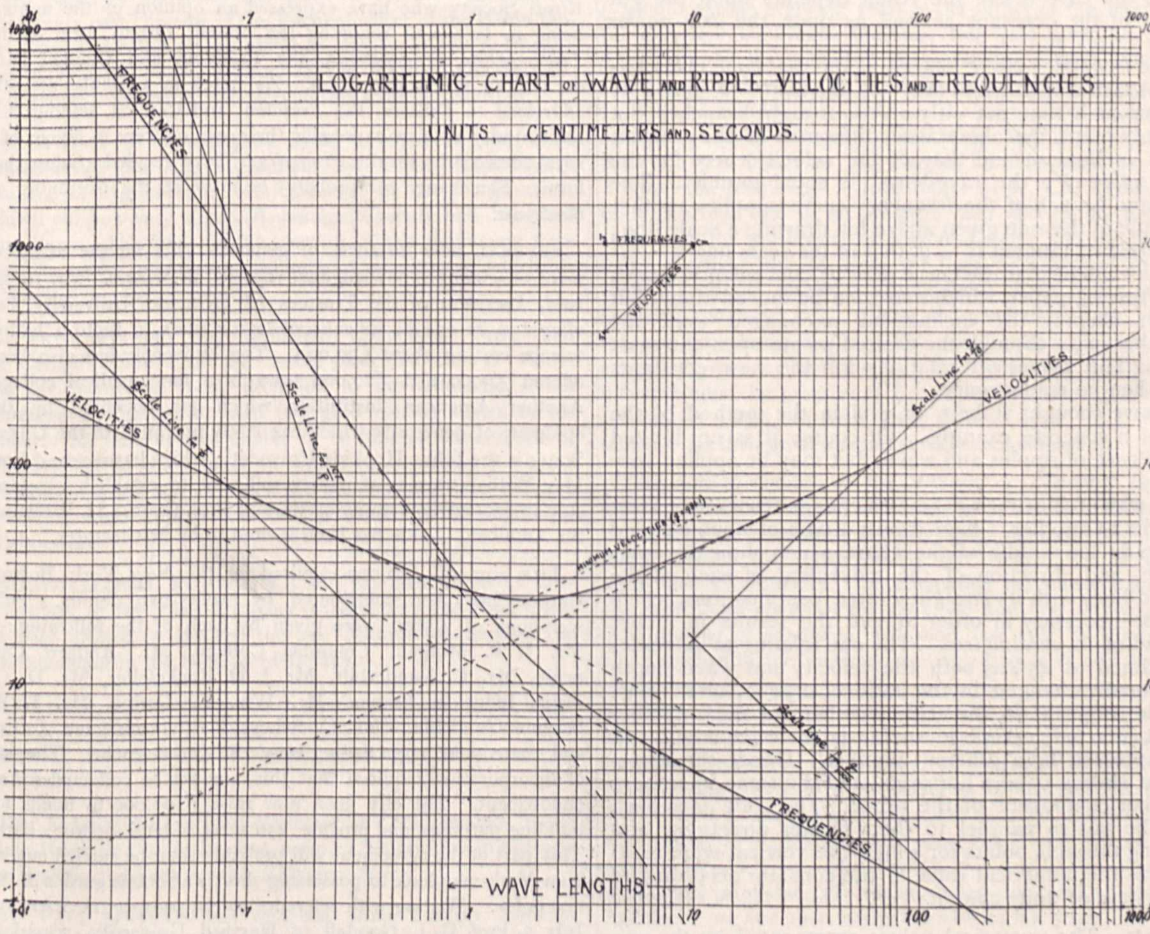
SCALE LINES ON THE LOGARITHMIC CHART

THE advantages of logarithmic plotting for certain classes of work have for some time been recognised, and now that, thanks to Mr. Human, logarithmically ruled paper can be obtained ready made, the facility of such plotting is greatly increased, so that there is all the more reason on this account why it should become more common than it seems to be at present. It may perhaps be well to point out shortly what the nature and effect of logarithmic plotting is, and to contrast it with the more common method on square-ruled paper. Instead of paper ruled in equal squares, logarithmic paper is ruled first in a series of large equal unit squares representing tenfold changes in the coordinates. Thus two units represent 100, three units 1000, and so on. Similarly the squares are broken up fractionally and unequally into a series of vertical and horizontal lines, whose distance from the left or lower side of the square is equal to the logarithms of the numbers 2, 3, 4, &c., and these are subdivided again logarithmically just in the same way that a slide rule is subdivided. In fact, if logarithmic paper is not available, logarithmic plotting can still be carried out fairly expeditiously by pricking off distances direct from a good slide-rule. The meaning of lines drawn upon logarithmic paper is very different from that upon ordinary square ruled paper. For instance, an inclined straight line ruled in the ordinary way represents the equation $y = a + bx$, whereas when logarithmic paper is employed the corresponding line gives $y = ax^b$. The consequence is that whenever two quantities are related so that one varies as any power, positive, negative, integral, or fractional of another, a straight line drawn in the proper position and inclination represents that relation, the power being equal to the trigonometrical tangent of the angle of slope of the straight line. If the relation that is to be represented is less simple, if the index changes gradually as either of the coordinates changes, so that a curve has to be employed, then the size and shape of the curve represents the law in the abstract, and the position of the curve on the sheet the actual numbers for the particular case and with the particular units; a mere shift of the curve bodily upon the chart, as pointed out by Prof. Osborne Reynolds long ago, being all that is necessary to adopt the same law to new circumstances or new units.

One very important feature of logarithmic plotting is the fact that, not only is it practicable to include an enormous range (in Mr. Human's sheets of four by five squares of 10,000 and 100,000 in the two directions), but the proportionate accuracy is identical in all parts, if it is possible to draw or read to, say, 1 per cent. in one part of a curve, the same figure is true everywhere. On the other hand, in ordinary plotting the proportionate accuracy of quantities near the origin is very small, while at a great distance it becomes enormous. In order to assist in the process of sliding any curve about on a logarithmic chart so as to represent particular cases, special logarithmic scales may be ruled upon the sheet, having a suitable magnitude depending on the index which connects the result with the new variable, or what I have called scale lines may be employed. In illustrating the laws which connect the velocity and frequency of waves and ripples at the Royal Society soirée, I exhibited these lines, and showed how, in order to determine by inspection either the velocity or the frequency of waves and ripples of any wave-length on the surface of any liquid under any acceleration of gravity, a single curve and two scale lines are all that are needed. As by their use the logarithmic chart is made even more comprehensive than it is at present, I feel that no apology is needed for making use of the columns of NATURE to make them more widely known.

As is well known, the velocity of surface waves on a fluid depend both on gravity and on kinematic capillarity or capillarity divided by density. In the case of waves of large size, capillarity is of practically no account, and the velocity depends only on the acceleration of gravity. Since it depends on the square root of this acceleration, the line on the logarithmic chart that represents the velocity of waves of any size travelling under the influence of gravity alone is straight, and slopes up so as to rise one square for every two that it moves to the right, its tangent is

$=\frac{1}{2}$. On the other hand, since the velocity of waves travelling under the influence of capillarity alone is proportional to the square root of the wave shortness or reciprocal of the wave-length, the line that represents their velocity is straight also, but slopes the other way and to the same extent. Actually both causes are in operation, but except over a range of wave-length of about 1 to 100, the one influence so largely predominates that the other is negligible. In the diagram this is made evident on the velocity curve which consists of two straight branches joined by a curve, which runs into them and is rapidly indistinguishable from them. The dotted continuation of the branches shows what would be the velocities under the influence of either cause alone. Where the two lines cross, both gravity and capillarity have equal influence, and the two together



produce a minimum effect. The actual curve may be planted anywhere on the chart; but in the diagram it is so placed as to represent the facts with water for which $T/\rho=81$ and with $g=981{\cdot}1$. If other liquids are chosen, then, since the gravitational branch of the curve is unaffected, the curve, as a whole, must be made to slide along the gravity branch on the right until the left branch assumes its proper position. Similarly to represent the effect of changes of g, the curve must be made to slide along its capillary branch on the left until the gravity branch on the right assumes its proper position. The proper position in either case may be indicated by a special logarithmic scale ruled to half the scale adopted for the squares of the chart, and placed upon the chart with its length vertical and so that the branches of the curve cut each scale, one at 81 and the other at 981·1. The *scale line*, however, is much simpler, more convenient, and less confusing. In order to draw it, find a point in either branch of the curve where the velocity reading on the vertical scale of the chart is equal to the value of T/ρ for the left, or of g for the right branch. If within the limits of the paper the branch of the curve does not indicate a velocity, of which the value is T/ρ or g, as the case may be, take some whole power of 10 or $\frac{1}{10}$ as a factor. For instance, though $T/\rho=81$ is within the limits of the left branch, $g=981{\cdot}1$ is outside the paper on the right, therefore find on the right branch $g/10=98{\cdot}11$. Now, in order to find some other point on the scale line, imagine that each of these quantities is multiplied tenfold. The corresponding branch of each will be raised vertically $\sqrt{10}$, or half a square. The new line so drawn will at some point cut the vertical scale of the chart, in a line of which the value is ten times the reality, or is one square higher up than the first point. Mark this point, and join it to the first. The result is a *scale line* having the property that wherever it is cut by the corresponding branch of the curve the reading on the chart gives at once the value of T/ρ or of g, as the case may be, that is proper to the new position of the curve, and conversely in order to fix the place of the curve for any value of T/ρ or of g, it is merely necessary to find the desired values of these quantities on the scale lines, and then to shift the curve until its two branches or its two branches produced if necessary pass through the points on the scale lines having the values sought. If the effect of a variation of the constant upon the value indicated by the curve line is one of simple proportion, the scale line will be vertical. If its power is less than one, it will be between the vertical and the slope of the curve; if more than one, it will slope the other way, if it is negative the slope will be less than that of the curve. In order to apply a general rule to all possible cases where both the index connecting x and y and the index connecting the result (y) with the variation of the constant may have any values whatever, it is merely necessary to find a point a upon the inclined straight line representing $y = ax$, at which y is equal to a, or to that part of a which may assume various values. At any distance above it rule a horizontal line. Where the horizontal line cuts the inclined line, write the figure 0; where it cuts the vertical through the point a, write the figure $+1$. Then complete a scale of equal parts on the horizontal line extending to $+\infty$ and $-\infty$. Lines drawn through the original point a and any point q on this scale will be scale lines corresponding to the case where the result depends upon the qth power of the constant as well as upon the bth power of x.

The frequency curve placed upon the same chart has two branches inclined at $\tan^{-1} - \frac{3}{2}$ and $\tan^{-1} - \frac{1}{2}$, joined by a curve such that not only on the straight branches, but at every point, the algebraical difference of the tangent of its inclination and that of the velocity curve for the same value of x the wave-length is equal to unity. The left-hand branch of the frequency curve supplies another example of the rule given above for drawing a scale line; for, while its tangent is $-\frac{3}{2}$, that of the scale line is -3.

It is evident that the curve may be conveniently drawn upon tracing-paper, which may then be moved about, but always keeping the inclinations unchanged until the branches pass through the desired points upon the scale lines. The numerical relations for the new constants may then be read at once.

I have thought it best to explain the method by the use of a concrete example. Of course it is not limited to the case of ripples and waves, but may be applied very widely.

By way of illustrating how to change from one system of units to another, I have drawn a pair of double-ended arrows in the middle of the chart, which show the magnitude and direction of the movement of each of the curved lines with its straight dotted continuations, which will be necessary in order to read the results in inches instead of in centimetres. The one relating to velocities is inclined at 45°, as both the velocity and wave-length are equally changed in the ratio of 2·54 : 1, or 1 : ·3937. On the other hand, the frequency being a mere number is not affected, except in so far as the wave-length will be expressed by a different number. Hence the direction of sliding is here horizontal and the same in amount as either component of the other. The scale lines must then be put in parallel to their former directions, and running through points for which the vertical scale reading has the numerical value of the constant according to the system of units chosen. C. V. BOYS.

[*Note*.—The numerical values represented by the vertical and horizontal lines in each square in the diagram are 1, 1·5, 2, 2·5, 3, 3·5, 4, 4·5, 5, 5·5, 6, 6·5, 7, 7·5, 8, 9, 10. The number of lines in the Human sheets is five times as great, but they are drawn in three degrees of darkness to distinguish them.—C. V. B.]

NOTES.

A REPRESENTATIVE meeting of friends and admirers of the late Mr. Huxley was held on Thursday afternoon, at the rooms of the Royal Society, under the chairmanship of Lord Kelvin, P.R.S., to consider what steps should be taken to initiate a national memorial. It was determined to call a general public meeting after the autumn recess, and, in the meantime, to form a general committee. Sir John Lubbock (15 Lombard-street) has consented to act as treasurer, and Prof. G. B. Howes (Royal College of Science, South Kensington) as secretary to the provisional committee.

WE notice, also, that it is proposed to establish a memorial to commemorate the connection of Huxley with the Charing Cross Hospital Medical School. At a meeting held at the School on Tuesday, the following resolution was passed:—"That the memorial shall take the form of a Huxley scholarship and medal to be awarded annually at the Charing Cross Hospital Medical School, and that if funds permit an annual public lecture at the Charing Cross Medical School dealing with recent advances in science, and their bearing upon medicine shall be instituted."

WE understand that a large majority of those Fellows of the Royal Society who have expressed an opinion on the matter, being in favour of retaining the present quarto form of the *Philosophical Transactions*, the President and Council have decided to retain that form. As stated in a circular recently addressed to Fellows, the President and Council, finding that the majority of those expressing their opinion were in favour of a royal octavo form for the *Proceedings*, have decided to adopt that form. The change will probably be made at the beginning of next year.

SEVERAL new instances of generous gifts for the advancement of scientific knowledge are reported in *Science*. Mr. Archibald, President of the Trustees of Syracuse University, has offered to be one of six subscribers for funds to build a hall of science costing about £30,000. The University has also been offered £2000 and £20,000 towards a new medical college. Another American institution which has benefited by the epidemic of generosity which has lately prevailed in the United States is the Johns Hopkins University, which has received from Mrs. Williams a sum of money sufficient to establish a lectureship in geology in memory of the late Prof. George H. Williams. Sir Archibald Geikie has been invited to be first lecturer.

THE sum of £50,000 required for the New York Botanic Garden has been contributed by twenty-two donors. Subscriptions of £5000 were given by each of the following:—Mr. J. P. Morgan, Columbia College, Mr. Andrew Carnegie, Mr. C. Vanderbilt, Mr. J. D. Rockefeller, Mr. D. O. Mills, Judge A. Brown. Mr. Wm. E. Dodge, Mr. J. A. Scrymser, and Mr. Wm. C. Schermerhorn each gave £2000, and there were eight subscribers of £1000 each. The act of incorporation required that this amount be collected for an endowment. The city must now raise £100,000 by bonds for building purposes, and provide 250 acres of land in Bronx Park. This part of the agreement will probably soon be carried out, so New York may look to possessing shortly a botanic garden of the first order. Writing with reference to the prospect in *Science* of July 5, Prof. G. L. Goodall, of Harvard University, remarks: "To Columbia College and the other educational institutions of New York and vicinity, this new appliance for instruction will mean indeed a great deal. To all the citizens who are to take advantage of the opportunities for instruction which the garden will afford, Bronx Park will be a constant delight. But far beyond these limits, wide as they are, the garden will exert a profound and beneficial influence. Other cities will surely be stimulated by this noble movement and enrich their park systems with an educational aid of the greatest value. Formerly botanic gardens, attached even in a remote manner to educational institutions, were largely used for the cultivation of medicinal plants, and for the reception of species from distant lands. Of course, this use, although its importance is now relatively less than ever before, will still long continue to be a factor in the direction of activities. But here and there new phases of plant relations are being displayed in the greater gardens, and with the most gratifying results. Geographical questions are asked and answered by skilful grouping of species, and in the most attractive way. The bearing of climate on the structure, habit, and possibilities of plants is made prominent in an interesting fashion. The capabilities of useful plants and the extension of their range of usefulness comprise another phase of illustration which always sets visitors to thinking. Beyond and, we may say, above these questions, which are pretty strictly utilitarian, there comes nowadays another class of illustrations which are of the highest educational value in a community, namely, the biological features which are invested with such important relations to all departments of intellectual activity."

WE regret to announce the death of Prof. F. Tietjen, for many years past Director of the Recheninstitut of the Berlin Observatory, and editor of the *Berliner Astronomisches Jahrbuch*; also of Prof. G. F. W. Spörer, of the Potsdam Observatory, well known amongst astronomers for his solar observations.

A STATUE to Boussingault was unveiled at the Paris Conservatoire des Arts et Métiers last week. The French Minister of Agriculture, who presided at the inauguration, pointed out how very largely Boussingault's work had benefited agriculture. The funds for the erection of the monument were raised by public subscription, through a Committee of which M. Schloesing was the president.

A FEW days ago, the Municipal Council of Paris, and the General Council of the Seine, presented Dr. E. Roux, who has devoted so much attention to the anti-toxic serum treatment of diphtheria, with two gold medals struck in his honour. M. Pasteur was unable to be present on account of ill-health, but he sent a letter in which he expressed his great gratification at the way in which the municipality were publicly expressing their appreciation of the work of his pupil and collaborator.

SIR WILLIAM H. FLOWER, K.C.B., has been elected a Correspondant of the Paris Academy of Sciences; and Prof. Cohn has been elected to succeed the late Marquis de Saporta, as Correspondant in the Section of Botany.

THE death is announced of Dr. Hermann Knoblauch, President of the Kaiserliche Leopoldinisch-Carolinische Akademie of Halle. He died in the seventy-sixth year of his age on June 30th.

DR. FABIAN FRANKLIN, Professor of Mathematics in the Johns Hopkins University, has resigned his position in order to take up editorial work on the *Baltimore News*.

M. PAUL SINTENIS has returned from Turkish Armenia with large collections of rare plants.

SIR EDWARD LAWSON will distribute the prizes to the students of the Charing Cross Hospital Medical School this afternoon, at 4 o'clock. Next Thursday evening, the distribution of prizes to the students of the Dental Hospital of London will be made by Sir William MacCormac, at a conversazione to be held in the Royal Institute Galleries, Princes Hall, Piccadilly.

THE University of Chicago has decided to add Terrestrial Physics to the subjects taught in the Physical Department under Prof. Michelson, says the *American Meteorological Journal*. Dr. L. A. Bauer has just commenced courses in terrestrial magnetism, thermodynamics of the atmosphere, and dynamic meteorology. This step marks a new era in the development of the study of meteorology in the United States.

PROF. F. OMORI, of the Seismological Institute of Tokio, contributes an interesting paper on the velocity of earthquake-waves to the *Bollettino* of the new Italian Seismological Society (vol. i., 1895, pp. 52-60). The chief value of his investigation lies in the fact that the distances traversed are generally short and the times exceedingly accurate, so that we thus obtain some idea of the surface-velocity in the neighbourhood of the epicentre. The mean velocity for twenty-five earthquakes (1891-94) is found to be 2·04 km. per second. Prof. Omori also shows that for earthquakes originating in the same region, the velocity is practically constant, whatever be the intensity of the initial disturbance or the distance of the place of observation from the centre.

THE prizes and medals of the Paris Société d'Encouragement have just been awarded. The prize of twelve thousand francs (£480), awarded every six years to the author of the most useful discovery to French industry, has been given to Prof. Lippmann, for his method of photographing colours. Among the other awards we notice the following: Prize of 2000 francs to M. F. Osmond for his works on the microscopic analysis of steel, of which an account is given in the May *Bulletin* of the Society; 500 francs to M. Garçon for his work on "La Pratique du teinturier"; 1000 francs to M. Ch. Tellier, 500 to M. Lacroix, 500 to M. Maignen, and 500 to M. Schlumberger, for the purification of potable waters; 500 francs each to M. Lartigue and M. Roux for their investigations in connection with the electrical installations; 1000 francs to M. Guerrier, 500 francs to M. Allard, and 500 francs to M. Martin for their agricultural studies. The grand gold medal, awarded every six years for works which have exercised the greatest influence upon the progress of French industry during the preceeding six years, has been given to the Comité de l'Afrique française for their great services to African colonisation.

THE current number of the *Annales de l'Institut Pasteur* contains an official account of the antirabic inoculations carried out at the Pasteur Institute in Paris during the past year. From this it appears that 1387 persons were treated, out of which seven died subsequently. On comparing the statistics for last year with those compiled for 1893, we find that although the total number of admissions fell short last year by 261 of the figure reached in the previous year, yet England's contribution in the shape of patients rose from 23 in 1893 to as many as 128 in 1894. Thus, in spite of the broadcast circulation of a vast amount of sentimental opposition to the carrying out of Pasteur's antirabic treatment in this country, we appear to be developing an increasing desire to avail ourselves of the benefits to be derived from its use across the Channel! In all, 226 foreigners were treated in the Institute last year; Spain and Greece each sending 26; Belgium, 16; Turkey, 7; Russia and Egypt, 1 each; and Holland, 2; whilst under the heading "Indes Anglaises" we find 19 as compared with 14 last year.

IN connection with the questions lately raised as to the relation of spectra to molecular structure, it is interesting to recall a paper by Prof. Eder and and Mr. Valenta, communicated to the Vienna Academy a year ago. Mr. J. S. Ames summarises the paper in the May *Astrophysical Journal* as follows:—"The paper deals with the different spectra of mercury. Observations on the arc and spark-spectra and on the ordinary Geissler tube discharge showed that all three were alike, the most prominent lines in one spectrum being also the most prominent in the others. But two entirely new spectra were discovered. If mercury vapour is distilling at a low pressure through a capillary tube, and if a spark be passed through it, spectra are observed which are quite distinct from the ordinary one. If there is a large number of Leyden jars in circuit, the spectrum consists of an *immense* number of fine, sharp lines; but if there are no jars in circuit, the spectrum is entirely changed; it becomes a series of bands whose edges are towards the red. One spectrum is just as complete as the other, neither one being a development of the other. The band spectrum corresponds to a trifle lower temperature than the new line spectrum; but it is difficult to see how complexity of molecular structure can account for the difference between the two spectra in the case of mercury, whose vapour is monatomic. This has, of course, a most important bearing on the theory of band and line spectra, and seems to decide definitely against some of the present ideas concerning them."

THE current number of *Wiedemann's Annalen* contains a paper by Herr J. E. Myers on the influence of gases dissolved in the electrolyte of a silver voltameter on the weight of deposited silver. The author finds, as has previously been shown by Schuster and Crossley, that if the same current is sent through two voltameters containing neutral solutions of silver nitrate of the same strength and at the same temperature, one voltameter being in a vacuum and the other in air, then the weight of the silver deposited in the vacuum voltameter is, for a solution containing from 20 to 40 per cent. of silver nitrate, about 0·1 per cent. greater than that of the silver deposited in the other voltameter. For a 5 per cent. solution, the difference is somewhat smaller. If the solution is saturated with carbon dioxide the deposit is about 0·055 per cent. lighter than when the solution is saturated with air. With nitrogen, however, the deposit is about 0·05 per cent. heavier than with air. The electrical resistance of a 5 per cent. solution saturated with air is practically the same as that of the same solution in a vacuum. With a current of more than 0·25 ampere, it is found that in vacuum an evolution of gas takes place at the anode. The author has also examined the grey deposit which is formed on the anode, and finds that it consists of pure silver oxide.

THE results of some observations on declination made by M. Ch. Lagrange, which, if unaffected by some unsuspected error, are most unexpected, are given in a recent number of the *Comptes rendus* (June 17, 1895). During the last three years the author has been making observations of declination at the Uccle Observatory at Brussels, using for this purpose magnets having very different magnetic moments. He finds that systematic differences occur in the values obtained, but what is most astonishing is that diminution, within certain limits, of the magnetic moment of the magnet causes an amplification of the observed changes in declination. In one set of observations, lasting for six months, one of the magnets consisted of the almost astatic magnetic system taken from a galvanometer. By comparing the readings obtained with this system of magnets with those obtained on the self-registering magnetometers, it was found that the amplitude of the movements of the galvanometer needle was from fifteen to twenty-five times as great as that of the magnetometer needle. Another set of observations have been made with a large steel magnet, only feebly magnetised, however, so that its magnetic moment was only about $\frac{1}{40}$ of that of the magnet of the magnetograph. This magnet was suspended by a fine platinum wire, and here again the amplitude of movement of the feebly magnetised bar was greater than that of the more strongly magnetised one.

WE have received *Bulletins* Nos. 119–124 of the Michigan Agricultural Experiment Station, dealing with a variety of subjects of horticultural interest. With regard to the troublesome disease of tomato rot, which is often the cause of serious loss, it is stated that spraying with Bordeaux mixture is efficacious. Last season, when the tomatoes had grown to the size of hickory nuts, the plants were given a thorough spraying, and three weeks later the application was repeated. Very little rot was noticed on the sprayed plants, whilst on those which were purposely left unsprayed many diseased fruits were to be seen. In the summary of results of experiments with potatoes, it is said that potatoes deteriorate rapidly under ordinary cultivation, and it is necessary to frequently change seed in order to keep them in their pristine purity and excellence. We need go no farther than Ireland, with its worn-out variety of the Champion potato, for a case in point. As a treatment for apple-scab (*Fusicladium dendriticum*, Fckl.) it is recommended to thoroughly spray the trees, before growth begins in spring, with copper sulphate solution. This should be followed with an application of Bordeaux mixture as soon as the blossoms have fallen. In a wet season two or three more dressings will be necessary to produce the best results. The addition of Paris green to the second and third applications will keep the codlin-moth and the canker-worm in check. A caution is given never to spray with arsenites when fruit-trees are in bloom, or the bees will be killed.

AN attempt at a partial restoration of the geography of the world in Cretaceous times is made by Dr. F. Kossmat, of Vienna, in the May number of the *Records* of the Indian Geological Survey. He recognises the broad distinction of Atlantic and Pacific faunal provinces in Cretaceous times, a distinction very marked in the northern hemisphere, but disappearing to the south of the then existing Indo-African continent. The Cretaceous beds of Southern India form the clearest link between the two; combining in their fauna the typical Pacific forms with others characteristic of Central Europe. Their connection with the latter area was a roundabout one, through Natal, Angola, and the Atlantic, by which they are also linked to the Cenomanian and Danian deposits of Brazil. The fauna of Northern India is quite distinct, and must be regarded as inhabiting the easterly termination of the Mediterranean province, one which was an almost isolated area, though to the westward, in the Gosau beds and those of Southern France, we can see evidence of a connection with the Atlantic. Further west a similar fauna is found in the Antilles, and extends even into the Pacific region in Peru. The fauna of North America shows close affinities with that of Europe, and less marked relations to that of Southern India, while it stands sharply contrasted with that of the Pacific side of the continent. The upper Cretaceous beds of Atlantic facies are found, however, to extend into British Columbia and Queen Charlotte's Islands, and there rest upon lower Cretaceous beds of Pacific facies. The American continent must thus have existed as two great insular masses forming a barrier between the two great marine provinces, broken across by two arms of the sea. The author purposes constructing a chart to embody these conclusions.

THAT quite a considerable number of bacteria exist which will only grow at such high temperatures as lie between 50° and 70° C., was first shown by Globig; but his investigations only succeeded in demonstrating them in the superficial layers of soil. Now, however, we know that such bacteria are to be found in river water and mud, in fœces, and at considerable depths in the soil. Quite recently Dr. Lydia Rabinowitsch has made extensive researches in Dr. R. Koch's laboratory on these so-called thermophilic bacteria, and their distribution appears to be much wider than was at first supposed. Thus Dr. Rabinowitsch has found them abundantly present in surface soil collected from various parts of Berlin and other places in Germany; they were also discovered in freshly-fallen snow, indicating their probable presence in the air, and large numbers were obtained from river Spree water, although they were not found in the Berlin water supply; they were also isolated from excrementitious matter derived from horses, cows, goats, dogs, rabbits, ducks, parrots, some fish and other cold-blooded animals, such as the frog and python. These bacteria are also present in large numbers in the mouth and all along the intestinal tract of man. Cow's milk contains them, and they are not destroyed even when the latter is vigorously boiled. The most favourable temperature for the growth of these thermophilic bacilli lies between 60° and 70° C., but they may be induced to grow also between 34° and 44° C. It would be interesting to learn what part is played by these bacteria in nature, and it is to be hoped that Dr. Rabinowitsch will continue these investigations, and instruct us as to these functions of thermophilic bacteria.

DR. J. HANN has sent us a copy of his paper on the conditions of atmospheric electricity on the summit of the Sonnblick mountain, deduced from the records of an improved registering hair hygrometer by Richard, which had been adjusted and tested at the Central Meteorological Office in Vienna. The discussion is one of much importance, and the subject is treated by Dr. Hann in a very thorough manner; but the space at our disposal will only allow us to notice briefly some of the general results. The yearly range of relative humidity on the mountain is the reverse of what it is over the plains; the minimum, or greatest dryness, occurs in winter, and the maximum in spring and summer. This much was known from observations at Alpine stations, but at these the uncertainty of the behaviour of the hygrometers in low temperatures made the results doubtful. Temperature and vapour pressure on the Sonnblick run in nearly parallel curves, each degree of difference of temperature corresponds to a change of tension of vapour in the same direction. With regard to the daily range, it is found that in all, except the three winter months, there is low relative humidity in the morning and a great humidity during the evening and night. In winter, however, the case is very different; from about 6h. p.m. to 7h. a.m. the relative humidity remains below the mean, and from 9h. a.m. to 5h. p.m. it is above the mean. The daily range of absolute humidity (vapour tension) is nearly the same in all seasons of the year; the minimum occurs early in the morning, and the maximum in the afternoon. The most remarkable feature in the daily range of relative humidity is that on very clear and warm days, long before the rise of the sun has any effect, the humidity falls below the mean value on the Sonnblick, and by about 6h. in the morning, it has fallen nearly 7 per cent. below the daily mean. This important fact seems to show that the relative dryness of the forenoon on mountains is due to a descending movement of the atmosphere, caused by the winds blowing from the mountains to the valleys during night-time, and thus cooling the sides of the mountains.

THE July *Journal* of the Chemical Society contains the paper on "Helium, a Constituent of certain Minerals," by Prof. W. Ramsay, Dr. J. Norman Collie, and Mr. M. Travers, read before the Society at the last meeting. There are also fifteen other papers read before the Society, and 138 pages of abstracts of chemical papers published in other journals.

WITH the current number, the *Medical Magazine* enters upon its fourth year of issue. The magazine is always readable, not only by members of the medical profession, but by the laity, and the papers which it publishes on medical history and literature are invariably of general, as well as technical, interest. We notice among the articles in the number before us, one on "Mountain Sickness," by Dr. H. Kronecker; and another on "Immunity," by Dr. J. G. Sinclair Coghill.

UNDER the title *Beiträge zur wissenschaftlichen Botanik* a new contribution to general botanical literature is announced, to be edited by Dr. M. Fünfstück, and published by Nägele, of Stuttgart. The first number, which is already published, contains papers on the physiology of woody plants, by Lutz; on the action of "Bordeaux-brühe" and its constituents on *Spirogyra longata* and on the uredespores of *Puccinia coronata*; and on the oily excretions of calcareous lichens, by the editor.

THE report for 1894 of the American Museum of Natural History shows that a number of valuable specimens were added to the collections last year. The new wing, for the building and equipment of which 550,000 dollars (£110,000) were voted in 1893 and 1894, is approaching completion, and is expected to be opened to the public in the autumn. Since the preparation of the report, the Legislature has given power to the authorities of New York City to appropriate £100,000 for a further enlargement of the museum, and for an increased grant of £4000 annually, for maintenance. The erection and equipment of another wing to the museum will provide the facilities for carrying out the plans of the Trustees for the establishment of a great department of Anthropology.

THE report of the Trustees of the South African Museum, for the year 1894, has been received. As the staff of the museum does not include collectors, it is gratifying to learn that nearly seven thousand specimens were presented by private collectors during last year. That the museum is appreciated is evidenced by the fact that the number of visitors in 1894 was nearly twenty-six thousand. The Curator, Mr. R. Trimen, has completed the manuscript of descriptions of new Lepidoptera from Mashonaland, which will be published at the beginning of the year. He has also begun the incorporation of the tropical African insects of this order in the South African collection, adopting the 16° of latitude S. as the South African limit. The staff has been increased by the appointment of Dr. G. S. Corstorphine as assistant in the department of geology and mineralogy. A report by him, on the existing collection of that department as at present exhibited, is appended to the report of the Trustees.

THE additions to the Zoological Society's Gardens during the past week include a Campbelli Monkey (*Cercopithecus campbelli*) from West Africa, presented by Miss C. Thompson; a Yellow-billed Sheathbill (*Chionis alba*), captured at sea, presented by Captain Plunket; four Common Chameleons (*Chamæleon vulgaris*) from Egypt, presented by Mr. J. C. Mitchell; a Sharp-nosed Crocodile (*Crocodilus acutus*) from Columbia, presented by Mr. James G. Green; a Royal Python (*Python regius*) from West Africa, presented by Colonel Frederick Cardew; an Alexandra Parrakeet (*Polytelis alexandræ*) from Australia, six Grey Francolins (*Francolinus ponticerianus*) from Mombassa, a Black Tortoise (*Testudo carbonaria*) from South America, deposited; five Fennec Foxes (*Canis cerdo*), two Variegated Jackals (*Canis variegatus*), two Libyan Zorillas (*Ictonyx lybica*), two Egyptian Cats (*Felis chaus*), three Dorcas Gazelles (*Gazella Dorcas*), four White Pelicans (*Pelecanus onocrotalus*), a Grey Monitor (*Varanus griseus*), from Cairo, received in exchange; a Wapiti Deer (*Cervus canadensis*), two Short-headed Phalangers (*Belideus breviceps*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

THE NEW MADRAS OBSERVATORY.—Prof. Michie Smith, the successor of Mr. Pogson at Madras, has lately made known a few particulars relating to the new Solar Physics Observatory which is to be erected in India. The funds have been voted by the Indian Government, and the site selected is in the Palani Hills at Kodaikanal, 300 miles south of Madras. The daily work of photographing the sun, which is now carried on for the Solar Physics Committee at Dehra Dûn by the officers of the Indian Trigonometrical Survey, will form part of the routine work of the new observatory. It is also proposed to undertake a systematic spectroscopic examination of the sun, but the details of this portion of the programme have not yet been finally determined upon. The climate of Kodaikanal seems to be almost all that can be desired for astronomical purposes. The mean daily temperature varies from 54°·1 C. in December to 62°·2 C. in May, while the rainfall is about 47½ inches. From March to December in the year in which observations were specially made, the bright sunshine amounted to 1634 hours; the morning is usually bright until about eleven o'clock, then clouds come up and continue until about four o'clock; by six o'clock the sky is generally cloudless. Except during the north-east monsoon, a night which is wholly cloudy is almost unknown. Under these highly advantageous conditions, there is every prospect that the establishment of this observatory will result in a great gain to astronomy, especially in the department of solar physics.

STAR CATALOGUES.—An admirable *résumé* of the history of star cataloguing, from the pen of Mdlle. Klumpke, the gifted directress of the *Bureau des Mésures* of the Paris Observatory, appears in the current number of the *Bulletin* of the Astronomical Society of France. From an instrumental point of view three great epochs may be recognised, each marked by some important discovery. The first epoch is that in which the line of vision is defined by hollow cylinders or by an alidade, and extends from the time of Hipparchus to that of Hevelius; it comprises the catalogues of Hipparchus, Ptolemy, Ulugh-Beigh, and Tycho Brahe. The catalogue of Hevelius, though drawn up from observations with the naked eye, marks a transition period, as he took advantage of the application of the pendulum to the regulation of clocks.

The second epoch is marked by the application of the telescope for accurate sighting of the heavenly bodies, and the employment of the sidereal clock. This period commenced with Flamsteed, and extends even to the present time. In the third epoch the photographic plate replaces the eye. Enthusiasm for this method of cataloguing the stars commenced with the fine results obtained by the Henrys, but it should not be forgotten that as far back as 1865, Rutherford obtained photographs of stars down to the ninth magnitude, and that he clearly foresaw the advantages to be derived from the photographic method. All the world knows now that a great photographic chart of the heavens, initiated by the late Admiral Mouchez, is in course of construction, eighteen observatories participating in the gigantic undertaking. Mdlle. Klumpke estimates that this international catalogue will contain upwards of three millions of stars.

The photographic method, however, does not yet appear to be without imperfections, as the impressions on the negatives are not certainly permanent. In a communication to the editor of the *Observatory*, Dr. Isaac Roberts gives some figures relating to the disappearance of the smaller images in the course of years; in one negative no less than 130 out of 364 star images had disappeared in nine and a quarter years. Hence it is important that as short a time as possible should elapse between the taking of a photograph and its reduction, or, better still, its manifolding by some carbon process.

THE PLACE OF ARGON AMONG THE ELEMENTS.

THE position of argon in a classification of the elements depending on atomic weights has been recently defined by C. J. Reed (*Journal of the Franklin Institute*, July). The elements are assigned positions on a plane determined by abscissæ proportional to their atomic weights and ordinates proportional to their valency. Oxygen is assumed to have an electronegative valency 2, and the valency of other elements is referred to this as standard; electro-positive valency is measured upwards, electro-negative downwards from the zero-axis. Under these conditions most of the elements fall on a peculiar series of double, equi-distant, parallel straight lines, connecting elements in order of their atomic weights and separated alternately by distances corresponding to one and sixteen units of atomic weight respectively.

If the plane be now folded into a cylinder with axis parallel to the abscissæ and a circumference of eight units of valency, it is found that the upper and lower parts of the connecting lines coincide; the whole of these lines then form a parallel pair of spirals on the surface of the cylinder, and valency in angular measure becomes directly proportional to atomic weight.

The regularity with which the elements of lower atomic weight fall alternately on each of the parallel spirals is very striking, but this regularity is not maintained among elements of high atomic weight, notable deviations occurring with most of the elements of which the atomic weight ranges from 100 to 130. The axis of atomic weights represents the valency + 0 or + 8 and is cut by the double spiral in fifteen points. There should then be a group of fifteen elements having a valency of zero or eight, and their atomic weights should be, respectively, 4, 20, 36, 52, 68, 84, 100, 116, 132, 148, 164, 180, 196, 212, and 228. All the known elements appear to be grouped together on certain regions of the surface of the cylinder, other parts remaining comparatively bare. The only members of this family to be expected to occur in terrestrial matter will be those in the inhabited regions of the cylinder surface. The hypothetical elements having atomic weights 20, 36, 84, and 132 are the most necessary from this point of view.

It seems reasonable to suppose from the peculiar position of these elements on the border-line between electro-negative and electro-positive valencies, that they should be more strongly electro-negative than the corresponding members of the sulphur group, and should nevertheless be without valency (or octads). They should, in general, be more volatile than the corresponding members of the sulphur group. As electro-negative valency diminishes in any group with increase of atomic weight, the element 196, if it exists, cannot be expected to be electro-negative. This element should be a volatile metal, heavier and scarcer than gold, and capable of easier reduction to the metallic state; it should be capable of forming an oxide RO_4 or a salt K_2RO_5. The volatile metal osmium agrees with the requirements of this element very closely. Similarly, ruthenium may possibly be the element 100.

Finally, argon falls naturally into the place of element 20, and possesses, so far as is known, the properties to be expected of this element in position 20 in the new group. Argon and element 36 should be comparatively abundant in nature, while 84 and 132 should be scarce, but not more rare than selenium and tellurium.

On Mr. Reed's system, argon should be element 36 if it be monatomic as now believed, and not 20 as he assumes; the actual atomic weight found, 39·9, would then indicate the possibility of the presence in argon of some small quantity of element 84 or element 132. It is remarkable also that, if helium has the atomic weight 4, it falls naturally in this group, and that its atomic weight deduced from the observed density is somewhat greater than this number. If this difference should be due to the presence of some small quantity of element 84, then the spectroscopic evidence leading to the conclusion that argon and helium contain a common constituent would be explained.

POCKET GOPHERS OF THE UNITED STATES.

IN *Bulletin* No. 5 of the U.S. Department of Agriculture, Mr. Vernon Bailey gives an account of the habits and life-history of the Pocket Gophers of the United States, which contains a number of interesting facts and observations derived from various sources. These curious little rodents live underground in burrows which they tunnel in the soil. When working their way through the earth, they use the upper incisors as a pick to loosen the ground, while the fore-feet are armed with strong curved claws for digging. When a sufficient quantity of soil has accumulated behind an animal, he turns in the burrow and pushes it out in front until an opening in the tunnel is reached; the earth is here discharged, and forms a hillock similar to the hills thrown up by moles. Gopher burrows are extended and added to year by year, and the course is marked by the hills of soil brought up to the surface. Gophers do not hibernate, as has been commonly supposed, but work steadily throughout the winter. They do a great deal of good in mixing the soil, and in this way are probably most useful on poor or uncultivated ground. But, on the other hand, in agricultural districts the animals are highly injurious; they devour potatoes and other tubers and roots in large quantities, as well as corn, wheat, and other farm crops; and they destroy great numbers of fruit trees by gnawing off the roots. Gopher burrows also often do a great deal of damage in meadows or on the banks of artificial water-courses. So great is the harm done by Gophers, that in many districts bounties have been offered for their capture. One of the most striking features of Pocket Gophers is their possession of cheek pouches opening outside the mouth. It is commonly supposed that these pouches are used for carrying earth out of the burrows; but Mr. Bailey's investigations lead him unhesitatingly to the conclusion that this view is erroneous; they are used only for carrying food—pieces of potato and roots, leaves, &c.—to be eaten at ease in the seclusion of the animals' burrows, or to be stored up for use in the winter. The food is passed into the pouches by the fore-feet; and the animals empty their pockets by pressing the sides of the head with the fore-feet from behind forwards, so that the contents fall out in front of them. In disposition Gophers are very fierce; and on the rare occasions on which they wander from their holes, frequently attack passers-by without any provocation. They are not very prolific animals, as is commonly stated, for only one litter of two or three young is produced in a year; but, although their rate of increase is slow, their mode of life protects them from many enemies which attack squirrels, mice, and many other rodents. The Pocket Gophers of the United States belong to three genera, *Geomys*, *Cratogeomys*, and *Thomomys*; Mr. Bailey gives two charts illustrating the distribution of these different genera and their constituent species.

COLOUR PHOTOGRAPHY.

AN important paper on the theory of colour photography is contributed to No. 6 of *Wiedemann's Annalen*, by Herr Otto Wiener. The paper deals with the methods of attacking this problem which are based, not upon the photography of the different constituents of coloured light and their subsequent recognition—like Mr. Ives's heliochromy and similar processes—but upon the direct production of colour by the influence of light upon certain chemical substances. The most recent, and in a way the most successful of these methods is that due to Lippmann, and the question raised by Herr Wiener is whether the old processes invented by Becquerel, Seebeck, and Poitevin are based upon interference colours like Lippmann's, or upon "body colours," *i.e.* colours produced by partial absorption of the incident light. That Lippmann's colours are due to interference may be very simply proved by breathing upon a plate with a photograph of the spectrum, when the colours quickly wander towards the violet end, this result being due to an increase in the distance between the nodal layers. This experiment cannot be applied to a spectrum photographed by Becquerel's method. But Herr Wiener succeeded, by a simple and ingenious contrivance, altering the path of the rays through the coloured film by placing a rectangular prism on the plate, with its hypothenuse surface in contact with the spectrum. This experiment had the startling result that that part of the spectrum covered by the prism appeared strongly displaced towards the red. Hence Zenker's theory of Becquerel's process, enunciated in 1868, which ascribed the colours to interference, is substantiated. Instead of Becquerel's homogeneous sheet of silver chloride containing subchloride, Seebeck used the powder, and Poitevin mounted the salt on paper. In these two processes the effect described is not observed. Hence these colours are body colours in these two cases. The production of these body colours is a very mysterious process, but the author hopes that here will eventually be found a satisfactory solution of the problem. To account for the production of these colours he advances a remarkable theory which has a well-known analogy in comparative physiology. Given a collection of compounds of silver chloride and subchloride of indefinite proportions, such as those which Mr. Carey Lea calls by the collective name of "photochloride," we must suppose according to the modern kinetic theories that they are undergoing a rapid series of successive modifications. When the red combination happens to be exposed to red light, it reflects it without absorption, and will therefore no longer be affected or changed by it. Similarly for the other cases. This is another process of "adaptation." The author describes some experiments which prove that this is the true explanation, and points out the importance of this view, not only for colour photography, but for the production of colours in the animal world.

THE SLATE MINES OF MERIONETHSHIRE.[1]

AN official Blue Book drawn up by a Departmental Committee appointed by Mr. Asquith, and referring to the dangers of slate quarrying in Merionethshire, has recently appeared. After a brief account of the mode of occurrence, the method of getting the slate by true mining operations is described, and the principal causes of accidents are enumerated and explained. Judging by the statistics of the last nineteen years, the underground worker in Merionethshire is exposed to greater risks than the average collier; some 40 per cent. of the deaths are caused by falls of rock, a fact which causes no surprise when one considers the conditions under which the slate-getters carry on their daily work in huge chambers, the roofs and sides of which cannot be examined without rigging up lofty ladders.

An interesting table of death-rates shows that the Merionethshire slate quarrymen are better off as regards the safety of their occupation than many other classes of workmen, such as navvies, railway servants, and sailors.

The medical evidence, especially that of Dr. Richard Jones, is very complete, and we learn that some of the ills of the Merionethshire quarrymen are practically of their own making. Judging by the report and the evidence upon which it is based, the men are not cleanly in their ways, and if their sober habits lead them to ruin their digestions by stewed tea, it becomes a question whether their so-called, but incomplete, temperance is an unmixed benefit.

For preventing accidents, the Committee make several useful suggestions; one of the most important is their advocacy of "channelling machines" or "groove cutters," for assisting in getting the slate, instead of violently wrenching off the blocks by blasting.

The value of the report is enhanced by some useful appendices, a copious index of the evidence, and several woodcuts and plates. The plates are noteworthy as being the first instances of reproductions of photographs in a Blue Book by the half-tone process. Five of the eight photographs were taken underground by magnesium light; the two best, which represent ladders set up in underground chambers, are the work of Mr. Burrow, of Camborne, already well known by his successful pictures of Cornish mines.

The report is signed by Mr. Le Neve Foster, the Inspector of Mines of the district, Mr. J. E. Greaves, the owner of one of the largest slate mines, Mr. E. P. Jones and Mr. J. J. Evans, both quarry managers of wide experience, and Mr. J. Jenkins, President of the Quarrymen's Union. The opinions of a practical Committee of this kind are entitled to consideration, and it will be interesting to note how far their suggestions are carried out, and how far they attain their object, viz. the increased safety and general well-being of the Merionethshire quarrymen.

[1] Report of the Departmental Committee upon Merionethshire Slate Mines, with Appendices. Presented to both Houses of Parliament by command of Her Majesty, 1895.

THE RELATION OF BIOLOGY TO GEOLOGICAL INVESTIGATION.[1]

II.

THE RELATIVE CHRONOLOGICAL VALUE OF FOSSIL REMAINS.

REJECTING the idea of special endowment held by early geologists, we must consider the relative chronological value of fossil remains with reference to the natural laws which have produced their characteristics and governed the various conditions of their origin. Much may profitably be said concerning the comparative chronological value of the different genera, families, &c., belonging to one and the same class of any branch of either the animal or vegetable kingdom, or to different classes; but I propose to discuss only the broader relations to one another of the more general kinds of fossil remains. These discussions will relate to the time-range of each of those general kinds, the various conditions under which they have been preserved, the various conditions of habitat of the animals and plants which they represent, the relative rate of evolutional development of the different kinds and their differences of reciprocal relation to one another.

No fact in historical geology is more conspicuous than that of the great differences in time range of the various kinds of organic forms, some of them having ranged through the whole of the time represented by the geological scale, while others, and among them some of the biologically most important kinds, ranged through only a comparatively small part of it.

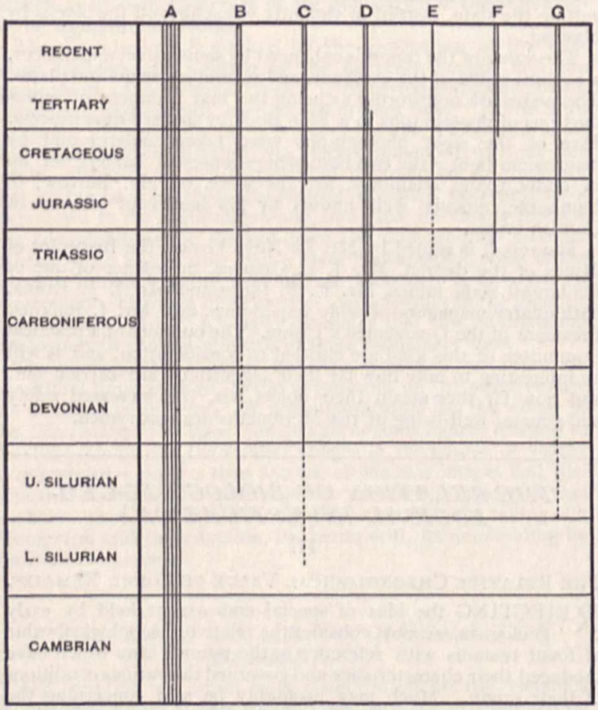
A special grouping of the different kinds of fossil remains is more appropriate for these discussions than is a strictly systematic one, and I have therefore adopted the following: (*a*) marine invertebrates, (*b*) non-marine and land invertebrates, (*c*) fishes, (*d*) batrachians and reptiles, (*e*) birds, (*f*) mammals, and

[1] By Charles A. White. Abstract of a series of eight essays published in the Report of the United States National Museum. (Continued from p. 261.)

(*g*) land plants. For convenience of reference, our present knowledge of the time-range of these kinds may be presented in tabular form. The accompanying illustration, representing the whole of geological time by its height, indicates in a general way by perpendicular lines the time-range of the kinds just mentioned, and remarks in following paragraphs further explain the known range of some of the subordinate, as well as that of the principal kinds.

The horizontal spaces of the table represent the systems or stages of the geological scale. The proportionate width of the spaces which contain the names of those systems or stages is not intended to indicate the actual ratio of geological time for each, but it may be stated as the general opinion of competent nvestigators that the portion of the scale from the Cambrian ' the Carboniferous inclusive represents a much greater length of time than does the portion from the Trias to the Tertiary inclusive. In other words, it is generally believed that the Palæozoic portion of the geological scale was of much longer duration than was that of the Mesozoic and Cenozoic portions together.

The perpendicular lines in the table, which are placed singly or in pairs or groups under letters of the alphabet from A to G



Time range of fossils.—(A) Marine invertebrates, (B) non-marine and land invertebrates, (C) fishes, (D) batrachians and reptiles, (E) birds, (F) mammals, and (G) land plants.

inclusive, represent the time-range of the kinds of animals and plants which have already been mentioned, and which for convenience of reference are again recorded with their corresponding letters at the foot of the table. This method of grouping the different kinds of animals and plants, as already intimated, is adopted only for present convenience in making comparisons of chronological values. All the principal kinds which are designated in the usual systematic classification are, however, included in these special groups, the few that are omitted being regarded as of little or no importance in this connection. The dotted portion of certain of the lines indicates uncertainty as to the real extent of the time-range which is shown by them, because of imperfect or doubtful representation of those kinds by discovered fossil remains.

Of all the animals which have existed upon the earth, and of which remains have been discovered, only those of marine invertebrates have been found to range through the whole geological scale. The time-range of these important portions of the animal kingdom is represented by the group of five perpendicular lines under the letter A. The marine invertebrate life thus represented includes the Protozoa, Cœlenterata, Annuloida, Annulosa, and Mollusca, the latter including the Molluscoida. That is, it includes five of the six sub-kingdoms or branches of the animal kingdom.

The non-marine and land invertebrates, the time-range of which is intended to be represented in the table by the two perpendicuiar lines under the letter B, are only insects and fresh-water, brackish-water, and land molluscs. The discovered fossil remains of all other non-marine and land invertebrates are regarded as either too rare or too unimportant to be profitably considered in the comparisons which are to follow. The longer of the two lines may be taken as representing the known time-range of insects, and the shorter that of land and non-marine mollusca.

The pair of perpendicular lines in the table under the letter C shows the approximate time-range of all the various kinds of animal remains which have been referred to the fishes. The shorter of the two lines indicates the known range of the teleostean fishes, and the longer that of the other kinds, the latter including certain forms that differ materially from any living fishes.

The time-range of batrachians and reptiles, so far as it is known, is shown by the three perpendicular lines in the table under the letter D, that of the dinosaurs alone being represented by the shortest line of the three.

The known time-range of birds is represented by the single line under the letter E. It is here assumed that most, if not all, the fossil tracks found in Triassic strata, and formerly referred to birds, are those of dinosaurs.

The two lines in the table under the letter F represent the known time-range of mammals, the longer line representing that of the non-placental, and the shorter that of the placental mammals.

The known time-range of land plants is represented by the two lines under the letter G. The shorter line represents the range of the dicotyledons and palms, and the longer one that of all other kinds. The algæ and diatoms are omitted from the table, as being of little or no importance in the comparisons and discussions which are to follow.

The earlier portion of the time-range for each of the kinds of animals and plants, as shown by the perpendicular lines in the table, is naturally more incompletely and indefinitely represented by fossil remains than is the later portion, because of the smaller variety and greater rarity of those earlier remains, and also in most cases because of the increasing difference in character from living forms which is observable from later to earlier formations. In some cases, however, the early portion of the time-range as it is now known begins so suddenly, and with forms of such high biological rank, as to make it evident that its real beginning was much earlier than it has yet been proved to be by actual discovery of fossil remains. The last-mentioned fact is of great importance in many respects, but it does not necessarily affect the question under consideration, because all estimates of the relative chronological value of fossil remains must be confined to the kinds already known, and the application of such estimates must refer only to those portions of the geological scale in the strata pertaining to which the remains are known to occur.

It has been shown that it is the general advancement in biological rank for all organic forms and for the whole of geological time that constitutes the ideal ultimate standard of measure for that time. It does not necessarily follow, however, that the geological scale is actually based upon the combined average rate of advancement of all those forms, because this is a factor which cannot be definitely ascertained. Still, in all cases it is necessary to apply that idea so far as is practicable.

In view of the facts recorded in the preceding paragraphs, the highest estimate of chronological value must necessarily be placed upon the fossil remains of those kinds which have existed under the most nearly uniform conditions through the whole of geological time, and which give evidence of the most nearly uniform advancement in biological rank. Accordingly, the remains of marine invertebrates possess legitimate claims to a higher estimate of chronological value than do those of any other kinds of animals or of plants.

It is true that the rate of development in biological rank of marine invertebrates does not embrace the entire advance for the whole animal kingdom, because it begins in the scale as it is now known with many highly organised forms, and ends without including the vertebrates; but this fact does not affect any of the necessary elements of their superior chronological value, which have just been mentioned. The following summary of facts relating to the marine invertebrates show their principal claims to the highest estimate of value in characterising the divisions of the geological scale, and in determining the geological age of the strata in which their remains are found.

The marine invertebrates embrace five of the six sub-kingdoms or branches of the animal kingdom.

They have coexisted in every stage of geological time, while the known time-range of other animals, as well as of land plants, has been very much less.

The preservation of their remains having been a natural consequence of the character of their habitat, they are faunally more complete than are those of any land animals, and for the same reason they are florally more complete than are remains of land plants.

They all lived under the same or closely similar conditions, and those conditions were more nearly uniform throughout all geological time than were those under which any other forms of life existed. Their remains have, therefore, produced a more nearly uniform chronological record.

Their relations to one another were wholly congruous, while the relations of all of them to all non-marine faunas and land floras was more or less incongruous, and in many cases extremely so.

The formations containing their remains are for the whole world and the whole of the geological scale far in excess of those which contain the remains of any other forms of life, especially the remains of land plants and land animals.

CORRELATIVE GEOLOGY AND ITS CRITERIA.

The term "correlative geology" is not in common use, but it is adopted as a present convenience in discussing the correlation of assemblages of strata as divisions or subdivisions of the geological scale as it is developed in separate regions, and the identification of formations within one and the same district or region. As here used, the term correlation refers to geological systems or other comprehensive series of stratified rocks which occur in different and more or less widely separated parts of the world, between which parts there is no physical continuity of strata, or none that it is possible to discover. Correlation applies to general geology, identification to local or regional investigations.

The latter may be discussed under two heads, direct and relative. Direct identification applies to formations the characteristics of which at one or more localities have been ascertained, and as these are naturally of limited geographical extent, the application is similarly restricted.

Although fossils in all cases constitute not only much the most, but usually the only, trustworthy criteria for such indentification of formations as is indispensable in the study of structural geology, the various kinds differ materially as to their relative value. This value, however, has no necessary relation to that which they may possess as indicators of geological time, or of the correlation of the strata containing them with those of other parts of the world. The two values are distinct, although one kind of fossil remains may often possess both.

While fossil remains unquestionably afford the most trustworthy and often the only means of either direct or indirect identification of formations, in the absence of these means the geologist often reaches conclusions in this respect by methods of reasoning that it would be difficult even for himself to formulate, and these conclusions are valuable in proportion to his acquirements and experience. Among these less clearly definable methods is that which takes cognisance of homogeny; that is, of a method in connection with which certain inherent lithological and stratigraphical characteristics, which are possessed by a formation or series of strata in one part of a given region under investigation, are accepted as evidence that it had a common origin with a formation or series presenting similar characteristics in another part of the same region. Such a conclusion necessarily implies that originally there was physical continuity of similar strata between such localities, and that it has either been destroyed or obscured.

This method of identifying formations is one of minor importance as compared with that which is based upon fossil remains, but unfortunately it has, especially within the last few years, been adopted by certain geologists in charge of important works, almost to the entire exclusion of palæontological considerations. Although it cannot be denied that in the hands of an experienced and broad-minded investigator this method of identifying formations is of great value, the fact remains that some of the most grievous mistakes that have ever thrown discredit upon geological investigation have occurred by its adoption to the exclusion of palæontological evidence.

It has been the custom of a large proportion of geologists to regard the geological scale as it has been established in Europe as the absolute standard for the whole earth. A necessary consequence of this view is their assumption that the systems which physically constitute that scale, and at least most of the divisions of those systems, may not only be recognised, but as clearly defined in all parts of the earth as they are in Europe, if in those parts contemporaneous deposits were made and still remain intact.

In view of known facts and principles, the idea held by the early geologists, as well as by some of those now living, that identity of fossil types proves synchronism or exact contemporaneity of origin of any two or more series of strata containing them, is quite untenable. The facts which have been presented also suggest that the term "homotaxy" must be used with some degree of latitude as to its application to the subdivisions of systems, because the order of sequence in the occurrence of the types which characterise them, respectively, in one part of the world is in another part sometimes partially reversed or partially interchanged. That is, the taxonomy of those divisions, as biologically indicated, is not the same for all parts of the world.

The presence in widely separated parts of the world of all the systems of the geological scale, as well as of some of their larger divisions, has been demonstrated by the labours of a multitude of geologists, so the fact of correlation is not called in question. The principal questions which are here raised concern the scope of correlation, or the limitation of the assemblages of strata, the relation of which to respective divisions of the scale is more or less obvious. These questions are of practical application in the study of the structural geology of any part of the world other than that in which the geological scale was established; but they are of such a character that they must be conventionally rather than arbitrarily determined.

For example, in discussing the questions which have arisen concerning the earlier and later limits of the systems of the geological scale in North America, the difference of opinion as to those limits have been wider and more various with regard to the later systems than to the earlier. This is because of the greater number and variety of the kinds of fossil remains to be considered in such discussions of the later systems. It is therefore evident that in reaching a conclusion as to the limitation of any of these systems, or of any of their subdivisions, it is necessary to take into consideration all available facts, physical as well as biological. It is equally evident that it is the duty of every American geologist to hold in abeyance any final decision as to the correlation of the groups of strata which he may study with the divisions of the European scale until all such facts have been duly and justly considered. In short, the idea of absoluteness in such cases is as much out of place as is the assertion or recognition of personal authority.

Although these remarks refer directly to North American geology and geologists, they are equally applicable to other parts of the world when reference is made to the scale as represented by the European rocks.

Notwithstanding the great excellence of the scale now in general use, and the fact that so little change has been made in it since it was first devised by the early geologists, the future progress of geological science will demand modifications the necessity for which will be especially urgent when the true character of correlation for all the principal parts of the earth has been ascertained. Hitherto correlation has been investigated with the single purpose of adjusting the series of formations which occur in each of the various parts of the world to the scale now in use; but although its general applicability to that purpose is not to be questioned, the ultimate result of the study of correlation will be to modify this scale and adjust it to the systematic geology of the whole earth. That is, the scheme of stratigraphic classification, which has been the main factor in adjusting the elements of systematic geology, must in turn be itself adjusted to the great system which it will have been the principal agent in producing.

CRITERIA OF PAST AQUEOUS CONDITIONS.

Among the more conspicuous facts in geology are some of those which relate to the manner of origin as well as to the original and present condition of the sedimentary formations. These subjects have already been discussed, and among those discussions are some references to the character of the water in which each formation was deposited. Studies of the sedimentary formations, especially those made from a biological standpoint, have demonstrated that the bodies of water in which they were deposited were of the various kinds that are now known; that is, some were marine, some fresh, and some brackish.

Upon physical evidence alone, it is not practicable to satisfactorily classify the sedimentary formations of the earth in such a manner as to serve the purpose of thorough geological investigation. Therefore such data are in this, as in most other cases, chiefly valuable as being accessory to the evidence afforded by biological data.

The biological criteria which are relied upon by geologists to distinguish from one another the sedimentary formations which have been produced in marine waters, or in those of inland seas, lakes, rivers, or estuaries, relate to the characteristics of faunas which now inhabit those waters respectively, and to the differences from one another of such faunas. That is, the conclusions which geologists reach concerning the questions just indicated are based upon now-existing physical conditions, upon the known character, structure, and habits of animals with relation to those conditions, and upon the assumption that in past geological epochs animals of a given character and structure had similar habits, and lived under conditions similar to those which are congenial to their living congeners.

The various bodies of water which existed during geological time, and which constituted the habitat of aquatic animals, were of the same kinds that now exist, namely, marine and fresh, together with those of the various intervening grades of saltness. Although it is probable that the marine waters of early geological time were not so salt as those of the present oceans, it is believed that this difference in saltness has not been so great as to make any appreciable difference as to legitimate conclusions of the kind that have been indicated. It seems to be especially evident that this difference has been thus inappreciable since the close of palæozoic time, since which time the greater part of the known unmistakably non-marine formations were deposited.

If all the known now living members of a given family are confined to marine, or to fresh waters, as the case may be, it is assumed that the habitat of the extinct members of such families were similarly restricted, and that the presence of fossil remains of such animals in a given formation, is, in the absence of conflicting facts, sufficient evidence of its marine origin on the one hand, or of its fresh-water origin on the other. Again, if a given family is known to have representatives now living in marine, brackish, and fresh waters, respectively, it is assumed that it had a similar range of habitat during past geological epochs. Therefore, the discovery in a given formation of fossil remains of a single representative of a family having such a varied range of habitat is not of itself sufficient to enable one to decide whether it was of marine, brackish, or fresh-water origin, and other evidence must be sought.

The criteria of past aqueous conditions here discussed are, of course, only such as may be derived from sedimentary formations and their contents. It cannot be said that there are any fully trustworthy physical criteria because a non-marine formation rarely presents any condition of stratification, or any lithological character, which is not observable in some marine formations. Still, there are many more or less valuable indications which may be observed and to some degree relied upon in the absence of fossil remains.

For example, although considerable accumulations of calcareous strata are sometimes found among the generally arenaceous strata of fresh-water formations, they have never been found to contain any important accumulations of regularly bedded limestones. Furthermore, estuarine deposits are often still more of a detrital character than are fresh-water formations, and also they more rarely contain calcareous layers. Therefore, if one should encounter a series of regularly bedded limestones, either magnesian or fully calcareous, he will rarely, if ever, be at fault in regarding them as of marine origin even without biological evidence.

In a large proportion of the non-marine formations, the stratification is less regular than is usually the case with marine formations. Still, this is by no means a certain criterion, and in some cases non-marine formations are found to rest so conformably upon the marine and to be so conformably overlain by them as to give little indication of the great difference in the condition of their origin.

These examples serve to show how indefinite is the character of physical evidence as to the past aqueous conditions under which the various sedimentary formations have been produced, but they serve to emphasise a statement of the fact that almost entire reliance must be placed upon the evidence furnished by fossil remains.

With reference to general indications of difference between marine and non-marine formations which are furnished by their fossil remains, we observe that a conspicuous difference lies in the comparative abundance and variety of forms of life which the fossil faunas of the formations respectively represent. Marine waters have always teemed with life in a wonderful variety of forms, and their fossil remains are proportionally abundant. The variety is less in brackish waters, and least of all in lacustrine waters. It is true that ichthyic life is abundant in some fresh waters, but never so generally abundant or so various as in marine waters. It is also true that molluscan life is often locally abundant in shallow fresh waters, but, as already several times mentioned, the variety is extremely meagre. All these peculiarities are distinctly observable among the fossil faunas of the non-marine formations.

Other general indications of difference between marine and non-marine formations are furnished by remains of land plants and animals. Open-sea formations are naturally free from any vegetable remains derived from the land, although coal and other materials of vegetal origin are not unfrequently found alternating with layers containing marine fossil remains. These, however, are regarded as cases of emergence of the bottom of shallow sea waters and the subsequent subsidence of the same as plant-laden marshy land. It is a matter of fact, the reason for which has been suggested in preceding sections, that plant remains of any kind, especially such as are in a classifiable condition, have so rarely been found associated with remains of denizens of marine waters, that the discovery of fossil plants in any formation is of itself presumptive evidence of its non-marine origin.

It has already been shown that the remains of land animals have so seldom reached marine waters, or, having reached them, they were probably so generally destroyed by the triturating action of coast waves, that the discovery of any of this kind of fossil remains in any formation may also be regarded as presumptive evidence of its non-marine origin.

The foregoing statements have been made with reference to indications which are either of a general character or without direct relation to the quality of the waters in which sedimentary formations have been deposited. All the direct evidence, as has been already fully stated, is derivable from the fossil remains of the denizens, especially the gill-bearing kinds, of the waters in which were deposited the formations under investigation.

Referring to the previous review of the animal kingdom, it will be seen that a large number of families of both fishes and invertebrates are confined to a marine habitat, and that every member of even some of the higher divisions is similarly restricted. For example, every known member of the classes Cephalopoda and Brachiopoda is confined to a marine habitat. It will also be seen that a certain small number of families, especially of the mollusca, are equally restricted to fresh waters. The significance of such cases as these has already been pointed out, but it is desirable to refer to them again.

Fossil remains representing any one of these kind of animals may be taken as positive evidence of the quality of the water in which the formation containing them was deposited, provided there shall be no room for reasonable doubt that the animals were really denizens of that water. That is, caution is necessary even in these more positive cases, especially when the amount of discovered fossil material is meagre.

Not only caution but the exercise of careful judgment is necessary in other cases. For example, it will also be seen by referring to the foregoing review that certain families, while most of its members are confined to one kind of water, may have one or more representatives in other kinds; and again, that certain families may have representatives in all the known kinds of habitable waters. In such cases as these it is plain that all evidence afforded by fossil remains, to be of any value, must be corroborated by other evidence.

Still, the cases are very few in which serious doubt need be entertained as to the true character of the water in which a given formation was deposited. This is especially true if the fossil remains are sufficient in quantity and perfection to approximately represent the whole fauna that lived in those waters. Indeed, if the facts which are recorded in this review are borne in mind, there need be no more doubt as to what was the quality of the water in which any given formation was deposited, than might arise concerning any other geological observation.

THE CLAIMS OF GEOLOGICAL SCIENCE UPON INVESTIGATORS, MUSEUMS, &C.

With reference to the ordinary pursuits of life it can hardly be said that, apart from a natural demand for respectable emulation, one's occupation has any claims upon him other than those which are either conventionally or legally imposed by society upon every one of its members. The geological investigator, however, is not only amenable to all such claims, but to others of a different nature which, although not enforceable by legal, and unfortunately not yet by conventional, penalties, are not less imperative in their character.

Much might be said in favour of the demands which may be made in the name of science upon the individual on the ground of justice and of moral and social ethics; but all considerations of this kind will be omitted, reference only being made to those claims which are supported by the urgent necessities of science itself. Claims of the kind referred to might be made in favour of all the various divisions of science; but on the present occasion the discussions will be confined to those which pertain to biological geology, including both its structural and systematic branches. With reference to the manner in which the subject is presented, it is proper to say that thehomiletic form has not been adopted merely from personal preference, but because it appears to be in the present case a proper and effective, if an indirect, method of calling attention to prevalent errors, and of suggesting necessary improvements in certain prevalent methods.

These claims of science will be considered not only with reference to the individual investigator, but to associations, museums, and geological organisations. Those which may be made upon the individual investigator relate to the manner of prosecuting his work and of publishing its results, and also to his final disposition of the evidence upon which his conclusions are based. Claims upon associations or societies relate to the character and methods of publication; those upon museums, to the conservation and installation of fossil remains, and of the records pertaining to them; and those upon organisations, to the preservation of the integrity of geological science.

In considering the claims of science upon the individual, it is desirable to make some reference to the amateur as well as to the special investigator. This recognition of non-professional work is desirable because the general subject of geology has acquired such a hold upon the popular mind, and the opportunities for making observations with relation to it are everywhere so common, that in every civilised country there is a multitude of persons who are in the habit of making more or less critical observations. Notwithstanding the usual limited and desultory character of such observations, they have often contributed materially to the general fund of geological knowledge, especially when accompanied by a faithful record and preservation of evidence. Indeed, some of the most valuable facts in geology have been brought out by amateur observers, who themselves were hardly conscious that they had made their way alone to the frontier of acquired knowledge; and from the ranks of such observers have arisen many of the leaders in geological investigation.

It has been shown that systematic geology could have no existence without the use of fossil remains, and also that without their use structural geology would be reduced to mere local and disconnected studies. It has also been shown that to arrive at a just estimate of the value of fossil remains in these branches of geology they must be thoroughly and systematically studied as representatives of faunas and floras, as well as tokens of the formations in which they are found. The proper collection and preservation of fossil remains is therefore a subject of the greatest importance. In view of these facts it is the plain duty of every geologist, upon beginning a piece of field-work in structural geology, to accompany every step of his examination of the strata by as full a collection as possible of the contained fossils, and to preserve them, together with notes recording the results of his observations and a statement of all the facts relevant thereto.

Fossils thus collected, and the facts concerning them recorded, become invested with a value which differs materially from that which is possessed by ordinary property, and the claims of science upon them and upon the investigator with relation to them at once begin. These claims, as just intimated, require that a careful descriptive record be made of the stratigraphical conditions under which the fossils are found, including a directive record of the locality and designation of the stratum from which they were obtained. They also require that these records should be inviolably preserved and made inseparable from every specimen by indices that shall be as intelligible to other investigators as to the original observer.

Apart from the claims of science such precaution is necessary, because reliance upon memory alone is always unsafe in the most favourable cases, and it can at best give rise only to such oral traditions as are out of place in scientific work. The immediate preparation of the records and indices just mentioned is also necessary, because, while every specimen is at all times competent to impart to an investigator all obtainable knowledge of its own character, it can of itself convey no information as to its original locality and stratigraphic position. With this information secured for a collection of fossils they may be made at all times available as aids to scientific research, not only by the collector, but by all other investigators.

The claims of science also require that immediately upon the completion of the original study of fossils thus collected and recorded, they shall be placed where they will be freely accessible to the scientific public, and that reference to their place of deposit shall be made in connection with their publication. It is needless to say that the only suitable places for such deposit are public museums. It is only when this indispensable evidence is thus made accessible that the public can exercise that arbitration over the accumulated results of the labours of investigators which has been shown to be imperative.

The preparation and publication of complete records concerning the locality and strata from which fossil remains are obtained are necessary even from a biological point of view alone, especially when those remains are studied with reference to the range of organic forms in time, and without such records fossil remains are comparatively worthless as aids in geological investigation. It is unfortunately true that a not unimportant proportion of the palæontological material contained in our best museums is without these essential records, and that many of the publications containing descriptions and illustrations of fossil remains give no satisfactory information as to the localities and strata from which they were obtained, or of the final disposition of the specimens. In such cases those authors and collectors have evidently assumed to decide for themselves and for science the exact taxonomic position in the geological scale of the strata from which their fossils came. In omitting such records as have been referred to, they seem to have considered any information unnecessary that would enable the scientific public to repeat their observations upon their specimens, or those which they may have made in the field, or to learn the biological characteristics of the formations from which their collections were obtained other than those which may be suggested by their own partial collections and their necessarily imperfect descriptions. It is doubtless true that such omissions have been largely due to an honest lack of appreciation on the part of authors and collectors of the importance of preserving such records, but it is to be feared that in some important cases the omissions or suppressions have been intentional. In the former class of cases the fact can only be deplored, but in the latter every geologist is justified in feeling that a crime has been committed against science.

The claims of geological science upon associations and societies are so generally and justly recognised, that only the one which relates to the manner of publishing the results of investigation need be referred to in this connection, and this reference will be confined to the necessity of enforcing the claims upon individual investigators which have already been discussed. This claim may be sufficiently indicated by reference to those last mentioned, and by the remark that if it is the duty of individuals to publish records of their observations in the manner that has been stated, it is plainly the duty of those persons who may be in charge of the means of publication to refuse to publish the writings of those authors who do not conform to that requirement.

The facts and principles which have been stated fully warrant the statements that individual authority can have no existence with relation to geological science, that the public must be the final arbiter of all questions concerning the value of proposed contributions to its advancement, and that a public exposition should be made of the evidence upon which any contribution to biological geology is based. In accordance with the last-named requirement it is necessary to consider the claims of this branch of science upon museums, the force of which is apparent when it is remembered that the material pertaining to it therein stored constitutes the vital evidence of the value of all contributions to its advancement, and that without such evidence this branch of science would be reduced to a mass of personal testimony.

In view of the great scientific value of fossil remains the following remarks are offered concerning the precautions which are necessary in their preservation. It is true that most, if not all, these precautions are observed in a large part of the principal scientific museums of the world, but it is also true that much remissness in this respect has occurred in others. Besides the propriety of referring to the latter fact, these remarks are necessary to complete my statement of the claims of science which constitute the subject of this essay.

Three general classes of specimens of fossil remains should be recognised in museum collections, namely, typical, authenticated, and unauthenticated. Under the head of typical or type specimens are included not only those which have been described and figured in any publication, whether original or otherwise, but those which have in any public manner been so used or referred to. While all such specimens as these should at all times be accessible to any competent investigator, the risk of loss or injury is so great that they should in no case be allowed to be taken from the museum building in which they are installed. Such specimens are in a peculiar sense unique, and there can be no substitution and no equivalent in value. Their loss greatly reduces the value of every publication any part of which is based upon them, and to that extent retards the advancement of science. It is not enough that other, and even better, specimens of presumably the same species may be discovered; the former constitute the original, the latter only suppositious evidence. Besides the risk of loss or injury to type specimens by removal from the place of their instalment, their absence is a disadvantage to science. That is, no one investigator should be allowed their use to the exclusion of any other.

The term "authenticated specimens" is here applied to such as have been studied and annotated by competent investigators and properly installed. Such material constitutes the bulk of every important museum collection, and next to the type specimens already mentioned, they are most valuable. Their increased value is due to the scientific labour that has been bestowed upon them, and it needs only the additional labour of publication to constitute them type specimens and to make them of like value. Authenticated specimens when installed are ready aids to all investigators of such value, that even the temporary removal of any of them from a public museum is, to say the least, of doubtful expediency.

Unauthenticated specimens are, of course, those which have not been studied and installed, and they constitute the great mass of material from which authenticated and type specimens are drawn. Among them are those which constitute the material evidence upon which original observations in biological geology are based. If these are accompanied by the records and descriptive notes which are essential to their value, they constitute proper material for acceptance by museum authorities; but if not, their instalment should be refused, whatever their character may be. That is, to apply a statement made in another connection, no specimen of fossil remains should be admitted to permanent installation in any public museum which is not accompanied by such a record of the locality and stratum from which it was obtained, as will enable any investigator to revisit the same. In every case of instalment such records should be so connected with every specimen as to be readily accessible, and so arranged that the danger of loss or disconnection shall be reduced to a minimum.

The foregoing discussion of the claims of science upon museums is intended to embrace reference only to those which are devoted to the preservation of material pertaining to biological geology, but they are of more or less general applicability. These partial claims alone demonstrate the important relation that museums hold to science and to civilisation as centres of learning and conservatories of the evidence concerning acquired knowledge. Museums should not only be made safe treasure-houses of science, but they should be what their name implies—temples of study—perpetually open to all investigators.

The claims of science upon geological organisations cannot be discussed at length here, but because the ratio of power for the advancement or retardation of science possessed by such organisations is so much greater than that of individuals working independently, it is desirable to make this brief reference to them. That power increases also with the ratio of the extent of the organisation, and it is largely centred in the director. His responsibility, especially if his organisation is a large one, is peculiar, and, to himself, of an unfortunate character. That is, while all, or nearly all, the advancement of science that may be accomplished by the organisation is the work of his subordinates, retardation, if it should occur, is mainly due to his failure to require that each branch of investigation should be prosecuted in accord with all others, and the case would be little less than disastrous should he himself favour *ex parte* methods, or fail to require a symmetrical development of the work in his charge. The claims of science upon geological organisations are therefore really claims upon their directors, and they are more responsible than any other class of persons for the preservation of the integrity of geological science.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

AT a meeting of the Council of University College, Dundee, last week, it was announced that the trustees of the late Miss Margaret Harris had allocated a number of securities, valued at nearly £14,000, to establish a chair of Physics in the College, as recommended by the University Commissioners. The Council resolved to institute immediately a chair of Natural Philosophy; and an appointment will be made before the beginning of next session. Hitherto the classes of Mathematics and Physics have been combined. The salary will be £400 with share of the fees.

THE invaluable *Record* of technical and secondary education continues, in the quarterly number just issued, the review of the work done by the Technical Education Committees of the English County Councils, commenced in the preceding issue. A summary is also given of the work of the Scotch County Councils, from which it appears that, out of a total of thirty-three County Councils, twenty-four are devoting the whole, and seven a part, of their grants to educational purposes, while two counties are applying the whole of the fund to the relief of the rates. Out of a total sum of £25,157 distributed among the County Councils of Scotland, £22,491 was devoted to education in the year 1893–94. Mr. P. J. Hartog contributes to the *Record* an illustrated description of the Owens College, Manchester.

THE Town Trustees of Sheffield have (says the *Athenæum*) voted a sum of £10,000 towards the endowment of Firth College, with a view to enabling the authorities to affiliate it to Victoria University. The actual endowment of the College is £23,000, in addition to its income of £1200 from the State and £800 from the Corporation. It is understood that a total of £50,000 would be sufficient, but no more than sufficient, for the purpose of affiliation. A further sum of £5000 has been conditionally promised by Sir Henry Stephenson, and a public appeal is contemplated for the remaining £12,000.

SCIENTIFIC SERIALS.

The Quarterly Journal of Microscopical Science for March 1895 contains:—On the variation of the tentaculocysts of *Aurelia aurita*, by Edward T. Browne. (Plate 25.) Of 359 Ephyræ collected in 1893, 22·6 per cent. were abnormal in possessing more or less than eight tentaculocysts; and of 1156 collected in 1894, nearly the same percentage, 20·9 was obtained. Of 383 adult Aurelia collected in 1894, 22·8 per cent. were abnormal.—On the structure of *Vermiculus pilosus*, by E. S. Goodrich, gives a detailed account of this interesting Oligochæte, found near Weymouth in 1892. (Plates 26–28.)—On the mouth parts of the Cypris stage of Balanus, by Theo. T. Groom. (Plate 29.) "It may be regarded as tolerably certain that: (1) The antennæ of the Nauplius become definitely lost with the moult resulting in the production of the Cypris stage. (2) The biramous mandibles of the Nauplius become reduced at the same time to the small mandibles, the ramus being probably preserved in the form of the small palp. (3) The first pair of maxillæ arise behind the mandibles, and at a later date, as a small pair of foliaceous appendages. (4) The second pair of maxillæ arise still later, just in front of the first pair of thoracic legs (cirri)."—A study of Coccidia met with in mice, by J. Jackson Clarke. (Plate 30.)—Observations on various Sporozoa, by the same. (Plates 31–33.)—Revision of the genera and species of the

Branchiostomidæ, by J. W. Kirkaldy (Plates 34 and 35), enumerates two genera, Branchiostoma (as sub-genera, Amphioxus, Heteropleuron) and Asymmetron. A new species of Heteropleuron, *H. cingalense*, is described.—On Sedgwick's theory of the embryonic phase of ontogeny as an aid to phylogenitic theory, by E. W. MacBride.

June.—On the anatomy of *Alcyonium digitatum*, by Prof. Sydney J. Hickson (Plates 36-39), gives a brief account of our knowledge of the anatomy of Alcyonium, the general morphology, the English species, their geographical and bathymetrical distribution, then the general anatomy, followed by the minute anatomy of the ectoderm, nematocysts, stomodæum, mesenterial filaments, mesoglœa, spicules, endoderm, ovaries and testes, the buds, concluding with a note on the circulation of the fluids in the colony and on the digestion. In the history of investigations, Pallas' name is not alluded to, and yet he deserves to be quoted as having even before Savgny assigned correct characters to Alcyonium ("Hist. nat. des Coralliaires," Milne-Edwards, tome 1, p. 114), and the "Contribution a l'anatomie des Alcyonaires," by Pouchet and Myevre, dates, if we mistake not, before Vogt and Jung's account in their "Lehrbuch," and while it may be of little use to the student, it is not without interest, as it figures, after a fashion, the nematocysts in *A. digitatum*, and this possibly for the first time (1870). Prof. Hickson, however, leaves all previous writers far behind in his modern treatment of this subject, and if he keeps his promise of publishing an account of the maturation and fertilisation of the ovum and its development, he will leave us under still further obligations, for except Kowalevsky and Marion's important papers on the developmental history of *Clavularia crassa* and *Sympodium coralloides*, we have but little light on Alcyonarian development —Note on the chemical constitution of the mesoglœa of *Alcyonium digitatum*, by W. Langdon Brown. It is chiefly composed of a "hyalogen" prior to the conversion of the hyalogen into hyalin the mesoglœa will yield a mucin; it also contains a small amount of an insoluble albuminoid body, whose nature was not determined; it does not contain gelatine or nucleo-albumen. A study of metamerism, by T. H. Morgan. (Plates 40-43). The author in a long memoir, that does not admit of being briefly abstracted, thinks that the cases he cites show very positively that the variations appearing in a radiate animal must have come simultaneously and all together into the antimeres; he thinks few will doubt that the relation existing between repeated organs in a radiate animal is at bottom the same relation existing between the right and left sides of the body of a bilateral animal. Mivart and Brooks have emphasised the further fact that the relation between the right and left sides of the body is the same relation that exists between the serially repeated parts of a metameric animal; and he concludes that if this line of argument be admitted, it puts the problem of metamerism into a large category of well-established facts.—On the Cœlom, genital ducts, and Nephridia, by Edwin S. Goodrich. (Plates 44-45). The chief object of this paper is to call attention to the theory, "that the cavity which is known as the cœlom in the higher Cœlomata is represented by that of the genital follicles in the lower types of that grade."

American Journal of Science, July.—On the pitch lake of Trinidad, by S. F. Peckham. This pitch lake is situated near the village of La Brea, on the Gulf of Paria. At first sight it appears to be an expanse of still water, frequently interrupted by clumps of trees and shrubs, but on a nearer approach it is found to consist of mineral pitch with frequent crevices filled with water. The consistence of the surface is such as to bear any weight, and it is not slippery nor adhesive. It is about 100 acres in extent. It occupies a bowl-like depression in a truncated cone on the side of a hill covered with tropical jungles. The cone consists of both asphalt and earth. A heavy stream of asphalt has overflowed to the sea, forming a barrier reef for a considerable distance. Asphalt has also overflowed to the south, and the general appearance of the escarpment seems to indicate that at some remote period the basin now occupied by the lake had been filled some three feet higher than the present level. It occupies what appears to be the crater of an old volcano. Some diggings have been pushed to forty feet without reaching the bottom. There is a steady outflow towards the sea through the side of the cone. The Trinidad Bituminous Asphalt Company have lately run a tramway from the pier through the lake and back, so as to facilitate the removal of the material. This tramway in crossing the lake is supported on palm-leaves, some of which are 25 feet long, and this plan has answered every purpose.—On some reptilian remains from the Triassic of Northern California, by John C. Merriam. The author gives a description of some of the few Californian Mesozoic reptiles. One of these resembles *Ichthyosaurus*, while the other is described as *Shastasaurus Pacificus*.—A further contribution to our knowledge of the Laurentian, by Frank D. Adams. This paper is accompanied by a map of a portion of the edge of the Archean protaxis north of the island of Montreal, Quebec. There are in the district considered at least two distinct sets of foliated rocks. One of these represents highly altered and extremely ancient sediments, while the other is of igneous origin.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, May 16.—"On Measurements of Small Strains in the Testing of Materials and Structures." By Prof. J. A. Ewing, F.R.S.

The paper describes a new form of "extensometer," or apparatus for measuring the elastic stretching of bars subjected to pull in the testing machine or otherwise. At the two extremities of the length under test, which is usually eight or ten inches, two cross-pieces are attached to the rod by means of a pair of diametrically opposed set-screws. Each piece is separately free to oscillate about the line joining its screw points, since it touches the rod under test at no other place, but the two pieces are caused to engage with each other in such a way that when the rod extends the end of one of the pieces becomes displaced through a distance which is proportional to the extension. The amount of this displacement is measured by means of a microscope attached to the other piece. The whole apparatus is self-contained, and the parts are arranged to have no unnecessary constraint. Its indications show the mean extension taken over the whole section of the rod, and are independent of any small amount of bending or twisting which the rod may undergo as it is stretched. The microscope is furnished with an eye-piece micrometer which reads the extension to $\frac{1}{50000}$ inch, and a calibrating screw is provided for testing and setting the micrometer scale. Two forms of the instrument are described, one suitable for laboratory use when the specimen under test stands vertically, and the other applicable to rods in any position, such as the members of bridge or roof frames *in situ*. In the laboratory use of the instrument the elastic properties of the material are examined by observing the strains under known loads; in the application to structures the object is to determine experimentally what the stress on any member is, from observation of the strain, the modulus of elasticity being assumed.

The author describes a number of observations made with the new extensometer, chiefly on rods of iron and steel. The following readings refer to successive loadings of a bar of steel, which conforms closely to Hooke's Law, the loads being well within the primitive elastic limit. They serve to illustrate the sensibility of the instrument. The zero of the extensometer was set at 400, and the unit of its scale was $\frac{1}{50000}$ inch. The bar was $1\frac{1}{4}$ inch in diameter, and the length under test was 8 inches.

Load in tons.	Extensometer readings.			Differences.		
	First loading.	Second loading.	Third loading.	First loading.	Second loading.	Third loading.
0	400	400	400			
$2\frac{1}{2}$	461	461	461	61	61	61
5	522	522	522	61	61	61
$7\frac{1}{2}$	583	583	583	61	61	61
10	645	645	645	62	62	62
$12\frac{1}{2}$	707	706	707	62	61	62
15	769	768	768	62	62	61
$17\frac{1}{2}$	830	829	830	61	61	62
20	892	891	891	62	62	61
0	400	400	400	492	491	491

In other experiments the rod under examination was allowed to become overstrained, that is to say the load was increased until the elastic limit was passed and permanent set was produced. In this condition the elastic properties of the rod are materially different from its properties in the primitive state. On reloading the overstrained rod it is found that the proportionality of strain to stress no longer holds good, even under very light loads, and further that there is "creeping," or continued extension with the lapse of time, when any load is kept on for a few minutes. Again, on removing load the bar continues to retract for some time. These features of the overstrained state are most conspicuous in tests made directly after the overstrain has taken place. They tend to disappear if the bar is allowed to rest for some days or weeks. This elastic recovery with the lapse of time, some features of which have been already noted by Bauschinger and others, is less rapid in moderately hard steel than in iron or mild steel, apparently because the condition of overstrain requires a greater load to produce it. Thus a rod of common iron, overstrained so much that the yield-point was reached, was found to have made a practically complete recovery of its elasticity in five days. On the other hand, in a rod of rather hard steel, overstrained by applying a load of 11 tons and subsequently tested with loads of 8 tons only, the recovery was still imperfect after three weeks. The following table shows the progress of the recovery by giving the observed extensions of this rod after three intervals, namely ten minutes, one day, and three weeks, after the overstrain took place.

Load in tons.	Ten minutes after overstrain.		One day after overstrain.		Twenty-one days after overstrain.	
	Extensometer readings.	Differences.	Extensometer readings.	Differences.	Extensometer readings.	Differences.
0	200	—	200	—	200	—
1	287	87	286	86	285	85
2	377	90	373	87	371	86
3	469	92	463	90	458	87
4	565	96	559	96	545	87
5	662	97	658	99	632	87
6	760	98	758	100	720	88
7	866	106	860	102	810	90
8	976	110	963	103	900	90

The molecular settlement which is shown by these experiments to be going on for some time after overstrain has taken place, is known to be associated with a rise in the yield-point. Instances of this were given by the author in a previous paper (*Proc. Roy. Soc.*, No. 205, 1880).

May 30.—"On the Motions of and within Molecules; and on the Significance of the Ratio of the Two Specific Heats in Gases." By Dr. G. Johnstone Stoney, F.R.S.

In treating of molecular physics it is found to be convenient to widen the meaning of the word motion, so that it may be employed in regard to any change or event in which energy is stored, whether as kinetic energy, or as potential, electrical, chemical, or any other. It is in this generalised sense that the term is to be understood throughout this paper.

The aim of the paper is to demonstrate the existence of events going on within the molecules of matter which are so sluggish in affecting its pressure when in the gaseous state, or its temperature as measured by the thermometer, that it is only after millions of encounters that any manifestation of their having thus lost energy by conduction becomes appreciable; while these same events are prompt and active agents in other operations of nature through chemical reactions or by radiation.

Molecular events may be distinguished into A or external events, and B or internal. The external events are the movements of the centres of inertia of the molecules relatively to one another. They present themselves most conspicuously in those comparatively protracted journeys which the molecules of gases make between their much briefer encounters. By B motions are to be understood all events in which energy can be stored that go on within individual molecules, including rotation of the molecule (if there be any movement of this kind, which, however, is not probable) along with every other relative motion of the parts of the molecule: movements within its ponderable matter, or of its electrons, changes in the configuration of its parts, and every other event within the molecule which can absorb and yield energy. The electrons are those remarkable charges of electricity, all of the same amount, which are associated in every chemical atom with each capacity that it possesses of entering into combination with other atoms.

It is convenient to distinguish the B or internal events, into Ba events between which and the A or translational motions of the molecules there is ready interchange of energy whenever encounters take place; Bc events which are so isolated that no such interchange takes place; and Bb events which lie between these extremes. In the struggle which takes place during an encounter, or in any one of the much longer intervals between two encounters, a Bb event will part with but very little of any excess of energy it may possess by conduction, *i.e.* by transferring energy over to A or Ba events. Nevertheless it may sustain an appreciable loss of energy in this way when the molecule has been buffeted in a sufficient number of encounters. This may easily occur in a time which seems short to us, since, if the gas be at atmospheric temperature and pressure, each molecule meets with some thousands of millions of encounters every second. Meanwhile, during this process, which is slow from the molecular standpoint, the Bb events, if they have electrons associated with them, may be engaged in a prompt and active exchange of energy with the æther by radiation.

In substances that are appreciably phosphorescent, it is easy to detect the presence of these Bb events; and, accordingly, a proof that they exist in this class of bodies is given in the paper. Moreover, by comparing the behaviour of different phosphorescent bodies, we learn that the degree of isolation in which Bb motions stand varies much from substance to substance. Motions of this type, which are so conspicuous in the bodies that can be perceived to be phosphorescent, are, of course, not confined to that class of bodies. In fact, they appear to be an important part of what is going on in every molecule of matter that can emit a spectrum, a description which probably embraces every molecule.

Since Bb motions are in various degrees isolated from the other events that are simultaneously going on in the molecules, it follows that in some gases the specific heat as determined by experiment will not be a definite quantity, but will partly depend on the duration of the experiment by which it is determined—*i.e.* upon whether or not there has been time for an interchange of energy between the Bb motions and the A and Ba events. This is likely in some gases to make an appreciable difference between determinations of γ—the ratio of the two specific heats—deduced from the observed velocity of sound in the gas (where the real experiment lasts only during one semi-vibration of the musical note employed), and determinations made by other experiments which require seconds, perhaps minutes, to carry them through.

There is reason to believe that it is with these Bb motions that the electrons within chemical atoms are chiefly associated, and that in most cases it is they which are concerned in luminous effects, whether in flames or when the gas is under the influence of electricity. Accordingly in both cases the luminous effects may have their origin in events that are in a considerable degree isolated from those that directly affect the thermometer; and wherever this is the case, the luminous effects will be in excess of what belongs to the temperature of the gas as determined by its power of communicating heat by conduction to bodies upon which its molecules impinge. This seems to have been proved by Prof. Lewes of flames (*Proceedings* of the Royal Society, vol. lvii. p. 404 and p. 467), and many phenomena indicate that it is also true of all gases which exhibit spectra of bright lines when in that state which has been miscalled incandescent.

It is specially to be noted that the interpretation usually put upon the value of γ in a gas has to be profoundly modified in consequence of the presence of Bb motions within the molecules, and of the degree in which the corresponding Bb motions of swarms of molecules are more or less linked together by the interaction that goes on between their associated electrons and the æther. (See Fitzgerald, in the *Proceedings* of the Royal Society, vol. lvii. p. 312.)

These examples may serve to show how a knowledge of the presence and activity of Bb motions supplies a clue to interpreting some of the phenomena of nature; and the extent of its applications may be judged by reflecting that it is electrons for the most part associated with Bb motions which appear to be primarily concerned in every chemical reaction and in all phenomena of radiation.

"On the Velocities of the Ions." By W. C. Dampier Whetham. A continuation of a former paper (*Phil. Trans.* 184, 1893 A, p. 337). The velocities of certain ions during electrolysis are observed by tracing the formation of the precipitates which they give with a trace of a suitable indicator. Thus solid agar jelly solutions of barium chloride and of sodium chloride containing a little sodium sulphate were set up in contact, and a current passed across the junction. The barium ions form a little insoluble barium sulphate as they travel, and so their velocity can be measured. The specific ionic velocity under a potential gradient of one volt per centimetre can then be calculated, the area of cross section of the tube, in which the solutions are placed, the mean specific resistance of the solutions, and the strength of current being known. The following table gives a comparison between the results thus obtained and the numbers theoretically deduced by Kohlrausch from the migration constants and the conductivities of the corresponding aqueous solutions :—

	Calculated velocity in c.m. per sec.	Observed velocity in c.m. per sec.
Barium	0·00037	0·00039
Calcium	0·00029	0·00035
Silver	0·00046	0·00049
Sulphate group (SO_4)	0·00049	0·00045

June 20.—"On the Occlusion of Oxygen and Hydrogen by Platinum Black." Part I. By Dr. Ludwig Mond, F.R.S., Prof. W. Ramsay, F.R.S., and Dr. John Shields.

The authors describe some preliminary experiments on the occlusion of oxygen and hydrogen by platinum sponge and foil, which in general confirm the results obtained by Graham. At most only a few volumes of these gases are occluded by the more coherent forms of platinum.

After giving details of what they consider the best method of preparation of platinum black, they next describe some experiments which had for their object the determination of the total quantity of water retained by platinum black, dried at 100° C., and the amount of water which can be removed from platinum black at various temperatures in vacuo. As the result of these experiments they find that platinum black dried at 100° retains in general 0·5 per cent. of water, and this can only be removed in vacuo at a temperature (about 400°), at which the black no longer exists as such, but is converted at least partially into sponge. At any given temperature the water retained by platinum black seems to be constant. The density of platinum black dried at 100° C. is 19·4, or allowing for the water retained by it at this temperature, 21·5.

The amount of oxygen given off by platinum black at various temperatures was determined. Altogether it contains about 100 volumes of oxygen ; the oxygen begins to come off in quantity at about 300° C. in vacuo, and the bulk of it can be extracted at 400° C., but a red heat is necessary for its complete removal. Small quantities of carbon dioxide were also extracted, chiefly between 100–200° C.

In determining the quantity of hydrogen occluded by platinum black the authors have carefully distinguished between the hydrogen which goes to form water with the oxygen always contained in platinum black, and that which is really absorbed by the platinum *per se*. Altogether about 310 volumes of hydrogen are absorbed per unit volume of platinum black, but of this 200 volumes are converted into water, or only 110 volumes are really occluded by the platinum. Part of it can be again removed at the ordinary temperature in vacuo ; by far the larger portion can be extracted at about 250–300° C., but a red heat is necessary for its complete removal. The amount of hydrogen absorbed by platinum is very largely influenced by slight traces of impurity, probably grease or other matter which forms a skin over the platinum.

Platinum black in vacuo absorbs a certain quantity of hydrogen. On increasing the pressure of the hydrogen up to about 200–300 mm. a further quantity is absorbed, but after this pressure is almost without effect. By increasing the pressure from one atmosphere up to four and a half atmospheres, only one additional volume of hydrogen was absorbed. On placing platinum black charged with oxygen in an atmosphere of oxygen, and increasing the pressure to the same extent, eight and a half additional volumes were however absorbed.

Platinum black charged with hydrogen and placed in an atmosphere of hydrogen kept approximately at atmospheric pressure, and platinum black charged with oxygen and confined in an atmosphere of oxygen, behave quite differently when heated. In the former case hydrogen is immediately expelled on raising the temperature, whilst in the latter case oxygen is steadily absorbed until a temperature of about 360° C. (the temperature of maximum absorption) is reached, when on further heating oxygen begins to come off again.

Incidentally it was noticed that mercury begins to combine with oxygen at 237° C., and that a mixture of platinum black and phosphorus pentoxide absorbs oxygen at a high temperature, probably with the formation of a phosphate or pyrophosphate.

In the discussion of the results special reference is made to the work of Berliner and Berthelot, and it is pointed out that there is not sufficient evidence for the existence of such chemical compounds as $Pt_{30}H_3$ and $Pt_{30}H_2$. Moreover, the authors are of opinion that the heats of combination of hydrogen and platinum as determined by Berthelot and Favre are valueless, and that the heat which they measured is due for the most part if not entirely to the formation of water by the oxygen always contained in platinum black. It has yet to be *proved* that the absorption of hydrogen by pure platinum black is attended by the evolution of heat, and as regards the formation of supposed true chemical compounds, solid solutions, or alloys, the authors prefer to wait until sufficient data have been accumulated for an adequate inquiry before coming to any definite conclusion.

Royal Microscopical Society, May 15.—E. M. Nelson, Vice-President, in the chair.—Messrs. Watson and Sons exhibited a simple centring underfitting for use with any ordinary student's microscope.—The Chairman exhibited a new low-lower lens by Zeiss, and a new photographic lens.—Mr. W. C. Bosanquet read a paper on the anatomy of *Nyctotherus ovalis*.—Mr. G. C. Karop read a paper, by Dr. A. Bruce, describing a new microtome for cutting sections.—The Chairman announced that the library would be closed from August 12 to September 9, and that the next meeting would be on October 16.

Mineralogical Society, June 18.—Lewisite and Zirkelite, two new Brazilian minerals, by Dr. E. Hussak, of the Geological Survey of São Paulo, and Mr. G. T. Prior. Lewisite is a new titano-antimonate of calcium and iron, which was found with xenotime, monazite, cinnabar and other minerals in the heavy sand obtained by washing the gravel from a hill slope at the cinnabar mine of Tripuhy, Minas Geraes, Brazil. It is cubic, occurs in small brown translucent octahedra, and has the composition $5RO.3Sb_2O_5.2TiO_2$. Zirkelite is a new titano-zirconate of calcium and iron found in association with the new zirconia mineral baddeleyite in the magnetite-pyroxenite from Jacupiranga, São Paulo, Brazil. It is cubic, occurs in black octahedra, and contains about 80 per cent. of ZrO_2 and TiO_2. The authors describe the physical and chemical characters of the two minerals, and also give an account of the minerals associated with the Lewisite at Tripuhy ; amongst these occurs sparingly a new titano-antimonate of iron, the description of which will be completed when more material is obtained.

PARIS.

Academy of Sciences, July 8.—M. Marey in the chair.—On the physical characteristics of the moon and the interpretation of certain surface details revealed by photographs, by MM. Lœwy and P. Puiseux. A general discussion of surface characters of the moon and their origin, and comparison with certain terrestrial features of possibly similar origin.—On the manner in which any confused but periodic wave-agitation becomes regular in the distance, reducing to a simple wave, by M. J. Boussinesq.—Action of zinc chloride on resorcinol, by M. E. Grimaux.—Comparison of the work done by muscles in the case of positive work with that developed in the corresponding case of negative work, by M. A. Chauveau.—Law of the distribution of mean magnetism at the surface of the globe, by General Alexis de Tillo.—Volumes of salts in their aqueous solutions, by M. Lecoq de Boisbaudran. The author considers all soluble substances to belong to a continuous series of which the members at the one end may show dilatation on solution, whereas the members at the other end may exhibit contraction under similar circumstances. He illustrates his theory by examples demonstrating that the former at low temperatures give contraction also on solution, whereas the bodies usually showing contraction on solution exhibit dilatation on solution in sufficiently concentrated solutions.—On diphenylanthrone, by MM. A. Haller and A. Guyot. The researches detailed prove that the substance $C_{26}H_{18}O$ is diphenylanthrone, $C_6H_4 \langle {}^{C(Ph)_2}_{CO} \rangle C_6H_4$. From this established constitution, the phthalyl tetrachloride melting at 88° C. must have the dissymmetrical formula, $C_6H_4 \langle {}^{CCl_3}_{COCl}$.—A new lymphatic gland in the European scorpion, by M. A. Kowalewsky. The gland described has already been made known by J. Müller, who, in 1828, termed it a salivary gland.—On the laws of friction in sliding, by M. Paul Painlevé. The conclusion is deduced, from the singularities developed in the paper, that the empirical laws of friction are logically inadmissible (even for ordinary pressures and velocities) so soon as the friction becomes at all noticeable.—On the mirage effects and differences of density observed in Natterer's tubes, by M. P. Villard.—On explosive statical and dynamical potentials, by M. R. Swyngedauw.—On direct spectroscopical analysis of minerals and of some fused salts, by M. A. de Gramont.—Determinations of the solubility, at very low temperatures, of some organic compounds in carbon disulphide, by M. Arctowski. Étard found the solubility of substances to be represented for other solvents than water by curves practically of hyperbolic form of which the branches respectively directed themselves towards the points of fusion of the solvent and of the dissolved substance; he even admitted that the solubility would be zero at the point of congelation of the solvent, and infinite at the point of fusion or ebullition of the dissolved substance. The author finds, with carbon disulphide, that the point of fusion of the solvent appears not to be an essential point on the curve of solubilities; and it is otherwise known that the property of dissolving is not an exclusive property of the liquid state of matter.—On some oxidising properties of ozonised oxygen and of oxygen in sunlight, by M. A. Besson.—Action of nitric oxide on some metallic chlorides: ferrous, bismuth, and aluminium chlorides, by M. V. Thomas. A fine red ferrous compound has been obtained of the formula $5Fe_2Cl_4.NO$. By decomposition of this, or by suitably heating anhydrous Fe_2Cl_4 in a current of nitric oxide, yellowish brown $Fe_2Cl_4.NO$ is obtained. A fine yellow bismuth compound and a pale yellow aluminium compound have also been obtained. They are very hygroscopic substances, and have the composition $BiCl_3.NO$ and $Al_2Cl_6.NO$ respectively.—Action of halogens on methyl alcohol, by M. A. Brochet.—On a physical theory of the perception of colours, by M. Georges Darzens.—On the presence and the *rôle* of starch in the embryonic sac of Cacti and Mesembryanthema, by M. E. d'Hubert. The observations favour the view that starch serves to preserve the embryonic sac in these plants in that state which characterises the ripe and readily fertilised sac.—On the tectonic characters of the north-west part of the Alpes-Maritimes department, by M. Leon Bertrand.—An inferior maxillary human bone found in a grotto in the Pyrenees, by MM. Louis Roule and Felix Regnault. From the characters of the bone described and other similar remains it is concluded that: In the time of the great Cave-bears, France was inhabited by a human race of normal height with a flat and powerful lower jaw.

New South Wales.

Linnean Society, May 29.—Mr. P. N. Trebeck in the chair.—Oological notes (continued), by A. J. North.—Note on the correct habitat of *Patella* (*Scutellastra*) *kermadecensis*, Pilsbry, by T. F. Cheeseman.—On two new genera and species of fishes from Australia, by J. Douglas Ogilby.—Descriptions of new species of Australian Coleoptera, Part II., by Arthur M. Lea. This paper comprises descriptions of over one hundred species, for the most part referable to the families *Malacodermidæ*, *Mordellidæ*, *Anthicidæ*, and *Corylophidæ*.—Life-histories of Australian Coleoptera, Part III., by W. W. Froggatt.—Description of a giant *Acacia* from the Brunswick River, New South Wales, by J. H. Maiden. This Acacia was collected by Mr. W. Bäuerlen on Tergoggin Mountain and on Mullumbimby Creek, Brunswick River, N.S.W. As far as known, it is confined to brushes, as distinguished from open forest. It attains a height of 120 feet and a diameter of 5 feet; it is therefore one of the largest of the genus. Its closest affinity is with *A. binervata*, from which it differs in the structure of the flowers, seeds, and pod, and in other less important particulars. The inflorescence is in loose, elongated panicles or racemes, with peduncles in clusters. The flowers are few—never more than twenty—with villous petals and sepals, which are spathulate and tetramerous. The pod is nearly six lines broad, thin and straight. The author proposes the name of *Acacia Bakeri* for the species, in honour of his colleague, Mr. R. T. Baker.

BOOKS, PAMPHLETS, and SERIALS RECEIVED.

Books.—Open-Air Studies: Prof. G. A. Cole (Griffin).—A Garden of Pleasure (E. Stock).—Dr. Schlich's Manual of Forestry, Vol. 4 (Bradbury).—The Alps from End to End: Sir W. M. Conway (Constable).—Nature *versus* Natural Selection: C. C. Coe (Sonnenschein).—Microbes and Disease Demons: C. Berdoe (Sonnenschein).—The Climates of the Geological Past: E. Dubois (Sonnenschein).—Physikalisch-Chemische Propaedentik Erste Halfte: Prof. H. Griesbach (Leipzig, Engelmann).—Die Physiologie der Geruchs: Dr. A. Zwaardemaker (Engelmann).—Experimental Plant Physiology: D. T. Macdougal (Holt and Co., New York).

Pamphlets.—Static and Dynamic Sociology: L. F. Ward (Boston, Ginn and Co.).—On Kaloxylon Hookeri and Lyginodendron Oldhamium: T. Hick.—On the Structure of the Leaves of Calamites (Manchester).—Report of the Trustees of the South African Museum for 1894 (Cape Town).—Returns of Agricultural Statistics of British India, &c., 1893-4 (Calcutta).—Studies on the Dissemination and Leaf Reflexion of Yucca Aloifolia: H. J. Webber (Missouri Botanic Garden).—On the Osteology of Agriochœus: J. L. Wortman (New York).—Fossil Mammals of the Uinta Basin Expedition of 1894: H. F. Osborn (New York).

Serials.—Journal of the Royal Statistical Society, June (Stanford).—Record of Technical and Secondary Education, July (Macmillan and Co.).—American Journal of Science, July (New Haven).—Psychological Review, July (Macmillan and Co.).—Engineering Magazine, July (Tucker).—Medical Magazine, July.—Natural History of Plants, Part 14 (Blackie).—Tokyo Sugaku—Butsurigakaukwai Kizi Maki, No. vi. Dai 1 and 2 (Syuppan).—Journal of the Franklin Institute, July (Philadelphia).—Bulletin of the American Mathematical Society, June (Macmillan and Co., New York).—Bulletin of the Johns Hopkins Hospital (Baltimore).

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